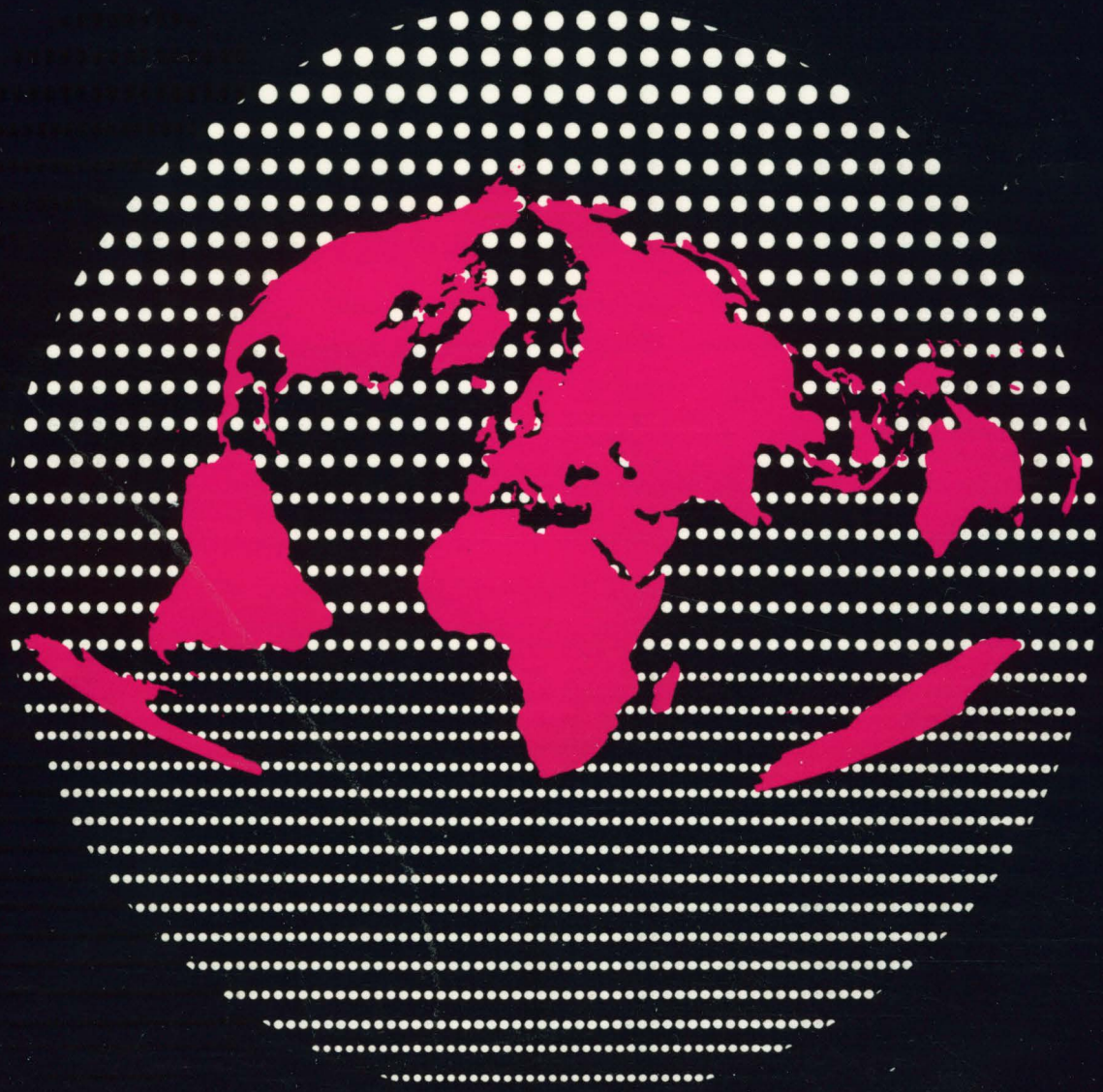
Consequences of Mortality Trends and Differentials

United Nations



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United Nations
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NOTE

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PREFACE

During the past five years, the Population Division of the Department of International Economic and Social Affairs of the United Nations Secretariat has carried on a vigorous programme of research in the areas of mortality and health encompassing the full spectrum of mortality studies: methodological innovations, monitoring of mortality change, demographic-epidemiological studies of factors affecting mortality and health, and differentials in mortality among population groups. Recent publications are *Levels and Trends of Mortality since 1950* (1982),[1] *Model Life Tables for Developing Countries* (1982),[2] *Stable Populations Corresponding to the New United Nations Model Life Tables for Developing Countries* (1982),[3] *Unabridged Model Life Tables Corresponding to the New United Nations Model Life Tables for Developing Countries* (1982),[4] *Proceedings of the Meeting on Socio-economic Determinants and Consequences of Mortality, Mexico City, 19-25 June 1979* (1981), *Data Bases for Mortality Measurement* (1983),[5] *Mortality and Health Policy* (1984),[6] and *Determinants of Mortality Change and Differentials in Developing Countries: The Five Country Case Study Project* (1985).[7]

From 1980 to 1984, the Population Division collaborated with the Division of Health Statistics of the World Health Organization on a programme of mortality studies in developing countries. This collaboration constituted a continuation of earlier co-ordination of work between the two agencies. The project has already resulted in the publication of two of the studies mentioned above: *Data Bases for Mortality Measurement* and the *Five Country Case Study Project*. A third publication prepared under the project has been issued by the World Health Organization, and published by the Australian National University Press, namely, *Sex Differentials in Mortality: Trends, Determinants and Consequences* (1983).

The present volume, *Consequences of Mortality Trends and Differentials*, is the latest result of the collaboration between the United Nations and the World Health Organization. It consists of 17 articles covering a wide range of thought on responses to high mortality and changing mortality, in the biological, cultural, social and economic spheres of the developing and developed worlds.

The articles make clear how mortality change can disrupt the long-held and traditionally established relationships of an individual within the household, and of households within the social and economic milieu in which they operate. Mortality change therefore plays an integral role in—and perhaps even initiates—what is often called modernization. Although longer and healthier life is desired by almost everyone, particular aspects of modernization may be defined in a particular person's "value-scheme" as neutral, negative or positive. But no matter how defined, mortality change often leads to the necessity of adjustments in the way of life of individuals and households and in their demand for services and resources from their governments and community leaders. Ultimately it is the commitment and ability of governments and community leaders to respond to mortality change, within the framework of popular participation in decision-making, that determines whether such change has positive, negative or neutral implications.

The articles in this publication do not, of course, provide definitive answers to questions about the effects of mortality levels, changes and differentials, and the ways governments and communities may need to respond to them, but they do raise important issues for thought and action by leaders, planners and researchers within communities, countries and international and non-governmental organizations.

Publication of this volume is made possible through the United Nations/World Health Organization Programme of Mortality Studies, largely financed by the United Nations Fund for Population Activities (INT/80/PO9). The United Nations Population Division and the World Health Organization are grateful to the Fund for its continuing support. Acknowledgement is also due to Terence H. Hull and Gavin W. Jones of the Australian National University, who with the United Nations prepared this volume.

NOTES

[1] United Nations publication, Sales No. E.81.XIII.3 and Corr.
[2] United Nations publication, Sales No. E.81.XIII.7.
[3] ST/ESA/SER.R/44.
[4] ST/ESA/SER.R/47.
[5] United Nations publication, Sales No. E.83.XIII.3.
[6] United Nations publication, Sales No. E.84.XIII.4.
[7] ST/ESA/SER.A/94 (to be issued as a United Nations sales publication).

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Explanatory notes

The term "country" as used in the text and tables of this publication also refers, as appropriate, to territories or areas.

The designations "developed" and "developing" economies are intended for statistical convenience and do not necessarily express a judgement about the stage reached by a particular country or area in the development process.

Symbols of United Nations documents are composed of capital letters combined with figures. Mention of such a symbol indicates a reference to a United Nations document.

The following symbols have been used in the tables throughout this publication:

Two dots (..) indicate that data are not available or are not separately reported.
A dash (—) indicates that the amount is nil or negligible.
A hyphen (-) indicates that the item is not applicable.
A point (.) is used in English to indicate decimals.
A slash (/) indicates a crop year or financial year, e.g., 1980/81.

Use of a hyphen (-) between dates representing years, e.g., 1981-1983, signifies the full period involved, including the beginning and end years.

Details and percentages in tables do not necessarily add to totals, because of rounding.

Reference to "dollars" ($) indicates United States dollars, unless otherwise stated.

INTRODUCTION: INTERNATIONAL MORTALITY TRENDS AND DIFFERENTIALS

Terence H. Hull and Gavin W. Jones***

A. Trends in mortality levels

In the course of the twentieth century, remarkable advances have been made in controlling premature death. In the early decades, the major advances were in the developed countries. In Western Europe and North America, declines in mortality originating in the mid-nineteenth century accelerated steadily until the mid-1950s, an acceleration broken only by a slowing of the gains during the 1930s. Eastern and southern Europe experienced particularly rapid gains in life expectancy in the 1920s and 1950s.[1] In the 1960s and 1970s the gain in life expectancy in these Western countries slowed down considerably.[2] In the developing countries the main upsurge in life expectancy came later. Life expectancy at birth during the period 1935-1939 was still only 30 years in Africa and Asia and 40 years in Latin America. By 1965-1970 the respective levels were about 43, 50 and 60 years. The quarter century following the end of the Second World War witnessed a decline in mortality levels unprecedented in speed and geographic extent.

The fall in mortality in less developed countries has continued but many observers claim that the mortality decline is slowing.[3] A recent United Nations study, based on only a limited number of countries that were able to supply the relevant data, draws the tentative conclusion "that mortality declines in developing countries have decelerated during the period from the 1960s to the 1970s but that this deceleration is largely confined to Latin American countries".[4] Since these countries have in general achieved the highest life expectancies within the developing regions, deceleration in their mortality decline could be more or less natural as they approach the biological limits of life expectancy. However, deceleration in mortality decline is also observed for countries that begin the period at lower levels of life expectancy. The United Nations study concludes that "approximately one third of the slowdown is attributable to the emergence of selected countries into the low mortality-slow advance zone, but the remaining two thirds is attributable to a reduced pace of improvement at higher mortality levels where the large majority of developing countries have been located throughout the post-war period".[5]

There is a degree of consensus, then, that although there are few instances of an actual reversal of the gradual decline in mortality levels,[6] the tendency for deceleration in mortality decline to occur in many countries at still relatively high mortality levels raises serious doubts about earlier expectations[7] of inevitable steady attainment of high levels of life expectancy.[8]

Why was mortality decline so rapid, and why is it now decelerating?[9] Large-scale programmes for the control of infectious diseases, notably malaria, smallpox, yellow fever, cholera, tuberculosis and measles, were in the vanguard of health programmes from the late 1940s onwards. Recently developed insecticides, vaccines and antibiotics were distributed to control the transmission of these diseases, to immunize populations and to reduce case fatality levels. However, even in countries where such programmes were a marked success, the increased availability of food supplies and other socio-economic changes were also playing a role, although there is much controversy about the relative contribution of various factors.

The sharpest debate has raged around the question of the ultimate levels of life expectancy attainable through such "programmed disease control" interventions dissociated from broader social and economic change,[10] and the argument is often made that the present deceleration in mortality decline reflects an overemphasis on technological interventions, which are now running up against the constraints of inadequate diet, lack of sanitation, poor housing conditions, ignorance of personal hygiene, and lack of potable water—in short, the environment in which the major killers, such as diarrhoeal disease and diseases of the respiratory system, flourish.

The debate on these issues has widened to include the systems of health care followed in developing countries, and appropriate disposition of available health manpower and budgets to deal most effectively with these major causes of death. The Alma Ata Declaration of 1978, endorsed by the United Nations General Assembly, recommended a wide range of measures as part of a primary health care package. The key issue here is the cost-effectiveness of Western hospital-based systems, which emphasize curative services in the developing country context, though increasingly the appropriateness of these systems in the Western setting is being questioned as well.

What of mortality trends in recent decades in the developed countries? Important gains were made between 1950 and the mid-1970s. The tendency was a narrowing of the mortality differences between these countries, since countries with the lowest values for life expectancy around 1950 tended to have the greatest increases, and countries with the highest life expectancies the smallest increases. Sex differences in life expectancy widened because the average increase over the period was about 6 years for males and 8 years for females.[11] Among 37 countries with relevant data, the following gains in life expectancy between 1950 and the mid-1970s were recorded:[12]

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Increase in life expectancy at birth	*Number of countries*	
	Males	*Females*
Less than 3 years	8	—
3-4 years	10	7
5-6 years	9	12
7-9 years	4	9
10 years and over	6	9
TOTAL	37	37

Broadly speaking then, the twentieth century has seen the transition of mortality to low levels in developed countries to the point where an extension of average expectation of life to ages 70-80 is quite common. At the same time, most developing countries have achieved relatively rapid reductions in mortality, but there has been some tendency for the rate of decline to slacken, although perhaps temporarily, as the level of life expectancy reaches 50-60 years.[9] Further major gains in average years of life will almost certainly depend on socio-economic improvements as well as on the conventional medical interventions.

Age patterns of mortality

Age patterns of mortality in developing countries are U-shaped, reflecting relatively high mortality in the early childhood ages. Because of the paucity of detailed data on age-specific mortality in such countries, it is convenient to consider the issue of changing age patterns through reference to model mortality tables such as those prepared recently by the United Nations Secretariat. We have chosen the "South Asian" set to illustrate the case (see figure 1).

At birth an infant (female) in a country with the "South Asian" pattern of mortality and a low level of life expectancy ($e_0 = 40$) faces an 82% probability of survival to age 1 and only a 68% chance of reaching age 5. Following this initial hurdle, the mortality risk faced by surviving children is greatly moderated so that the chance of dying between age 10 and age 15 is only 2%. As mortality falls overall, and life expectancy rises from about 40 years on average to 50 or 60 years, the greatest improvement is registered in rapidly falling risks of death among the group under 5 years of age, and particularly among infants under age 1. By the time the expectation of life at birth has reached the 60s, a situation found today in such developing countries as the Philippines, Thailand and Burma, the level of infant mortality falls to around 90 per 1,000 live births.

Age patterns of mortality for low-mortality countries are more J-shaped when plotted on a logarithmic scale (see figure 2). Death rates fall rapidly during the early years of life, reaching a low point between the ages of 10 and 12 years, but then there is a steep rise in the curve at ages 15-19 (steeper for males than for females), followed by a flattening and then a gradual increase. Death rates similar to those of infancy are reached again by about 55-59 years of age among males, but not until 60-64 or even later among females. Thus even at low levels of overall mortality there are quite significant differences in mortality according to age, with the very young and the old at highest risk.

There is evidence that, by comparison with European countries when they were at the same levels of overall mortality, infant and early childhood mortality is substantially higher in Latin America and in the Indian sub-continent.[12] The United Nations has hypothesized that this difference is due to "a disequilibrium between improvements in socio-economic conditions and health interventions", with the latter more readily able to affect the mortality of adults in the absence of significant improvements in nutrition and sanitation.[13] The gains in lowering mortality rates in developing countries have not been uniform across age groups. When measured by the absolute decline in age-specific death rates, they have tended to be largest at ages under 5 (especially infancy) and above 40, although the proportionate declines have been largest in the childhood ages, after infancy.

Changing patterns of causation

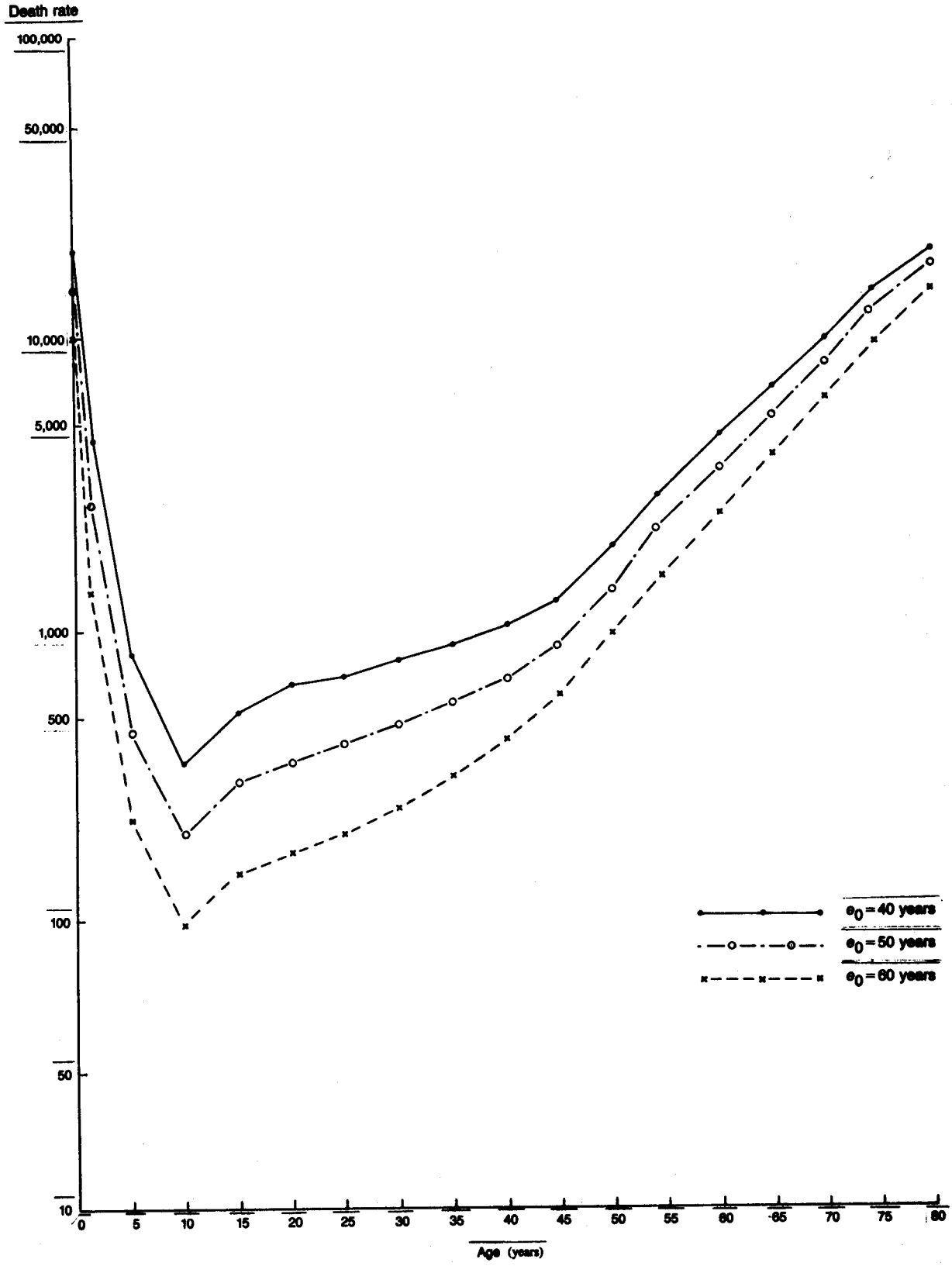
Data on cause of death in the developing countries are still very limited and those countries which produce usable data are generally unrepresentative of the poorer countries. What is clear is that there are major differences between developed and developing countries in the major causes of death. These differences are also marked when contemporary developing countries are compared with the historical experience of high mortality in developed countries.[14] The incidence of different causes of death in individual countries is shifting steadily, and there are very wide differences between developing countries in patterns of causes of death. What is less clear, because of lack of data, is time trends in changes in causes of death, in developing countries as a whole or in particular countries. Changes in these countries do not appear to be as marked as might have been expected on the basis of the massive campaign to control or eliminate various infectious diseases. Ruzicka and Hansluwka observe that "the list of the major health problems that the WHO *World Health Reports* compiled from reports of national governments reads in the late 1970s almost exactly as did the list submitted in the mid-1950s".[15] Health problems and cause of death are, however, not the same thing.

A recent United Nations study[16] of 23 developed countries over the period 1955-1974 found that, aside from the well-known fact that different causes of death assume quite different importance at different parts of the age range and between the sexes, there has been a shift over time in the proportions of death from particular causes. The major increases were for cardio-vascular diseases and malignant neoplasms (cancer), whereas infectious diseases declined markedly. The increases in cardio-vascular diseases and cancer were due not only to their increased incidence at different ages, but also to a shift in the age structure of the population towards the older ages where these diseases are more common. At the same time, an increase in the importance of accidents as a cause of death in the under-35 age groups was dampened, in the overall figures, by a fall in the proportion of these age groups in the total population.

In developing countries, infectious and parasitic diseases, particularly the diarrhoeal diseases, are very prominent as causes of death. (They cause only 1 per cent of deaths in developed countries.) Their percentage of all deaths in Latin American countries ranges from 3 to 7 per cent in the group of countries with relatively low mortality (Argentina, Costa Rica and others) to about 27 and 30 per cent in Ecuador and Guatemala, respectively, and no doubt even higher in high mortality countries with no data.[17] Relatively few deaths are attributed to nutritional deficiencies, though these are

Figure 1. Patterns of median age-specific female death rates (M_x) for countries at high levels of mortality, exemplified by United Nations "South Asian" model life tables

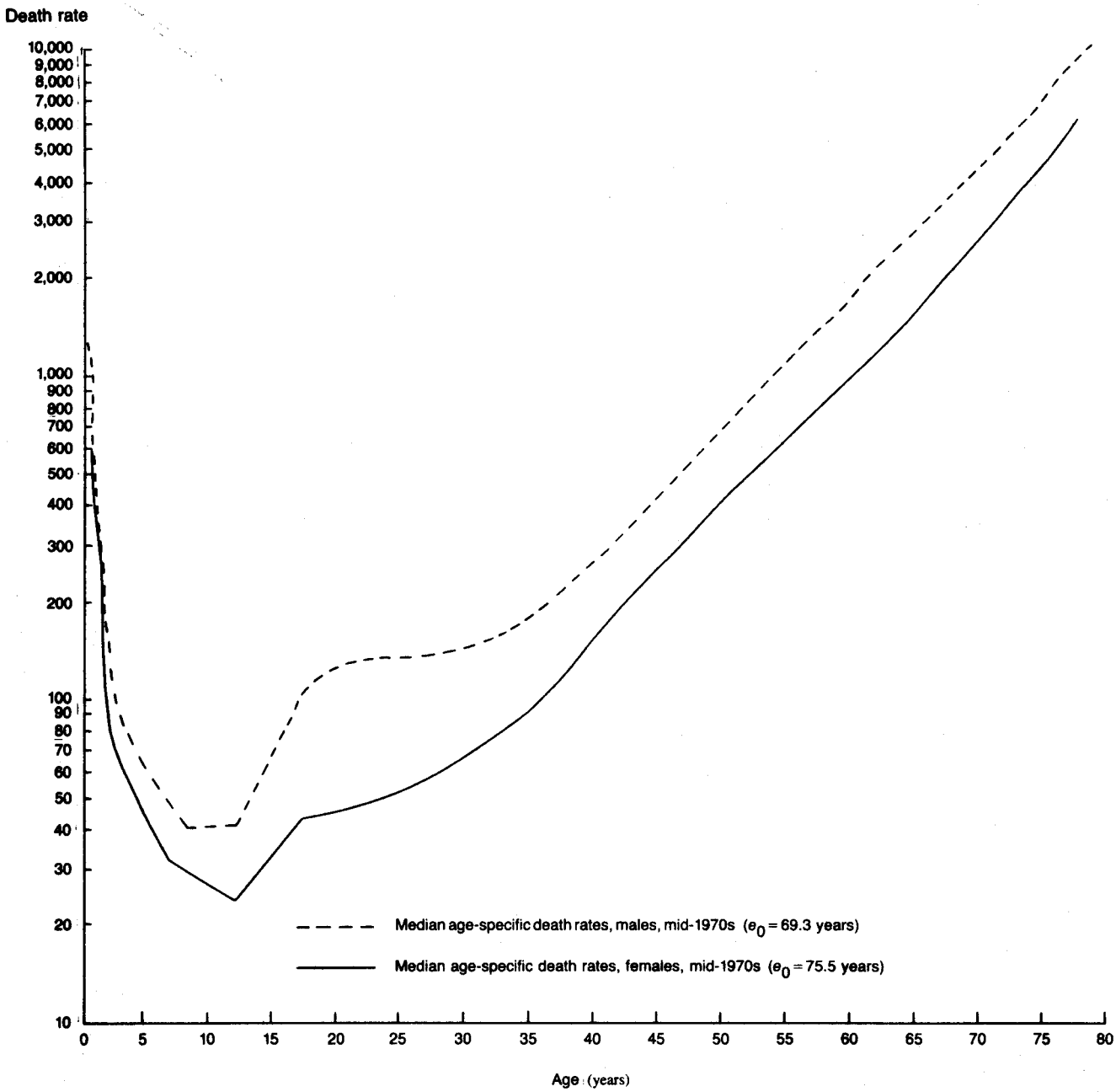
(Deaths per 100,000 population)



Source: United Nations, Department of International Economic and Social Affairs, *Model Life Tables for Developing Countries*, Population Studies No. 77 (United Nations publication, Sales No. E.81.XIII.7), pp. 141, 146 and 151.

Figure 2. Age patterns of death rates for countries at low levels of mortality

(Deaths per 100,000 population)



Source: Based on *Levels and Trends of Mortality since 1950* (United Nations publication, Sales No. E.81.XIII.3 and Corr.1), figures 113 and 114.

known to combine synergistically with infectious diseases in causing death.[18]

In an attempt to overcome the complete lack of reliable data on cause of death in Indonesia, indirect estimates[19] have been produced using regression equations developed by Preston.[20] While meant primarily as an exercise to inform policy-makers about the likely priorities for health care expenditure implied by reasonable assumptions concerning age patterns and cause structures of death in Indonesia, the results also serve to underscore the fact that most deaths in developing countries are preventable through the application of technologically simple interventions. The real problems are not in finding a "cure" but in attaining an organizational and economic environment in which existing technology can be applied.

Another important area of investigation concerns the relationship between levels of economic development,

levels of mortality and patterns of cause of death. Have these relationships been changing, and if so, what does it imply about the potential impact of various kinds of health invervention programmes at different stages of economic development and in particular social settings? Pioneering work in this area has been done by Preston,[21] who shows that the national life expectancy related to given levels of real per capita income shifted to much higher levels between the 1930s and the 1950s.[22] Regressing life expectancy on income, calorie consumption and literacy for all countries with available data, Preston concludes that about half of the total gain in life expectancy between 1940 and 1970-1975 was attributable to these factors, and about half (just under 9 years in expectation of life) to factors exogenous to national levels of income, literacy and calorie consumption.[23] For more recent periods it may be argued that a smaller share of rising expectation of life can be divorced from structural socio-economic change, as is implied by the discussion of deceleration of mortality decline, mentioned above.

Mortality/morbidity relationships as mortality declines

Consideration of the cause of death patterns leads logically to consideration of changing mortality/morbidity relationships as certain causes of death are brought under more effective control. In a paper focused on developed countries, Gruenberg[24] has argued that medical research work, in producing tools which lower the mortality rates from diseases that had been fatal to persons suffering from chronic conditions, has facilitated the prolongation of life of such persons and increased the proportion of persons who have a disabling or chronic disease. He advocates a shift in emphasis in medical research away from thwarting fatal complications and towards the prevention of chronic diseases.

Similar issues arise in the developing countries, where some kinds of illness lead to few, or no, deaths and yet play a major role in debilitating the population. Examples are onchoceriasis, schistosomiasis and filiariasis, all of which affect large numbers of people in Africa, and goitre, which is common in many developing countries. Internal parasites such as hookworm have a debilitating effect on populations in many parts of Asia. The recent upsurge in malaria in countries of the Indian subcontinent has caused much debilitation, but few direct fatalities. As mentioned earlier, nutritional deficiencies are rarely cited as a cause of death and yet they contribute to very large numbers of deaths in the developing countries. While diarrhoeal and respiratory diseases lead to high levels of mortality, it is important to remember that the vast majority of cases survive, but in a greatly weakened condition. It is important to cure such diseases to prevent death. It is equally important to ensure that survivors shall be fully rehabilitated so they may not be at risk of contracting the same disease again or other diseases that could be fatal. In this context it is worth noting that the treatment of neither diarrhoeal nor respiratory diseases provides immunity. As the sufferer (normally a child) is returned into the same environment, he or she is likely to experience another attack, especially if weakened by the earlier episode.

It has been hypothesized that the sharp declines in mortality achieved in many developing countries since the Second World War have not been reflected in corresponding declines in morbidity or improvement in health.[25] As Hansluwka has summarized it, the argument is as follows: "Because of the 'autonomous' nature of declining mortality, a reduction in mortality is not equivalent to an improvement in the health status of the population but may place an immense burden on already poverty-stricken societies just by keeping people alive under debilitating health conditions".[26] Unfortunately, there is a dearth of information suitable for testing the validity of this assertion.

Relationships in this area are quite complex. The kind of problem one faces is well illustrated by the question, "What is the ultimate effect on mortality levels of preventing an infant death from cholera or rotavirus by oral rehydration methods?" The immediate death has been prevented, but the environment has not been altered in any way, and the susceptibility to further attacks therefore remains high. If death in these subsequent cases is also prevented by oral rehydration treatment, is the child's susceptibility to death from other diseases increased because of its diarrhoeal episodes, and does the lowering of the death rate in the shorter term imply an offsetting increase in a somewhat longer term? A fully offsetting increase appears highly unlikely, but it appears logical to expect some increase.

Social and economic differentials

Information on socio-economic differentials in mortality in developing countries, particularly in Asia and Africa, is surprisingly limited, in view of the potential for deriving usable estimates from census data for many developing countries.[27] In very recent years, however, more information has become available, notably from analysis of World Fertility Survey data.[28]

Mortality differentials (aside from the demographic ones by age and sex) have typically been examined by region, urban-rural residence, education, and socio-economic status. Available data for developing countries[29] suggest that the socio-economic differentials tend to be the widest.[30] In any event, they are arguably the most important, since urban and regional differentials tend to reflect different "mixes" of socio-economic groups and their differing mortality levels. Differences, of course, do sometimes remain between regional and rural-urban mortality levels even after controlling for the socio-economic "mix" of the population. The sharpest differences of all tend to be found when different combinations of region and socio-economic status are compared: for example, in Thailand, infant mortality in 1970 was estimated to vary between 87 per thousand live births for mothers with no schooling living outside municipal areas, and 16 for those with secondary or university education in municipal areas.[31] In Chile, the probability of dying during the first two years of life rises from 46 per 1000 for urban children whose mothers had 10 or more years of education to 136 per 1000 for rural children whose mothers had no education.[32]

In both the Latin American and the Asian data, education of the mother appears to be a particularly important factor in explaining infant mortality levels. This may reflect also associated factors such as income and occupation, although the education of mothers does appear to be extremely important in its own right. This is certainly the case in studies of individual Latin American countries, although international variations in early child mortality levels (q_2) in these countries are

unaccounted for by educational level of the mother. In these international comparisons, most of the variation "is probably associated with contextual factors which affect entire populations regardless of educational categories".[33]

A comparative study of World Fertility Survey data for 10 countries[34] found that in the impact of mothers' education on child survival, the step from primary to secondary schooling was more critical than the step from illiteracy to primary education. The education of husbands had an independent, though smaller, effect. Another study of 28 countries covered in the World Fertility Survey found the education of the father to be more important than this earlier analysis would suggest, particularly in those Asian and African countries where the education of girls and women is very limited.[35] A recent study of Indonesia, Pakistan and the Philippines using a hazard model confirmed the importance of the education of both mothers and fathers, which assumed particular importance beyond the primary school level, and the independent importance (in the Philippines) of sanitary facilities and electricity.[36] The explanation of the way in which maternal education affects mortality probably has as much to do with the changes schooling brings to the cultural context as to the actual transmission of innovations in health care.

B. Implications of World-Wide Declines in Mortality

While mortality is declining at very different rates, and at any given time displays very different levels among nations, the general pattern world wide is one of steady improvement in life expectancy to the point where the average age at death under the best conditions is over 80 for females and about 73 for males.[37] This change in mortality patterns is closely connected to the decline in fertility experienced by developed countries in the latter part of the nineteenth century and the first half of the twentieth century, and is currently under way in much of the developing world. Both changes have grown out of the restructuring of societies, improvements in material welfare, and technological innovations that have made widespread control of birth and death feasible. Because of these close interrelations in causes of demographic change, it is difficult to isolate the consequences of any one factor, such as mortality. None the less it is useful to consider the ways in which mortality decline contributes to changes in the social and economic lives of people in different societies.

Aging, family structure and social policy

The demographic transition leads to the aging of societies in two ways. First, declining fertility means that the relative prevalence of young people in the total population decreases. Even if mortality remained unchanged, this would mean that the population would become older on average. However, as mortality declines, successive cohorts of individuals spend more of their lives at older ages, implying that there is a further aging of the population as the relative proportion of older people increases. These two forces work to narrow the base of the population age-sex pyramid, and broaden the top, so that the structure takes on a more rectangular appearance, implying that in the course of time there will be relatively similar numbers of people in successive age groups (except the oldest ones).

From economic, cultural and social viewpoints such changes are not innocuous. Traditional institutions were largely built on the assumption that the young greatly outnumbered the old in the population, and systems of production, exchange, leadership, socialization and even religion and settlement were adapted to the demographic facts of high fertility, high mortality and the resulting age structure. Changes in the demography erode the logic of such adaptations and put pressure on society to alter such traditional institutions, to reflect new patterns of needs. Commonly the conflict of interests that arises in the evolution of new institutions leads to hardship for some groups as others gain temporary advantages or cling to traditional rights. For example, the recent rapid declines in fertility and mortality in Java have created strains on the systems of care for children and the elderly. Though there are relatively fewer children, parents are under pressure to spend more on each child to meet new standards of consumption, including schooling. The economic changes also imply that old people have to be cared for at higher standards of comfort, while the growing probability of survival to older ages means that the current generation of parents is more likely to have living parents which tradition dictates they should assist, at least financially, and possibly by taking them into their homes (if they are not there already). As the current smaller birth cohorts mature and marry, they will face an increasing burden not only because of the rising expectations and lengthening lives of their parents, but also because they will have fewer siblings with whom they can share the burden.

While the impact of mortality declines on family structure in developing societies such as Java is quite dramatic, developed countries are not immune from such pressures. In his 1984 presidential address to the Population Association of America, Preston[38] sounded a note of warning about the conflicting interests of older people and the infant and school-age groups in the United States of America. Drawing on a wide variety of data he showed that by health, social services, and other opportunities, people over 65 had been relatively advantaged between the 1960s and the 1980s compared to those under 20. While some of this could be explained in terms of the racial and class positions of the two groups, in large measure it reflected the ability of the older generation to mobilize power through the electoral process, and through the application of pressure on legislators in the form of highly organized lobbying efforts.

Of course, not all the changes taking place in the relative positions of different generations can be attributed to the effects of mortality or fertility declines. They are issues of institutions, and different societies respond in quite distinct ways to the need to restructure the relations between members. Choices are made among a wide range of competing options, and there is nothing to say that Javanese society could not develop a means of ensuring adequate care of both the dependent old and the dependent young, perhaps at a more modest level of material welfare, or perhaps through the development of extra-familial old age security. Nor is there any reason to think that older Americans will not eventually use their power to ensure adequate care for their nation's children, even at the expense of their personal interests. What is important in both cases is that the demographic changes have produced shifts in both the relative needs and relative power among

generations, and this will be accentuated as time goes on and mortality continues to decline.

Social policies addressing the problems of an aging population thus involve two sets of considerations which require detailed study. First, the nature of contemporary and traditional social institutions provide the context within which any proposals for change must be made. Secondly, the magnitude and speed of demographic changes indicate the dimensions of the problems and provide the basis for projecting what issues might be most salient under various assumptions about future trends. Thus while mortality declines do have very important consequences, it is important for policy-makers to see these consequences in the context of their particular socio-cultural setting.

Rising life expectancy and health care costs

While there is some debate over the relation of falling mortality and the morbidity burden on a population, it is generally true to say that, historically, most deaths prevented were of a type that would have involved very short periods of illness, either because they occurred as a result of the trauma of accident or childbirth, or because they were due to an infection which either killed or was cured in a short period of time. The elimination of these deaths and the extension of the average length of life imply that long-term illnesses would be relatively more prevalent in the society. The major causes of death in cases of low mortality involve a greater proportion of degenerative and environmental conditions that produce longer periods of incapacity preceding demise.

A volume edited by Fuchs[39] indicates that the economic and social conditions that have produced low mortality do not lead to a concomitant satisfaction in the attainment of longer life expectancy, but rather the demand for health care increases in line with improvements in income and the elaboration of the health care industry. Moreover, while there is increasing evidence that most of the remaining major health problems are not amenable to curative treatment, but can be prevented by modifications in lifestyle, diet and environment, people in developed countries are none the less spending more on expanding curative services, physicians are becoming more specialized in very narrow fields associated with curative work, and programmes of disease prevention suffer from chronic shortages of funds and political support.[40] Tobacco consumption is only the most dramatic and well-known instance of this contradiction; there is a long list of other medical issues involving neoplasms, cardio-vascular illness, accidents and the abuse of substances with regard to which people in developed countries daily opt to risk the "pound" of cure rather than institute the "ounce" of prevention. At base, it seems clear that the factors underlying the morbidity-mortality relations in advanced countries are cultural and institutional and consequently the issues of spiralling health care costs cannot be treated merely as problems of rational economic choice.

The situation in developing countries is different, both because the patterns of causes of death involve a fair proportion of curable conditions and because many of the relevant preventive measures such as immunization involve either clinical facilities that are in short supply or a network of health centres from which to run an immunization programme. A collection of papers compiled by Lee and Mills[41] demonstrate that poor countries face many difficult decisions in allocating their health care budget. Economic appraisals of the costs and benefits of projects in terms of expenditure, indirect costs, and the likely number of deaths prevented or conditions cured can be very useful in guiding policy-makers to make appropriate allocations in respect of their countries' needs. None the less, cultural and institutional issues are still important, since the decision to undertake a given expenditure generally implies some assumptions about the effective availability of skilled people, and the ability to organize them efficiently. Thus barefoot doctors might be a very cost-effective means of dealing with health care in China, and the same principle of stationing para-medical personnel at the village level underlies most primary health care approaches, but might be quite unacceptable in some social and political contexts. In both developed and developing countries health care expenditures probably do bear some relation to the rising expectation of life, and the changing pattern of illness, but in the long run expenditures are largely determined by the choices people make about their own lives and the structure of their societies.

Mortality trends and the stabilization of population growth

As the expectation of life increases around the world, and as fertility declines in an increasing number of societies, attention is drawn increasingly to the question whether, and if so how, a stabilization of population will occur at levels of economic production and demographic reproduction that will allow for a sustainable system. At the simplest level the demographic balancing equation implies that reductions in death rates will lead to increased population growth if fertility remains unchanged. Historical experience in the West and a number of examples in developing countries indicate that sustained declines in death rates usually precede reductions in fertility in early stages of economic and social development. From this perspective it is sometimes argued that mortality decline causes increased population growth, which in turn can threaten the viability of economic improvements. Turning the argument around, however, shows that fertility is the engine of population growth, and mortality functions merely as a brake. It is fertility that has the greatest effect on such economically important issues as the age structure of the population and that can be seen as the "responsible" factor in the balancing equation in producing high rates of growth. While it is a consequence of mortality decline that growth rates rise, it is equally an implication that the reduction of growth rates requires the control of fertility, since at both the national and the international level governments are committed to the prevention of deaths.

The world is currently in a state of transition with high and moderate mortality rates still prevalent in many countries. It is hard to imagine the attainment within the next half century of global expectations of life at birth at levels now common in Europe; and the idea that each country might achieve Bourgeois-Pichat's "maximum average life span" seems almost fanciful in the context of current problems of faltering economic growth, resource constraints, the threat of nuclear conflict, and the tremendous momentum of population growth that has built up over the last century and

virtually assures high growth rates into the next.[42] Such a pessimistic perspective may yet prove to be wrong, and the gradual improvements of life expectancy in the past give some hope that it will be possible to overcome the current difficulties. None the less socio-economic inequalities in expectation of life are likely to persist, even in the most advanced countries.

C. Problems of mortality; problems of death

If the world does achieve population stabilization at low levels of both fertility and mortality, the problems of death will certainly not disappear. Simone de Beauvoir[43] summed up the dilemma in her account of her mother's death:

> "There is no such thing as a natural death: nothing that happens to a man is ever natural, since his presence calls the world into question. All men must die: but for every man his death is an accident and, even if he knows it and consents to it, an unjustifiable violation."

The very notion of "preventing" death in any absolute sense is obviously invalid; at best a prevention of premature death is achieved. At low mortality people still face the inevitability of death, sometimes with humour, sometimes with anxiety, mostly with a subconscious fear of the pain that might precede death and the uncertainty concerning an afterlife. Because the increasing quantity of life available to each person is related to greatly increased material standards of living, the economic value of a life has increased. Some authors have argued that it is precisely because of the attainment of low mortality that the problem of evaluating lives in economic terms becomes important, especially as regards decisions related to safety and preventive health measures.[44] On the other hand the declining risk of mortality at each age does not seem to have reduced the fear of death proportionately, and in certain social situations, such as large metropolises where violence is widely reported, it often seems that fear of death has risen even as the statistical risk of death falls. Low, stable levels of mortality have also posed new challenges to societies in the area of grief and funeral customs.[45] Geoffrey Gorer has noted that in some countries death has become a source of acute unease best handled privately, almost secretly.[46] In response to such feelings groups have been formed in many countries to give support to the dying and their families, and to define purposes for death which will satisfy the sceptical modern mind.[47] While many of the traditional causes of death have ceased to be important medical problems, the fact and inevitability of death continues to throw up difficult social and psychological problems even where low levels of mortality have been achieved.

The long-term consequences of mortality decline can thus be summarized along three dimensions. First, persistence of inequalities in mortality experience will pose dilemmas between countries and among social classes within each country. Secondly, the evolving cause structures of mortality will continue to generate contradictions between the technological promise of prevention of premature death and the socio-economic ability to choose and implement appropriate technologies. Thirdly, as societies approach the biological limits of life expectancy, fear of death urges them to attempt greater advances even as those who die do so in an increasingly industrialized setting, often bereft of support from extended family or wide networks of friends. On the basis of current trends, the difficult challenge in the next century may be less one of controlling mortality than of dealing with death.

Notes

[1] United Nations, *The Determinants and Consequences of Population Trends*, No. 1, 1973; Davidson R. Gwatkin, "Indications of change in developing country mortality trends: the end of an era?", *Population and Development Review*, 6(4) (1980), p. 616.

[2] Gwatkin, *loc. cit.*, p. 618.

[3] *Levels and Trends of Mortality since 1950* (United Nations publication, Sales No. E.81.XIII.3 and Corr.1); M. Sivamurthy, "The deceleration of mortality decline in Asian countries", in *Solicited Papers: International Population Conference*, Manila, 1981 (International Union for the Scientific Study of Population, Liège), vol. 2, pp. 51-76; E. E. Arriaga, "The deceleration of the decline of mortality in LDCs: the case of Latin America", in *Solicited Papers: International Population Conference*, Manila, 1981 (IUSSP, Liège), vol. 2, pp. 21-50.

[4] *Levels and Trends of Mortality . . .*, p. 4.

[5] *Ibid.*, p. 5.

[6] Documented examples of reversals include Argentina between 1960 and 1970; Uruguay during the period 1963-1971; some cities of Brazil during the 1960s; Sri Lanka from about 1967 to 1974; and Matlab Thana in Bangladesh, in the early 1970s, probably reflecting more widespread mortality increases in other parts of Bangladesh (Gwatkin, *loc. cit.*, pp. 622-623; S. D'Souza, "A population laboratory for studying disease processes and mortality: the Demographic Surveillance System, Matlab, Comilla, Bangladesh", *Special Publication No. 13* (International Centre for Diarrhoeal Disease Research, Dhaka, Bangladesh, 1981), fig. 1.

[7] For example, *Population Bulletin of the United Nations No. 6* (with special reference to the situation and recent trends of mortality in the world), (United Nations publication, Sales No. E.62.XIII.2), p. 12; G. Stolnitz, "A century of international mortality trends", *Population Studies*, 1955, 9(1), p. 525; Kingsley Davis, "The amazing decline of mortality in underdeveloped areas", *American Economic Review*, 1956, 46(2).

[8] L. Ruzicka and H. Hansluwka, "Mortality transition in South and East Asia: technology confronts poverty", *Population and Development Review*, 1982, 8(3): 567-588; Gwatkin, *loc. cit.*

[9] It is important to note that there is tentative evidence that mortality declines are beginning to accelerate again in a number of less developed countries, especially among the early-age groups. See United Nations, *World Population Trends and Policies, 1981 Monitoring Report*, vol. I (United Nations publication, Sales No. E.82.XIII.2).

[10] G. Stolnitz, "International mortality trends: some main trends and implications", in *The Population Debate: Dimensions and Perspectives*, papers of the World Population Conference, Bucharest, 1974, vol. II (United Nations publication, Sales No. E/F/S.75.XIII.5), pp. 151-159; E. E. Arriaga, *Mortality Decline and Its Demographic Effects in Latin America*, Population Monograph Series, No. 6 (Berkeley, University of California Press, 1970); S. H. Preston, "The changing relation between mortality and level of economic development", *Population Studies*, 1975, 29(2): 231-248; World Health Organization, "Health trends and prospects in relation to population and development", World Population Conference, Bucharest, 1974 (E/CONF.60/CBP/26); H. Hansluwka, "Health programmes and the prospects for further reduction of mortality in low-mortality countries", in *International Population Conference* (International Union for the Scientific Study of Population, Liège, 1973), vol. 3, pp. 283-300.

[11] For a detailed evaluation, see Alan D. Lopez, "The sex mortality differential in developed countries", in Alan D. Lopez and Lado T. Ruzicka, eds., *Sex Differentials in Mortality: Trends, Determinants and Consequences* (Canberra, Department of Demography, The Australian National University, 1983).

[12] United Nations, *Levels and Trends of Mortality . . .*, p. 7.

[13] *Ibid.*, p. 151.

[14] Consistent with the fact that countries attaining a particular level of life expectancy in more recent years have tended to do so at lower levels of real per capita income than countries reaching the same level in earlier years, it has been found that diseases most closely associated with standards of living and least amenable to attack by specific medical and public health measures (for example, diarrhoeal diseases) contribute a larger share of total mortality in the former group (Preston, "The changing relation . . .").

[15] Ruzicka and Hansluwka, *loc. cit.*, p. 573.

[16] United Nations, *Levels and Trends of Mortality . . .*, pp. 18-38.

[17] *Ibid.*, p. 172.

[18] Ruth R. Puffer and Carlos V. Serrano, *Patterns of Mortality in Childhood: Report of the Inter-American Investigations of Mortality in Childhood*, Scientific Publication No. 262 (Washington, D.C., Pan-American Health Organization, 1973), pp. 180-185.

[19] Terence H. Hull and Jon Rohde, *Prospects for rapid decline of mortality rates in Java: a study of causes of death and the feasibility of policy interventions for mortality control*, Working Paper Series No. 16, Yogyakarta, Indonesia, Population Institute, Gadjah Mada University (1978); T. H. Hull, A. D. Lopez and J. E. Rohde, "A framework for estimating causes of death in Indonesia", *Majalah Demografi Indonesia* (1981), vol. 8, No. 15, pp. 77-125; A. D. Lopez and T. H. Hull, "A note on estimating the cause of death structure in high mortality populations", *Population Bulletin of the United Nations* (1981), No. 14 (United Nations publication, Sales No. 82.XIII.6), pp. 66-70.

[20] Samuel H. Preston, *Mortality Patterns in National Populations; with Special Reference to Recorded Causes of Death*, Studies in Population (New York, Academic Press, 1976).

[21] Preston, "The changing relation . . ."; and S. Preston, "Causes and consequences of mortality declines in less developed countries", *in* R. A. Easterlin, ed., *Population and Economic Change in Less Developed Countries* (Chicago, University of Chicago Press, 1979).

[22] Preston, "The changing relation . . .", p. 235.

[23] Preston, *Mortality Patterns in National Populations . . .*, p. 307.

[24] E. M. Gruenberg, "The failures of success", *Milbank Memorial Fund Quarterly*, 55 (Winter, 1977).

[25] L. T. Ruzicka, and H. Hansluwka, "A review of evidence on levels, trends and differentials since the 1950s", in *Mortality in South and East Asia: A Review of Changing Trends and Patterns, 1950-1975*, Report and selected papers presented at Joint WHO/ESCAP Meeting held in Manila, 1-5 December 1980 (1982, World Health Organization), pp. 126-127.

[26] H. Hansluwka, "Mortality in South and East Asia: an overview", paper presented at 1984 Hong Kong Conference, p. 63.

[27] Gavin W. Jones, *Social Science Research on Population and Development in South-East and East Asia: A Review and Search for Directions* (Mexico City, International Review Group of Social Science Research on Population and Development, El Colegio de Mexico, 1978), appendix 3, pp. 57-58.

[28] For example, S. A. Meegama, "Socio-economic determinants of infant and child mortality in Sri Lanka: an analysis of post-war experience", *World Fertility Survey Scientific Reports*, 1980, No. 8; Frank L. Mott, "Infant mortality in Kenya: evidence from the Kenya Fertility Survey", *World Fertility Survey Scientific Reports*, 1982, No. 32; J. L. Somoza, "Illustrative analysis: infant and child mortality in Colombia", *World Fertility Survey Scientific Reports*, 1980, No. 10; J. Hobcraft, M. McDonald and S. Rutstein, "Socio-economic factors in infant and child mortality: a cross-national summary", paper presented at the Annual Meeting of the Population Association of America, San Diego, 1982; G. Linda Martin, J. Trussell, Florentina Ryes Salvail and Nasra M. Shah, "Co-variates of child mortality in the Philippines, Indonesia and Pakistan: an analysis based on hazard models", *Population Studies*, 1983, 37(3).

[29] For example, for Indonesia, see Jones, *Social Science Research . . .*, pp. 53-56; for the Philippines, M. Concepcion, "Factors in the decline of mortality in the Philippines, 1950-1975", in *Mortality in South and East Asia . . .*"; and for Latin America, see United Nations, *Levels and Trends of Mortality . . .*, pp. 163-169; Raul Urzua, *Social Science Research on Population and Development in Latin America*, Mexico City, International Review Group of Social Science Research on Population and Development, El Colegio de Mexico, 1982, chap. 3.

[30] This is not the case in Kenya, where regional differences are the most marked. A quite different mortality régime prevails in the humid tropical lowlands from that in the plateau areas (Mott, "Infant mortality in Kenya . . .").

[31] John Knodel and Apichat Chamratrithirong, *Infant and Child Mortality in Thailand: levels, trends and differentials as derived through indirect estimation techniques*, Papers of the East-West Population Institute, No. 57, Honolulu, 1978, table 8.

[32] United Nations, *Levels and Trends of Mortality . . .*, table V.14.

[33] *Ibid.*, p. 169.

[34] J. C. Caldwell and P. F. McDonald, "Influence of maternal education on infant and child mortality: levels and causes", *International Population Conference*, Manila, 1981 (International Union for the Scientific Study of Population, Liège, 1982).

[35] J. Hobcraft, M. McDonald and S. Rutstein, "Socio-economic factors in infant and child mortality . . .".

[36] Martin and others, "Co-variates of child mortality . . .".

[37] Jean Bourgeois-Pichat, "Future outlook for mortality decline in the world", *Population Bulletin of the United Nations*, No. 11, 1978 (United Nations publication, Sales No. E.78.XIII.7), pp. 12-41.

[38] Samuel H. Preston, "Children and the elderly: divergent paths for America's dependants", Presidential address, Population Association of America, 4 May 1984, Minneapolis. Forthcoming in *Demography*.

[39] Victor R. Fuchs, *Essays in the Economics of Health and Medical Care* (New York, National Bureau of Economic Research; distributed by Columbia University Press, 1972).

[40] Victor W. Sidel, and Ruth Sidel, *A Healthy State: an International Perspective on the Crisis in United States Medical Care*, rev. ed. (New York, Pantheon Books, 1983).

[41] Kenneth Lee and Anne Mills, *The Economics of Health in Developing Countries* (Oxford, Oxford University Press, 1983).

[42] See Ansley J. Coale, "Recent trends in fertility in less developed countries", *Science*, 221, 26 August 1983, 828-832.

[43] Simone de Beauvoir, *A Very Easy Death*, trans. Patrick O'Brian from *Une Mort très douce* (Harmondsworth, Penguin, 1969 and 1983).

[44] M. W. Jones-Lee, *The Value of Life: An Economic Analysis*, (London, Martin Robertson, 1976).

[45] Richard Huntington and Peter Metcalf, *Celebrations of Death: The Anthropology of Mortuary Ritual* (Cambridge, Cambridge University Press, 1979), especially pp. 184-211.

[46] Geoffrey Gorer, *Death, Grief, and Mourning in Contemporary Britain* (London, Cresset Press, 1965), pp. 169-175.

[47] Elisabeth Kubler-Ross, *Death: the Final Stage of Growth* (Englewood Cliffs, New Jersey, Prentice-Hall, 1975).

Part One

SOCIETAL AND BIOLOGICAL ADAPTATIONS TO MORTALITY CHANGE

I. ADAPTATION OF SOCIAL SYSTEMS TO CHANGING MORTALITY RÉGIMES

*Geoffrey McNicoll**

One of the formative differences distinguishing the modern world—say, the present century—from its predecessors is the radically altered pattern of mortality. The fact of routine human survival from infancy to old age has profound consequences for the predictability of human relationships, for what Peter Laslett has called "the conversation between the generations,"[1] and for those appreciable parts of human culture and economy that derive from the uncertainties surrounding debility and death. How these shifting patterns of mortality have worked their way on societies and the nature of that influence are the subjects of this chapter.

The topic, broad though it is, at first seems to have a straightforwardness to it. Thought experiments positing mortality as an independent variable are set up, the putative societal responses traced out and classified. The neatness, however, is illusory. Historically experienced patterns of mortality change are outcomes of complex interactions between more or less exogenous forces of mortality and specific features of a society's technology, culture and social organization. Situations in which a mortality change comes close to being truly exogenous—for example, the appearance of a new disease organism—are probably more the exception than the rule. Increasingly, moreover, mortality differentials among societies also reflect disparities in will and capacity for collective action against disease and malnutrition and in the values placed on such action by political leaders in comparison to alternative uses of resources. Analytical untangling is not prevented by these complications but the task is rendered more difficult and the results a good deal messier.

Not all aspects of mortality are of interest here. A few principal dimensions of mortality change over time suffice to define a mortality régime for present purposes. Similarly, not all the processes by which social systems and mortality régimes come into line as new régimes take hold merit attention, describable though they all may be by that capacious term "adaptation". Of especial interest are the existing or emerging societal capacities to cope with novel mortality conditions over the (demographically) short or medium run of a generation or so. The economic and demographic outcomes of these processes are often the most obvious, but they in turn are governed by social organizational and cultural configurations of the society that themselves may constitute dynamic elements of the societal response. Sorting out the behavioural and deeper social structural adaptations to mortality change is the main task addressed below. It is, of course, impossible, in one brief chapter, to do justice to this difficult and elusive subject. At most it can sketch its outlines and indicate some of the intriguing issues that lie within them..

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A. Characterizing mortality régimes

The mortality régime is described below in terms of four characteristics: level and age-pattern, volatility over time, variation across socio-economic classes and pattern of cause-of-death and antecedent morbidity. Each of these characteristics calls for some further comment.

Level and age pattern

The most obvious characteristic of the age distribution of human mortality is its bimodality: mortality peaks at infancy and old age. A single index of central tendency, such as the mean age at death, is thus inherently inadequate as a summary measure of the distribution. Where mean does not even roughly coincide with mode, intuitive interpretation suffers. The two modes of the mortality distribution do, however, move together to a considerable extent. In a given population, a mortality decline can usually be described by a one- or two-parameter transposition of the initial age distribution of mortality. Underlying that initial age pattern and explaining regional and cultural similarities in the way such patterns change with improving longevity (permitting identification of life-table "families") are specific constellations of diseases and causes of death, each with a characteristic age incidence.

Table I.1 shows how the distribution of age at death changes under varying levels of mortality (and associated fertility) in one widely applicable life table family, the Coale-Demeny "West" model. The demographic régimes are selected to illustrate a stylized path of demographic transition from high to low mortality and fertility, although in each case the distribution refers to the stable population to which the régime would ultimately give rise. In a "pretransition" régime, with very high mortality (life expectancy of 30 years) and high fertility (an average of 6 children per woman), half of all deaths occur to children below age 5; over three quarters of all deaths take place before age 45. A substantial increase in life expectancy—by 50 per cent, in the second row of table I.1—has virtually no effect on the distribution of age at death. Even a doubling, to a life expectancy of 60 years, makes a relatively minor change: now two thirds rather than three quarters of all deaths occur to persons aged below 45 years.

The large differences in the distribution of age at death come later in the transition, and are associated more with declining fertility than with improving mortality. As fertility drops from, say, 6 children per woman to 3, as in the middle three rows of table I.1, death moves decisively from childhood to old age. In the stylized post-transition population represented in the last row of the table, with life expectancy of 75 years and fertility averaging 2 children per woman (corresponding closely to a stationary population), not more

TABLE I.1. DISTRIBUTION OF AGE AT DEATH UNDER DIFFERENT DEMOGRAPHIC RÉGIMES[a]
(Percentage)

Life expectancy at birth (years)	*Total fertility rate*	*Age at death (years)*				
		0-4	*5-44*	*45-64*	*65+*	*All ages*
30	6.0	52	26	13	9	100
45	6.0	50	26	11	13	100
60	6.0	45	22	13	20	100
60	4.0	28	20	17	35	100
60	3.0	16	16	19	49	100
75	3.0	4	5	15	76	100
75	2.0	2	3	12	83	100

[a]For "West" model stable populations characterized by given life expectancy and total fertility rate.

than five per cent of deaths occur prior to age 45; more than 80 per cent are to persons aged over 65 years.

In the actual course of demographic transition, of course, the intermediate demographic régimes generated by fertility decline would be far from the stable population model. There would be both fewer children and fewer elderly than under stable conditions. Hence the middle rows of table I.1 would show correspondingly smaller proportions of deaths at those ages and larger proportions at young adult ages.

Even though the age distribution of death may be little affected, improved survivorship rates early in the transition do of course have a dramatic impact at the family level. As life expectancy passes about 50 years the infant mortality rate drops below 100 per 1,000 births and the probability of a child surviving to age 5 reaches 80 per cent. (This is under a West model mortality pattern; other life-table models would not differ very much.) These are still considerable figures, but they are vast improvements on the typical mortality levels in much of the world even well into this century. As late as the 1920s many countries still had life expectancies around 25 years. Assuming that in each case the probability of death is independent of other deaths in the family (not a defensible assumption, but adequate for this illustration), the same total fertility rate of 6 would give the following average distributions of numbers of children surviving to age 20 under life expectancies of 25 and 50 years (percentage):

Life expectancy at birth	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*Total*
25 years	3	13	27	30	19	7	1	100
50 years	0	0	3	11	28	37	21	100

The family-level relationship between total births and total surviving children is becoming predictable enough to permit realistic demographic planning by individual families.

Volatility

Analytical demography is almost wholly premised on the relative stability of ratios of vital events to populations at risk (aside from a minor interest in systematic seasonal variation). Yet year-to-year fluctuations are often large. In the mortality case, describing mortality decline in terms of a monotonic sequence of model life tables is to level the peaks and troughs in death rates that may well have been dominant features of the demographic landscape.

High-mortality régimes are characterized by a much greater variance of mortality over time than low-mortality régimes. In Wrigley and Schofield's time series data for England, for example, over the period 1550-1850, during which long-run (25-year) average crude death rates ranged from the low 20s to the low 30s per 1,000, the means of the annual absolute percentage deviations from the 25-year moving average crude death rate were as follows:[2]

1550-1600	14.8
1600-1650	11.8
1650-1700	10.5
1700-1750	9.2
1750-1800	5.4
1800-1850	4.3

The substantial drop in volatility evident in the last two of these figures corresponds to the early phases of secular mortality decline in England. (By the mid-nineteenth century English life expectancy was around 40 years.) France, with death rates significantly higher than in England until well into the nineteenth century, also showed higher volatility.[3]

The European historical change in volatility is attributed by McNeill[4] to the gradual shift from epidemic to endemic diseases (see below). The same factors have presumably also operated in the secular mortality decline of the developing countries over the past 40 to 50 years. But in this case perhaps more important in reducing volatility are the enhanced will of Governments and the capacity of government administrative systems to combat famine-related mortality. Will and capacity can, of course, on occasion work to generate famine mortality by competently applying incompetent policy—as illustrated most strikingly in the estimated 16 million to 27 million famine deaths in China in 1958-1963 resulting from the "Great Leap Forward" campaign.[5] Crisis mortality, even on this scale, however, has only a slight influence on overall population growth. Volatility effects, if they exist, must operate through factors such as predictability and vulnerability, and resulting hedging behaviour, rather than through aggregate growth consequences.

Socio-economic variation

Although data on socio-economic variation in mortality tend to be scarce, the available studies show broadly consistent findings. Status differences, whether measured by income, occupation or education, are associated with large differences in mortality.[6] A difference by a factor of two in the death rates of top and bottom occupational status groups is fairly typical. In economic crises these differences may be further widened, with status groups closest to the margins of survival absorbing most of the demographic consequences. Bangladesh data for a rural area in 1975, a famine year, show a crude death rate of 12 per 1,000 among farm families owning more than 1.2 hectares of land; the rate was 36 per 1,000 for landless households.[7] Child mortality differences follow those in adult mortality. With increasing affluence in the society at large or increasing attention on the part of the public sector to health services these differentials narrow but they are by no means eliminated.

For the subject under consideration, the important implication of socio-economic variation in mortality is that a substantial range of mortality experience exists at any given time in most societies. A mortality régime is in effect a layering of subrégimes.

Morbidity and cause of death

The final characteristic of a mortality régime to be noted here is its disease structure. Demographers for the most part treat death as a simple exit from a population, an accounting debit to be entered in a particular age, sex and status category. Yet the consequences that are of interest here pertain not just to this arithmetic event but to its corporeal and cultural antecedents: illness or injury, pain and debility, dread and hope, and so on—qualities and perceptions in part tied to the characteristics of the person and society involved, but in part tied also to the specific cause of death.

Broad patterns of disease that correspond roughly to different overall levels of mortality can be identified. Omran[8] proposed the concept of an "epidemiologic transition" accompanying mortality decline. In Omran's stylized picture, under high, pretransition mortality the principal causes of death are the major infectious diseases: typhoid, cholera, typhus, measles, diphtheria, whooping cough, smallpox. At intermediate mortality levels, non-epidemic infectious diseases predominate—pneumonia, bronchitis, tuberculosis and enteritis. Finally, as these too are brought under control, causes of death in low-mortality régimes shift to the degenerative and chronic diseases of old age.

Preston's later review of the evidence puts greater weight on respiratory diseases as causes of death early in the transition.[9] Parasitic diseases, with the major exception of malaria, play a fairly limited role. In general, "the exotic tropical diseases are typically much more important sources of morbidity than of mortality". In the overall mortality decline in the developing countries from 1900 to 1970 Preston estimates that one half to three quarters is accounted for by pneumonia, bronchitis, influenza, tuberculosis and malaria.

Modern categorizations of diseases by agent or vector have no necessary bearing on societal responses to changes in disease patterns. Those responses, deriving rather from culturally based classifications and interpretations, show the same divergencies as the cultures themselves.

* * *

In any mortality change in a population, each of these four characteristics is likely to be affected. In a stereotypical mortality decline, temporal volatility is lessened; socio-economic differentials, after possibly widening for a time, are steadily and substantially narrowed; and the age pattern shifts systematically in directions set by the initial disease structure and the conventional array of economic advances and public health interventions brought about by development. There is, however, considerable intercountry variation in the details of régime changes over time. The range of societal adaptations therefore reflects not only institutional and cultural differences among the groups experiencing mortality change but also these further dimensions of the change itself.

B. Varieties of societal adaptation

Toulmin usefully distinguishes four kinds of human adaptation.[10] Applied to societies, these are:

(1) Calculative or rational adaptation—explicit choice among alternative courses of action, as, for example, in national planning and policy making;

(2) Homeostatic adaptation—where economic or social mechanisms exist for channelling negative feedback to counter effects of external changes, so as to restore in some sense the *status quo ante*;

(3) Developmental adaptation—emergence of the capacity to cope with novel problems through either (1) or (2) or in other ways;

(4) Selective or evolutionary adaptation—the selective survival of certain cultural or behavioural variants at the expense of others less equipped to meet novel conditions.

Little in the way of societal responses to changes in environment is excluded here, since maladaptive responses (failures in the first three of these types) presumably are selected against in the long run. For the present purpose, however, central interest attaches to homeostatic and developmental adaptation.

The emergence, by design or happenstance, of the apparatus that can be brought to bear for calculative adaptation—both the self-conscious policy-making process and the instrumental capacity to give effect to policy decisions—is appropriately part of the third category. What remains under (1) is the disembodied choice itself: more or less "rational" *ex ante*, given the existing knowledge base and circumstances, and more or less successful *ex post*, given the actual outcomes. Important though this choice is substantively, much of the social scientific interest in calculative adaptation is found in (3).

Selective adaptation (Toulmin's category 4) cannot be wholly ignored in this account or relegated to the dim reaches of human evolution. In prehistorical times human survival depended on social arrangements that could assure positive net reproduction in the face of a strong and erratic force of mortality. Modern hunter-gatherer societies suggest the probable nature of those arrangements prior to the development of agriculture: long interbirth intervals generated by extended breast-feeding, often backed by infanticide of births that follow too closely.[11] Such a system, in which couples reproduce at rates well below biological limits, in effect holds ample reproductive time in active reserve, and is thus able to respond rapidly to a mortality crisis. With the establishment of settled villages in the neolithic era, there was likely to have been a vastly increased role of contagious diseases; eventually, with still closer settlement, populations became large enough for the maintenance of certain diseases (measles, for example) in endemic form.[12] Reproductive reserves, drawn on routinely rather than sporadically, would often have been inadequate for population replacement. Societal continuity—selective success in human ecological terms—would then hinge on recruitment and acculturation of migrants.

Selective adaptation at a biological level should also be noted. For many infectious diseases, routine exposure confers immunity on survivors. In other cases the diseases themselves seem to lessen in virulence over time for the populations affected. Such epidemiological adjustments over the millennia were suddenly disrupted in historical times as improvements in transport technology permitted contacts between what had for long been continental demographic isolates. The spread of bubonic plague to Europe followed the patterns of migration established by the Mongol conquests; the spread of smallpox, measles, diphtheria and other diseases to the

Americas came with the earliest Spanish expeditions. The details of these contacts and their devastating demographic and cultural consequences are recounted in William H. McNeill's classic study, *Plagues and Peoples*.

The remaining two categories of adaptation in Toulmin's scheme, homeostatic and developmental, are treated in the following discussion. They lack the drama of responses to the "great mortalities",[13] but in a consideration of routine social change and economic development over periods of a few decades they cover the chief kinds of societal responses that actually take place. Three distinct manifestations of adjustment processes are considered: economic and demographic responses, social organizational responses and cultural responses.

C. Economic and Demographic Responses

In a characteristically lucid discussion of behavioural consequences of mortality decline, Preston[14] uses an expanded form of the familiar population balance equation to classify all possible behavioural adjustments. A change in the death rate of a population must necessarily result in a change in at least one of the following factors: the birth rate, the rate of net migration, the growth rate of total product and the growth rate of per capita product. A drop in mortality may be compensated demographically through lowered fertility or increased net outmigration, or economically through increased output; otherwise per capita product will fall.

That improvement in child survivorship rates should elicit a decline in fertility makes evident sense at various societal levels. Within families, attainment of family size or child-spacing goals may well call for such a response; so might pressure on economic resources or demands on social services at the community level. Demographic homeostasis at a societal level would presumably hinge for the most part on such economic incentives or social pressures within families and communities, although broader cultural changes sustaining these adjustments may also be a significant factor in the longer run.

But is this fertility response borne out empirically? Most research on the question has been directed at family responses, where findings have not generally shown a strong relationship. Preston summarizes these: "The principal conclusion . . . is that, on average, an additional child death in the family, *ceteris paribus*, leads to far less than one additional birth . . . . The picture is not attractive for those who look to mortality reduction as a means of reducing fertility through familial effects, let alone for those who advocate such measures as a means to reduce growth rates."[15] Less direct fertility adjustments, working through induced changes in socio-economic conditions or cultural and institutional patterns, remain plausible but elude straightforward quantitative demonstration.

Homeostatic societal outcomes need not be defined in terms of net reproduction. Indeed to do so would be tantamount to ignoring both the spatial and technological dimensions of human societies. Individual material well-being can be preserved under population growth through territorial expansion or through improvements in economic productivity. Outmigration as an alternative to lowered fertility is explicitly recognized in the demographic transition model sketched out by Davis,[16] and empirical instances where existence of a migration outlet seems to have interfered with a fertility response are not hard to find.

Economic responses are even more familiar. Various writers have argued for the likelihood of demographically induced technological change.[17] Gourou[18] documented a number of cases where increasing population densities could be seen to have compelled the change-over from shifting cultivation to settled agriculture. This particular transition is used by Boserup as the basis for her more general argument that population growth has historically been the chief determinant of agricultural development. A radical shift to a new technology, however, tells us little about the forces making for more routine productivity improvements. Here, the numerous cases of failure that can be pointed to should give pause to any generalized expectation that total productivity will respond to population growth. Substitution of labour for other factors of production, typically yielding increases in output per unit of land but diminished labour productivity, would define a range of neutral responses.

Challenges that a society encounters recurrently elicit institutionalized means of coping with them—whether collective responses to a given problem or procedures to channel resulting costs away from those with most political access. However, secular mortality decline which in the space of a few decades may shift population growth from nearly stationary to a doubling per generation presents for most societies that experience it a wholly new kind of challenge. Societal homeostatic responses, where they occur, are thus more than a little fortuitous. Families and individuals may indeed struggle to maintain the *status quo ante*, but no law of aggregation ensures that the societal-level outcome shall be successful. Indeed, exploring what determines "success" is at the heart of the study of socio-economic development. The self-conscious process of institutional redesign to generate better than homeostatic responses, where individual efforts formerly were dissipated or nullified in social conflict, is a central part of development policy.

These considerations call attention to the structural conditions under which behavioural adaptations to a new mortality régime make sense for the society as a whole. For example, agrarian societies vary greatly in the degree to which their economic organization remains intact under population growth. At one extreme, exemplified by peasant proprietorship or by larger-scale capitalist agriculture, the institutional system is such that either increased population that might otherwise undermine the system's stability is extruded or the system can ensure the productive and distributional means to sustain the added numbers. At the other extreme, social structures seem to have a flaccidity that permits continuing accommodation of population growth with steady dilution of per capita resources. The origins of these contrasting societal types (the former seen particularly in pre-industrial Europe and Japan, some other parts of East Asia and areas of European settlement; the latter in much of the rest of the world) are obscure and controversial. In part, they are autochthonous residues of cultural solutions to a different array of problems, in part perhaps the outcomes of colonial intervention. Striking accounts of flaccid social structures in India and Indonesia are given by Marriott[19] and Geertz.[20] What may be deemed material failure, however, may sometimes still be adaptive in

institutional and cultural terms, albeit with material achievement long deferred and its potential perhaps truncated. When even this cannot be claimed, remedy through imposed institutional reform would nevertheless generally be possible. In rare instances social disintegration may seem irremediable, although that is much more likely to be the outcome of catastrophe than of routine demographic pressure.[21]

Collapsing the independent variable in this discussion to "mortality decline", not further specified, leaves out most of the details of a mortality régime shift. The régime characteristics described earlier may have significant separate effects on economic or demographic behaviour. If régime changes differ markedly in the age-incidence of mortality decline as between infants, children and adults, one would expect behavioural differences in responses. Nathan Keyfitz, for example, has speculated on the enhanced effect on government economic policy of a mortality decline that rapidly increases the absolute numbers of children in a population, sometimes leading to increases in annual numbers of labour force entrants four or five times the rate of population growth.[22] Mortality declines at later ages would not have comparable effects in claiming government attention or in generating political action in its absence.

The age differences here can presumably be traced to particular changes in underlying cause-of-death structures. Allocative decisions on health services can in effect discriminate among ages. The fact that the pattern of age-incidence of mortality decline across societies is comparatively uniform may reflect the dominance of non-deliberate factors behind it.

Uniformity is less in evidence in the socio-economic dimension of mortality decline. Improvements in health conditions can readily be envisaged that primarily affect the richer or more educated groups, others that primarily affect the poor and still others that influence death rates across the socio-economic spectrum. Specific medical or public health attention focused on countering particular causes of death may well have effects that vary in this respect, depending on the focus selected. For a given effect on life expectancy in the population as a whole, there is no reason to anticipate identical behavioural outcomes in these three cases. The existence of distinct mortality subrégimes at different socio-economic levels within the population may at first seem to suggest a ladder up which groups would move as their mortality lessened, adopting appropriate other economic and demographic behaviours as they did so. But mortality differences are only one, and sometimes a fairly minor, characteristic of the socio-economic hierarchy. A substantial equalization of mortality across class divisions is quite consistent with perpetuation of those divisions and of their behavioural patterns.

D. Social organizational responses

Behavioural responses to mortality change—comparatively easy to observe statistically and within the disciplinary purview of demographers and economic planners—tend to obscure more interesting and ultimately more consequential structural effects. A society's institutional arrangements and cultural patterns—its family and community organization, its arrangement of property rights, its system of government and economic administration, and the culturally specific meanings that attach to these forms—are mediating structures that channel mortality changes in particular ways on to individuals, giving rise to behavioural outcomes of the sort noted earlier; they may also be dynamic components of the societal response itself. (Dividing the realm of social organization from that of culture, as in the discussion following, is a convenient if arbitrary procedure.)

A familiar and valuable if somewhat static view of society is as a role structure persisting over time which members of a population enter by birth or migration and through which they pass as they age, being assigned or themselves claiming different roles during the process. This conceptualization suggests some immediately evident social organizational consequences of mortality change: a sudden shift in numbers of entrants or in rates of relinquishment of roles compels an adjustment in the normative content of particular roles and in their relationships to each other. We have, in other words, institutional change.

As an important example, a larger number of surviving children in a family imposes a clear strain on traditional systems of intergenerational obligations—that is, on the roles of parents and children. The obligations of children to parents can be readily met, since the burden per child is lessened; but those of parents to children cannot be. In Ryder's words, "mortality decline sets the stage for generational confrontation".[23] To the extent that the costs of high net reproduction can be passed forward in time, running down assets within the family or spreading the sacrifices more widely through attenuated labour market access, the system can continue. But like a pyramid sales (Ponzi) scheme or a chain letter, eventually something has to give. A new role structure emerges, with new behavioural outcomes.

As Ryder has pointed out elsewhere,[24] however, a peculiarity of family demography is that much of the added dependency burden from mortality decline for the society as a whole is deflected away from individual families seen as social units with their own life cycles. Within any family, although more children survive, the family has longer to reap productive contributions from both parents and children. The societal burden is seen in the faster creation of families, and hence in there being proportionately more in the early, high-dependency years of child raising. Each individual family may look forward to recouping its expenditures on children. Thus the dependency costs of improved survivorship are diffused across families, disguising the necessity for change even as economic conditions may be steadily worsening.

A second example of role changes induced by mortality decline is relevant especially at the later stages of decline when survival to adulthood is practically assured. Too easy survival to old age has virtually eliminated the role of sage in modern societies. Fourastié has drawn the contrast in striking terms:

> Autrefois, la vieillesse était le couronnement d'une carrière exceptionnelle; ayant triomphé de mille dangers, "trompé la mort" . . . , entouré d'une pléiade d'enfants, de petits-enfants ou de neveux, le vieillard était reconnu et se considérait lui-même comme un "sage", détenteur d'un pouvoir magique, au bénéfice de son village et de sa famille; en un mot, c'était un "ancien". Aujourd'hui, la vieillesse n'est plus que

l'usuelle et pitoyable décadence d'un corps usé, qui retourne à la mort à travers la vie végétative.[25]

Increasing overlap between successive generations as a consequence of lower mortality might at first seem to favour greater emphasis on lineage affiliation in a society. The forces working against any such trend are far greater, however. Routine expected survival to old age permits orderly individual planning of life and erodes the important mutual insurance basis for close lateral kin ties. Paradoxically, as the task of managing one's family to ensure generational continuity becomes demographically straightforward, it becomes socially intractable. The family in the capacity of lineage drastically weakens.

These changes were once assumed to be reflected in a transition of family structure, from extended to nuclear. A growing body of empirical evidence, however, belies this stereotype. Fourastié's picture of the traditional family describes a rarely achieved ideal rather than a common reality of the time.[26] "The joint family as described and discussed in the literature of family sociology and cultural anthropology appears to be more a sociological tradition than a statistical reality."[27] Yet the casual transference of findings from the European case to the rest of the world, where the supporting evidence is mainly census data on household composition, may be hazardous. Census concepts of household cannot capture long-run changes in obligational networks—changes that with little counterpart in residence terms can massively alter the fabric of social relations. Gerontocratic control in a family system, to take one instance especially important in many African societies, is inconsistent with too many gerontocrats.

In institutions where relationships are not established through kinship, changes that declining mortality might seem to dictate are more easily impeded. Seniority systems are notably resistant to change: a radical slow-down in promotion in any hierarchy resulting from lower rates of attrition through retirement or death is as likely to be simply accepted, with consequent loss of the dynamism that comes from renewal through population turnover, as it is to induce institutional change to accommodate the new realities.[28]

E. Cultural responses

Admitting institutional responses to mortality change already adds greatly to the degrees of freedom in societal response, although a narrow focus on behavioural outcomes may overlook these complexities or fuse them into a seemingly unproblematic "lag". Complication does not stop here, however. Any human society also has a cultural domain, a more or less well-articulated and coherent system of shared meanings, conceptually distinct from the society's material and social organizational realities but to a degree influenced by and in turn influencing these realities. The preservation of coherence in such a system under changes in technology or demography—interpreting such changes in its own terms, making "sense" of them—is a familiar characteristic of a culture. Under too large and sudden a change the system can of course disintegrate.

In a classic essay published nearly eighty years ago Robert Hertz described the inherent problems a society faces in confirming its continuity over time in the face of its members' aging and dying.

> Society imparts its own character of permanence to the individuals who compose it: because it feels itself immortal and wants to be so, it cannot normally believe that its members, above all those in whom it incarnates itself and with whom it identifies itself, should be fated to die.[29]

It must carry out the twin tasks of separating the dead from the continuing society and reallocating their former roles to the living. Blauner also develops this theme. In high-mortality societies where death is so disruptive, "funerals are not 'mere rituals,' but significant adaptive structures".

> [T]he dead body must be buried with the appropriate ritual so as to give the dead man a new status that separates him from the living . . . ; his property, roles, rights and privileges must be distributed so that social and economic life can continue; and, finally, the social units—family clan, and community as a whole—whose very existence and functioning his death has threatened, must have a chance to vigorously reaffirm their identity and solidarity through participation in ritual ceremony.[30]

More generally, Blauner argues that "to the extent death imperils the continuity of a society, its major institutions will be occupied with providing that sense of identity and integrity made precarious by its severity".[31] Kinship, community and religion are among such institutions, providing a permanence and stability lacking in a smaller nuclear unit.

What then would be the effects of mortality decline? The gradual removal of death from common experience—and its literal segregation in the case of many modern low-mortality régimes—lessens the need for reallocations of roles and dissociates reallocation from death. The institutions that coped with it would presumably tend to erode, with important, even profound, consequences for the nature of society. For kin and community, the breakdown of local ties plausibly leads to a shift towards individualism on the one hand and towards supra-village loyalties on the other. The diminishing significance of religion in modern life is even more far-reaching. Paul Johnson writes that "The decline and ultimately the collapse of the religious impulse [leaves] a huge vacuum. The history of modern times is in great part the history of how that vacuum has been filled".[32] There are other forces making for each of these changes, but mortality decline contributes.

Routine survival to old age has probably accentuated the age-grading of modern societies. Various writers have pointed to the emergence of distinctive life "stages" as death ceases to be a significant risk in childhood or the middle years of life. The recognition of "childhood", "adolescence" and "old age" is dependent on achievement of a degree of predictability of life.[33]

Cultural responses are probably not generated in the first instance unless more straightforward and less disruptive options are precluded. William McNeill records a remarkable instance of quite different reactions by the same society to a mortality crisis on two occasions 50 years apart. Venice was threatened by the plague in the sixteenth century and again in the early seventeenth century. The first time the experience led to significant development of public health measures; the second time to "a great outburst of piety".[34] We have in effect a multiphasic societal response in the sense of Davis but in a radically expanded domain.

* * *

I have sketched three modes of societal adaptation to changing mortality conditions: through the existing institutional set-up in the society, eliciting appropriately altered demographic and economic behaviour; through adjustments in those institutions, leading (perhaps only eventually) to a structure that better accords with the new mortality régime; and through changes in the larger cultural system that imposes and, if imperfectly, preserves a degree of coherence in the meanings that attach to death and its tangible consequences.

Adaptation connotes "successful" adjustment, with success for the most part interpreted in the sense of material well-being. Failure in simple homoeostatic adaptation, the first of these modes, leaves open the chance of subsequent remedy through institutional change; and failure in institutional adaptation leaves open the route of culturally led material achievement. (Behavioural and institutional change necessarily have their own cultural consequences, layering the analytical problem in complexities.) Yet success has a time dimension, which no attempt has been made to take into account in this chapter. What over a generation or so (the distant horizon of development planning) meets all the canons of adaptational accomplishment for a society, may in the longer historical scheme of things be brought to nothing. Nations long ago ceased to be economic or geographic isolates, and hence cannot define their futures and direct their adaptive responses as if they still were. And the modern mortality régime itself, casually and so far accurately characterized by extremely low volatility, may at any time be decisively transformed in a demographic convulsion of a scale unknown in history since the Great Plague in Europe and the post-Cortez devastation of the Americas—as an outcome of the very technological prowess that made the era of mortality decline one of unparalleled material advance.

NOTES

[1] Peter Laslett, "The conversation between the generations", in *Philosophy, Politics and Society,* Fifth Series, Peter Laslett and James Fishkin, eds. (New Haven, Yale University Press, 1979).

[2] E. A. Wrigley and R. S. Schofield, *The Population History of England 1541-1871: A Reconstruction* (Cambridge, Mass., Harvard University Press, 1981), p. 317.

[3] See David R. Weir, "Life under pressure: France and England, 1670-1870", *Journal of Economic History* 44 (1983), table 3.

[4] William H. McNeill, *Plagues and Peoples* (Garden City, N.Y., Anchor Press, 1976).

[5] Ansley J. Coale, *Rapid Population Change in China, 1952-1982* (Washington, D.C.: National Academy Press, 1984), p. 70.

[6] See the summarized results of studies spanning nearly a century given in United Nations, *The Determinants and Consequences of Population Trends,* Population Studies, No. 50, vol. I, pp. 137-140.

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[10] Stephen Toulmin, "The natural past and the human future: an introductory essay", in *How Humans Adapt: A Biocultural Odyssey,* Donald J. Ortner, ed. (Washington, D.C., Smithsonian Institution Press, 1983).

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[13] Hubert Charbonneau and André Larose. *The Great Mortalities: Methodological Studies of Demographic Crises in the Past* (Liège, Ordina Editions, 1979).

[14] Preston, loc. cit., p. 318.

[15] Samuel H. Preston, ed., *The Effects of Infant and Child Mortality on Fertility* (New York, Academic Press, 1978), pp. 11, 15.

[16] Kingsley Davis, "The theory of change and response in modern demographic history", *Population Index* 29 (1963): 345-366.

[17] See, for example, Albert O. Hirschman, *The Strategy of Economic Development* (New Haven, Yale University Press, 1958); Ester Boserup, *The Conditions of Agricultural Growth* (London, Allen and Unwin, 1965); and Colin Clark, *Population Growth and Land Use* (New York, St. Martins Press, 1967).

[18] Pierre Gourou, *The Tropical World,* 4th ed. (London, 1965), pp. 103-107.

[19] McKim Marriott, "Technological change in overdeveloped rural areas", *Economic Development and Cultural Change* 1 (1953): 261-272.

[20] Clifford Geertz, *Agricultural Involution: The Processes of Ecological Change in Indonesia* (Berkeley, University of California Press, 1963).

[21] See, for example, the case study by Kai T. Erikson, *Everything in Its Path: Destruction of Community in the Buffalo Creek Flood* (New York, Simon and Schuster, 1976).

[22] Nathan Keyfitz, "Age distribution as a challenge to development, *American Journal of Sociology* 70 (1965): 659-668.

[23] Norman B. Ryder, "Fertility and family structure", *Population Bulletin of the United Nations,* No. 15 (United Nations publication, Sales No. E.83.XIII.4), p. 27.

[24] Norman B. Ryder, "Reproductive behaviour and the family life cycle", in *The Population Debate: Dimensions and Perspectives,* vol. II (United Nations publication, Sales No. 75.XIII.5).

[25] Jean Fourastié, "De la vie traditionnelle à la vie 'tertiaire': recherches sur le calendrier démographique de l'homme moyen", *Population* 14 (1959), p. 419.

[26] Compare the picture set out in Peter Laslett, *The World We Have Lost* (London, Methuen, 1971).

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[28] These issues are explored in characteristically entertaining fashion in Kenneth E. Boulding, "The menace of Methuselah: possible consequences of increased life expectancy", *Journal of the Washington Academy of Sciences* 55 (1965).

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[30] R. Blauner, "Death and social structure", *Psychiatry* 29 (1966), p. 387.

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[33] See Tamara K. Hareven, "Historical changes in the timing of family transitions: their impact on generational relations", in *Aging: Stability and Change in the Family,* Robert W. Fogel and others, eds. (New York: Academic Press, 1981).

[34] William H. McNeill, "Disease in history", *Social Science and Medicine,* 12, series B (1978), p. 84.

II. THE DIRECT AND INDIRECT EFFECTS OF MORTALITY DECLINE ON DEMOGRAPHIC VARIABLES

*Robert Schoen**

The last hundred years may well be remembered as the era of the great decline in mortality. Around 1880, life expectancy at birth was in the mid-40s in northern and western Europe and in the mid-20s in Africa, Asia and Latin America. Now most countries have life expectancies at least in the low 40s, and many have life expectancies in the high 70s.[1] Over all, almost a doubling of the length of life has taken place, a profound change that has led to enormous growth in the size of the human population and to alterations in its composition by age, sex, nationality and many other characteristics.

This chapter will deal only with the effects of mortality decline on demographic variables, especially measures of mortality, fertility, population growth and age composition. Three principal topics are addressed. First, the effects of a mortality decline on the experience of a cohort (a group of persons born in the same year) will be examined, using the life table model. Secondly, the effects of a mortality decline on a cross-sectional (or period) population will be explored, using the stable population model. In both instances, Coale-Demeny "West" models will be used to illustrate the typical pattern of mortality. Thirdly, the possible influences of population heterogeneity on mortality will be considered.

A. THE EXPERIENCE OF A COHORT: THE LIFE TABLE MODEL

Measuring mortality

In many respects, mortality is a phenomenon that readily lends itself to accurate measurement. It is an event of consequence, it is generally unambiguous, and it occurs once and only once for every person. Still, there are a large number of measures of mortality in the literature, because the phenomenon can usefully be considered from a number of perspectives.

Perhaps the most basic measure is the force of mortality, the instantaneous probability of death at an exact age expressed as an annual rate.[2] If the exact age is x, and the number of survivors to age x in a cohort is ℓ_x, the force of mortality at age $x(\mu_x)$ can be expressed by

$$\mu_x = -\frac{1}{\ell_x}\frac{d}{dx}\ell_x . \qquad (1)$$

The force of mortality can be used to construct other measures of mortality, for example, the age-specific death rate (ASDR). An ASDR can be defined over any age interval, say from exact age x to the instant before the attainment of exact age $x+n$, by

$$_nm_x = \frac{\int_0^n \ell_{x+t}\,\mu_{x+t}\,dt}{\int_0^n \ell_{x+t}\,dt} = \frac{_nd_x}{_nL_x} \qquad (2)$$

where $_nd_x$ represents the number of deaths in the cohort between the ages of x and $x+n$ and

$_nL_x$ represents the number of person-years lived by the cohort between those ages.

The force of mortality is conceptually precise, but cannot be measured exactly, while there are a number of ways to obtain good measures of the age-specific death rate. The ASDR is a weighted average of the force of mortality over an age interval, and in most cases

$$\mu_{x+\frac{1}{2}n} \approx {}_nm_x .$$

The ASDR needs to be distinguished from $_nq_x$, the probability that a person exact age x will die before attaining exact age $x+n$. That probability of death is given by

$$_nq_x = \frac{_nd_x}{\ell_x} . \qquad (3)$$

Comparing $_nm_x$ in equation (2) with $_nq_x$ in equation (3) reveals that both quantities are ratios with identical numerators but different denominators. For one-year age intervals (when $n=1$), it can be seen that m_x will always be greater than q_x, as ℓ_x must be greater than L_x if anyone dies at attained age x (i.e., at age x last birthday). If the ℓ_x function can be taken as linear between ages x and $x+1$, that is, if

$$L_x = \tfrac{1}{2}(\ell_x + \ell_{x+1}) ,$$

we have

$$q_x = \frac{m_x}{1+\frac{1}{2}m_x} \qquad (4)$$

which can be used with the relationship

$$\ell_{x+1} = \ell_x - d_x$$

to calculate the survivorship (ℓ_x) column from the death rates (m_x). Another useful measure is $_np_x$, the probability that a person exact age x will survive to exact age $x+n$. Since every person aged x must either survive to age $x+n$ or die before attaining that age, we have

$$_np_x = 1 - {}_nq_x . \qquad (5)$$

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A number of indexes summarize mortality over the life span. The expectation of life (or life expectancy) of a person aged x, the average number of years a person aged x can expect to live under a given age-specific schedule of mortality, is given by

$$e_x = \frac{\int_0^\infty t\ell_{x+t}\,\mu_{x+t}\,dt}{\int_0^\infty \ell_{x+t}\,\mu_{x+t}\,dt} = \frac{T_x}{\ell_x} \qquad (6)$$

where T_x represents the number of person-years lived by the cohort at and above exact age x. The symbol e_0 denotes the expectation of life at birth. One can also speak of the "variance of life", that is, the variance of the distribution of deaths,[3] which is

$$\sigma_d^2 = \frac{1}{\ell_0}\int_0^\infty (t-e_0)^2\,\ell_t\,\mu_t\,dt = e_0\,(2A_L - e_0) \qquad (7)$$

where A_L can be defined by

$$A_L = \frac{\int_0^\infty t\ell_t\,dt}{\int_0^\infty \ell_t\,dt}.$$

It is easier to think of such functions as σ_d^2 and A_L in period as opposed to cohort terms. In one sense, a life table represents the experience of a birth cohort, with ℓ_x the number of survivors to age x and L_x the number of person-years lived at age x last birthday. However, the life table can also be thought of in period terms as a "stationary population". A stationary population will arise from a long history of unchanging mortality rates and annual birth cohorts of ℓ_0 persons, and does not change in either total size or age composition. The mortality experience of the stationary population in one year is identical to the mortality experience of any cohort in the population over its entire lifetime. For example, every year the stationary population will experience ${}_nd_x$ deaths between the ages of x and $x+n$, and ℓ_0 deaths at all ages. Furthermore, in the stationary population L_x is the number of persons alive at age x last birthday, A_L is the mean age of the stationary population, and σ_d^2 is the variance of the distribution of deaths in any year.

Another index which summarizes mortality at all ages is the crude death rate, which is simply the total number of deaths in a year divided by the total population. In terms of the stationary population, the life table crude death rate (LTCDR) is

$$LTCDR = \frac{\sum_x d_x}{\sum_x L_x} = \frac{\ell_0}{T_0} = \frac{1}{e_0}. \qquad (8)$$

The expectation of life and the crude death rate have been termed "aggregative indexes",[4] as they aggregate a number of deaths, aggregate a number of persons, and then take the ratio of the two, thus reflecting a weighted distribution of deaths. An alternative type of index was termed an "average of relatives", as it averages a weighted set of ASDRs and thus reflects a weighted distribution of death *rates*. An example of an average of relatives mortality index is del,[5] defined by

$$\nabla = \left(\prod_{i=1}^{n} m_i\right)^{1/n}. \qquad (9)$$

Del is thus the geometric mean of the set of ASDRs, and is usually calculated using the conventional 19 age categories 0, 1-4, 5-9, . . . , 80-84, and 85+.

With the above measures in hand, we can proceed to examine changes in mortality. A good place to begin is with typical patterns of mortality at different levels of life expectancy.

Levels of mortality

It is a common practice to use the expectation of life at birth to represent the level of mortality implied by a set of age-specific death rates. However, while one can always calculate e_0 from the ASDRs, knowledge of e_0 alone is not sufficient to identify the underlying age pattern of mortality. The ASDRs are, in principle, unconstrained, although they do exhibit considerable regularities in practice. A number of researchers have studied those regularities, and have put forth mathematical formulas and sets of model life tables to express them. For present purposes, we will focus on the work of Coale and Demeny.[6]

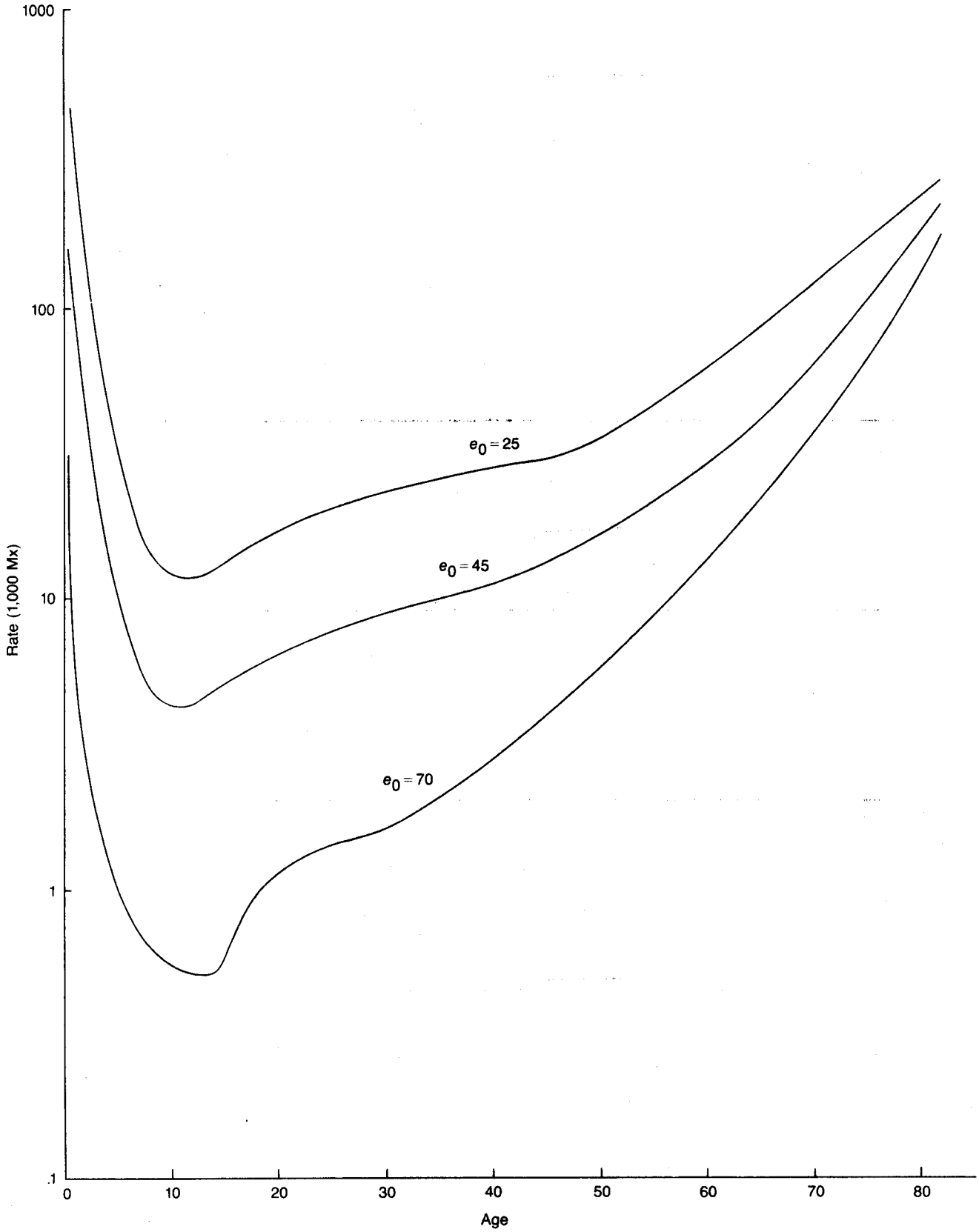
Changes in measures of mortality

The Coale and Demeny model life tables identified four "families" of mortality patterns, denoted "North", "South", "East" and "West" because they tended to characterize the patterns of mortality observed in those regions of Europe. Within each family, the ASDRs were seen as varying in a systematic and predictable way as the level of mortality changed. Let us consider the West pattern, as that appears to characterize both Western Europe and overseas European populations and is assumed to reflect the experience of a number of third world countries as well. Figure II.1 shows the age curve of mortality for "West" females at life expectancies of 25, 45 and 70 years. The basic similarity of the three curves is evident, even though they do differ somewhat. In these models and in a number of observed populations, mortality declines tend to produce a downward shift of the entire age curve of mortality, while the shape of the curve, that is, the relative magnitudes of the individual ASDRs, changes only slightly.

Table II.1 presents several mortality measures calculated from the Coale-Demeny "West" model life tables for females at different levels of mortality. It is clear that, while the age curve of mortality changes little, the age distribution of cohort deaths changes drastically as one moves from low to high life expectancies. At an e_0 of 20 years, 53 per cent of the cohort die before attaining age 5, while only 8 per cent survive to age 65. In contrast, at an e_0 of 75 years, only 2 per cent die before age 5 while 83 per cent survive to age 65. The variance of the ages at death (σ_d^2) provides another measure of those changes. As e_0 increases from 20 to 45 years, σ_d^2 increases, as the numbers of deaths at young and old ages tend to become more equal. At higher life expectancies, σ_d^2 falls, as deaths are increasingly concentrated at ages over 65. Even when e_0 is 75, few persons survive to age 90, and thus there is relatively little variability in the age at death.

At the higher life expectancies, changes in the expectation of life are largely dependent on changes in ASDRs at ages over 65, as changes in the very small ASDRs at younger ages result in only minor changes in the distribution of deaths. For example, when e_0 increases from 50 to 55, ∇ falls 18 per cent, from 17.6 per

Figure II.1. Age-specific death rates (x1,000), Coale-Demeny "West" model life tables for females



Source: Calculated from A. J. Coale and P. Demeny, ***Regional Model Life Tables and Stable Populations*** (Princeton, New Jersey, Princeton University Press, 1966).

TABLE II.1. MEASURES OF MORTALITY DERIVED FROM THE COALE-DEMENY "WEST" MODEL LIFE TABLES FOR FEMALES

Average age at death (e_0)	Proportion of deaths: under age 5	Proportion of deaths: over age 65	Variance of the ages at death (σ_d^2)	1,000 x del[a] (∇)	Product $e_0 \cdot \nabla$
20	.53	.08	621	49.0	.98
25	.45	.12	741	41.2	1.03
30	.39	.17	833	34.9	1.05
35	.33	.23	897	29.6	1.04
40	.27	.30	930	25.1	1.00
45	.23	.36	932	21.1	.95
50	.18	.44	897	17.6	.88
55	.14	.51	820	14.4	.79
60	.10	.58	715	11.4	.69
65	.07	.66	580	8.6	.56
70	.04	.75	417	5.7	.40
75	.02	.83	269	3.2	.24

Source: Calculated from A. J. Coale and P. Demeny, *Regional Model Life Tables and Stable Populations* (Princeton, New Jersey, Princeton University Press, 1966).

[a] Here del is the 18th root of the product of the death rates for ages 0, 1-4, 5-9, . . . , 75-79 and 80+.

1,000 to 14.4 per 1,000. However, when e_0 increases from 70 to 75, ∇ falls 44 per cent, from 5.7 to 3.2. In effect, at higher life expectancies a larger proportionate decline in death rates is required to produce the same increase in longevity. The last column of table II.1 illustrates that point in a slightly different manner. It represents the ratio of del to the life table crude death rate ($1/e_0$) or the product of e_0 and del. That product is approximately unity for values of e_0 from 20 to 45, but then drops sharply as large declines in del are associated with relatively small increases in e_0.[7] The interaction between the degree of responsiveness to mortality change and the initial level of mortality exhibited by aggregative indexes should be borne in mind when choosing and interpreting summary measures of mortality.

Changes in the age profile of a cohort

The shape of the survivorship (ℓ_x) function provides an age profile for a cohort, and reflects the cumulative age distribution of cohort deaths. Let us take ω to be the limit of the human life span, or the age at which the number of survivors becomes zero. If every member of the cohort survives to just before age ω, then the ℓ_x curve will be a horizontal straight line from 0 up to ω. If there are the same number of deaths at every age, then

$$\ell_x = \ell_0 \left(1 - \frac{x}{\omega}\right).$$

To summarize the shape of the ℓ_x curve, Demetrius proposed a measure of entropy, where entropy refers to the information content (or randomness) of a distribution.[8] Demetrius' measure of entropy, H, can be written as

$$H = - \frac{\int_0^\infty \ell_x \, \ell n \left(\frac{\ell_x}{\ell_0}\right) dx}{\int_0^\infty \ell_x \, dx}. \qquad (10)$$

Since the integral in the numerator is always negative, H is always positive, except that H is zero if all mortality occurs at age ω. The value of H reflects the degree to which the ℓ_x curve is concave upward (the smaller the value of H, the less the concavity), and provides a measure of the extent to which mortality declines are allowing the great majority of cohort members to survive to the high ages. If an equal number die at every age, ℓ_x is a straight (diagonal) line, and H = .5. For contemporary Western populations, H is approximately .15-.20, down from about .30-.40 in the years immediately following the Second World War.[9] The entropy measure can be of value in examining the effects of mortality changes, as will be seen in the next section.

Effects of mortality declines on survivorship

In the cohort context, we are primarily interested in the effects of a reduction in mortality on the probability of survival to a given age and on the expectation of life at birth. Keyfitz showed[10] that if μ_x, the force of mortality at age x, became μ'_x, where

$$\mu'_x = \mu_x + \Delta \mu_x,$$

then the probability that a person would survive from birth to age y ($y > x$) would change by

$$\frac{\Delta \ell_y}{\ell_0} = - \frac{\ell_y}{\ell_0} \Delta \mu_x .$$

More generally, Arthur[11] showed that changes in mortality at ages up to age y would change the probability of survival to that age by

$$\frac{\Delta \ell_y}{\ell_0} = - \frac{\ell_y}{\ell_0} \int_0^y \Delta \mu_x \, dx . \qquad (11)$$

For example, if the original probability of surviving to age y was .90 and the sum of the changes in the force of mortality up to age y was $-.05$ (the minus sign indicating a mortality decrease), then the change in the probability of surviving to age y would be $-(.90)(-.05) = .045$, or the new probability of survival would be .945.

If the force of mortality changes at age x, Keyfitz[10] found that the expectation of life at birth would change by

$$\Delta e_0 = -\frac{\ell_x}{\ell_0} e_x \Delta \mu_x .$$

In the case of proportional changes in mortality at all ages, that is, when

$$\mu'_x = (1+k)\mu_x \quad 0 < x < \omega,$$

Keyfitz[9] showed that

$$\Delta e_0 = -k e_0 H \tag{12}$$

where H is entropy, as defined in equation (10). For example, males in the United States of America in 1959-1961 had a life expectancy of 66.84 years and a value of H of .2083. A 1 per cent decline in mortality at all ages would increase life expectancy by $-(-.01)(66.84)(.2083) = +.14$ years. Since H declines as e_0 rises, we again note that equal proportional declines in mortality at all ages produce smaller proportional gains in longevity for higher values of e_0. The proportionality assumption is of particular interest because, as figure II.1 suggests, a number of mortality declines have been roughly proportional at most ages.

B. Experience of a period: the stable population model

The period-cohort contrast

A stable population will arise from the persistence of given age schedules of mortality and fertility, and is characterized by an unchanging age structure and by a constant "intrinsic" rate of growth, denoted as r.[12] In a stationary population, every birth cohort is the same size, but in a stable population the birth cohort in year $t+1$ is e^r times the birth cohort in the year t. A stationary population can thus be thought of as a special case of a stable population, one where $r = 0$.

Mathematically, a stable population is defined by its "characteristic" or "renewal" equation, which can be written

$$\ell_0 = \int_0^\omega e^{-rx} \ell_x f_x \, dx \tag{13}$$

where f_x is the fertility rate at exact age x. The expression under the integral sign, $e^{-rx}\ell_x f_x$, can be interpreted as representing the number of births to persons aged x; as it is (a) the number of survivors to age x of a birth cohort of ℓ_0 persons (ℓ_x), (b) discounted for x years of population growth to indicate the size of the birth cohort x years before (e^{-rx}), and (c) multiplied by the fertility rate at age x (f_x). When integrated over all ages x, that number of births is constrained to equal ℓ_0, the number of births in the stable population in the reference year. Equation (13) thus characterizes a stable population by showing how its age structure, fertility and mortality act to renew the population and continue its exponential birth sequence.

In a stable population, the mortality experience of every cohort is the same, as mortality does not change, but the lifetime experience of a cohort is no longer the same as the population's experience in a given year, because the population is composed of cohorts of unequal size. For example, in a stationary population, the birth rate is equal to the death rate. In a stable population, that is not the case, and the relationship is

$$b = d + r \tag{14}$$

where b is the crude birth rate of the stable population (that is, the number of births divided by the total population) and
d is its crude death rate.

Age composition and levels of fertility and mortality

The age composition of a stable population is completely determined by its fixed schedules of fertility and mortality. Let $c(x)$ represent the proportion of the stable population at exact age x. As a stable population is generally considered closed to migration, we have

$$c(x) = \frac{e^{-rx}\ell_x}{\int_0^\omega e^{-rt}\ell_t \, dt} = b e^{-rx} \frac{\ell_x}{\ell_0} \tag{15}$$

as

$$c(0) = b = \frac{\ell_0}{\int_0^\omega e^{-rt}\ell_t \, dt}.$$

Mortality at every age thus affects $c(x)$ directly through ℓ_x and indirectly through its role in determining r. Fertility affects $c(x)$ only indirectly through r. Still, one should not expect mortality to exert the greater influence. People die at all ages, but they are born only at age 0. Therefore, fertility exerts its impact on age composition at a specific point, while the effects of mortality are distributed over all ages, and are likely to be offsetting.[13]

Table II.2. The mean age of the population and the proportion under age 15 for a range of mortality and fertility assumptions, Coale-Demeny "West" model stable populations for females

Gross reproduction rate[a]	Expectation of life at birth			
	25	45	60	70
0.8	44.15	43.28	42.95	43.27
	(.108)	(.134)	(.146)	(.149)
1.0	40.92	39.58	39.01	39.15
	(.141)	(.173)	(.188)	(.192)
1.5	34.86	32.87	32.01	31.89
	(.214)	(.258)	(.279)	(.286)
2.0	30.65	28.42	27.46	27.23
	(.277)	(.328)	(.350)	(.359)
2.5	27.55	25.26	24.30	24.02
	(.329)	(.384)	(.408)	(.417)
3.0	25.17	22.92	21.99	21.68
	(.373)	(.429)	(.454)	(.464)
3.5	23.29	21.11	20.22	19.91
	(.411)	(.468)	(.492)	(.502)

Source: A. J. Coale and P. Demeny, *Regional Model Life Tables and Stable Populations* (Princeton, New Jersey, Princeton University Press, 1966).

Note: The figures in parentheses are the proportions under age 15.

[a]The gross reproduction rate (GRR) is the number of daughters a woman would have in her lifetime under a given set of age-specific fertility rates in the absence of mortality.

To compare the effects of different combinations of mortality and fertility on age composition, we can again make use of the Coale-Demeny "West" model populations. Table II.2 presents two measures of age composition, the mean age of the population and the proportion under age 15, for model female stable populations with life expectancies ranging from 25 to 70 years and gross reproduction rates ranging from 0.8 to 3.5. Looking down each of the four columns one can see that the age composition changes substantially when fertility varies and mortality is held constant. High-fertility populations have mean ages under 30 and over 30 per cent of the population under age 15. Low-fertility populations have mean ages over 30 and less than 30 per cent of the population under age 15. Looking across each of the five rows one can see that only small to moderate changes in age composition occur when mortality varies and fertility is held constant. At life expectancies of 45 and over, most changes are quite modest.[14]

We will next consider the magnitude and direction of the effects of mortality decline on stable population parameters in more detail, and examine why those effects are often small. It should be noted, however, that the present chapter deals only with the formal linkages between mortality and fertility. It does not consider the effects of the social and cultural factors that link the two, including lactation practices and the implications of declining infant mortality for fertility intentions.

Effects of mortality declines on stable population measures

A neutral change in mortality

As death occurs at all ages, one can conceive of a "neutral" change in mortality, that is, a change in the μ_x schedule that does not affect the age composition of the population. In particular, if the force of mortality declines by amount K at all ages, the intrinsic growth rate will increase by K but the $c(x)$ schedule will be unchanged.[15] While the number at every age will increase, the proportion at every age will remain the same. To demonstrate that mathematically, we can write, from equation (1),

$$\ell_x = \ell_0 \, e^{-\int_0^x \mu_t \, dt}. \tag{16}$$

Since

$$\mu'_x = \mu_x - K$$

$$\ell'_x = \ell_0 \, e^{-\int_0^x \mu'_t \, dt} = \ell_0 \, e^{-\int_0^x \mu_t \, dt} e^{\int_0^x K dt}$$

$$= \ell_x e^{Kx}.$$

Using that result in the characteristic equation, we obtain

$$\ell_0 = \int_0^\omega e^{-r'x} \ell'_x f_x \, dx$$

$$= \int_0^\omega e^{-(r'+K)x} \ell_x f_x \, dx$$

and thus, from equation (13), we must have

$$r' - K = r.$$

Recalling equation (15), we find that the new age composition is

$$c'(x) = \frac{e^{-r'x} \ell'_x}{\int_0^\omega e^{-r't} \ell'_t \, dt} = \frac{e^{-rx} e^{-Kx} e^{Kx} \ell_x}{\int e^{-rt} e^{-Kt} e^{Kt} \ell_t \, dt}$$

$$= c(x).$$

Thus declining mortality will always have a direct effect on increasing growth, but will only affect age composition when it deviates from a pattern of constant change at all ages.

Coale[13] examined mortality changes using the ratio of survivorship probabilities

$$\frac{p'_x - p_x}{p_x}$$

where the prime indicates the probability after the mortality decline. As he observed, that ratio would be the same at all ages in the case of a neutral change in mortality. While he found that the ratio was relatively constant for ages 5 to 50 inclusive, he reported that it took on much higher values at both extremes of life. While mathematically convenient, the idea of a neutral change in mortality must therefore be used with some care in empirical work.

One noteworthy example of a case where the concept of a neutral change in mortality was of value is the study by Preston,[16] who examined the relations between individual (cohort) life cycles and (period) population characteristics. Let $g(x)$ be the proportion of persons aged x who have attribute G. A neutral change in mortality does not affect G_P, the proportion of persons in the stable population with characteristic G. Preston showed, however, that a fall in mortality at all ages by amount K does affect G_L, the prevalence of G over the life cycle of a cohort. Mathematically,

$$\frac{dG_L}{dK} = G_L \, (A_G - A_L)$$

where A_G is the mean age of persons with G in the stationary population and

A_L is the mean age of the stationary population.

Thus the proportional change in G_L is directly related to the extent to which persons with characteristic G are older than all persons in the stationary population.

The general case of a change in mortality

The analysis of the effects of changes in mortality on stable population parameters is simplified by examining changes in the survivorship (ℓ_x) curve rather than in the force of mortality (μ_x) curve. Those two functions are closely related, as shown by equations (1) and (16), and the effect of changes in μ_x on ℓ_x is given in equation (11). The present treatment will draw heavily on Arthur,[11] who used functional differentials to relate changes in one function to changes in another.

Let us begin by examining the effect of changes in survivorship on the intrinsic growth rate. If the changes are described by

$$\ell'_x = \ell_x + \Delta \ell_x$$

and

$$r' = r + \Delta r$$

then

$$\Delta r = \frac{1}{A_M} \int_0^\omega e^{-rx} \left(\frac{\Delta \ell_x}{\ell_0}\right) f_x \, dx \qquad (17)$$

where A_M is the average age at childbearing in the stable population. The change in r is equal to the value of the characteristic integral with $\Delta \ell_x$ used instead of ℓ_x, and with the integral annualized by means of division by the average age at childbearing. Changes in survivorship thus affect r through changes in exposure to the risk of childbearing. Changes in mortality that only affect ages beyond the highest age of childbearing have no effect on r at all.

The increase in population growth is perhaps the most significant consequence of declining mortality; and as such it merits further examination. Let us therefore consider equation (17) in the case of a proportional decline in mortality, that is, when

$$\mu'_x = (1+k)\mu_x$$

for all x. Then

$$\Delta \mu_x = k \mu_x$$

and from equations (11) and (16) we can write

$$\frac{\Delta \ell_x}{\ell_0} = k \left(\frac{\ell_x}{\ell_0}\right) \ln \left(\frac{\ell_x}{\ell_0}\right). \qquad (18)$$

Substituting equation (18) into equation (17) we have

$$\Delta r = \frac{k}{A_M} \int_0^\omega e^{-rx} f_x \left(\frac{\ell_x}{\ell_0}\right) \ln \left(\frac{\ell_x}{\ell_0}\right) dx \qquad (19)$$

where the characteristic integral is weighted by $\ln \left(\frac{\ell_x}{\ell_0}\right)$.

If we can make the rather strong assumption that all fertility is concentrated at the average age at childbearing, equation (19) simplifies to

$$\Delta r \approx \frac{k}{A_M} \ln \left(\frac{\ell_{A_M}}{\ell_0}\right). \qquad (20)$$

Equation (20), which is believed to be new, indicates that the change in growth can be estimated without taking fertility into account. However, trial calculations suggest that equation (20) should be considered only a rough approximation. For example, equation (20) was used to estimate r for an increase in life expectancy from 25 to 30 years in a Coale-Demeny "West" female stable population with a GRR of 3.0. The value of k was found using the del measure (for all ages). The calculated value of Δr was .0050, while the published tables showed a Δr of .0061. Still, given the only approximate linearity of the mortality change and the strong fertility assumption, that estimate was seen as reasonably good.

The intrinsic birth rate, or the crude birth rate of the stable population, is also affected by mortality changes. Arthur found that the proportional change in b is given by

$$\frac{\Delta b}{b} = \frac{A_P}{A_M} \int_0^\omega e^{-rx} \left(\frac{\Delta \ell_x}{\ell_0}\right) f_x \, dx - b \int_0^\omega e^{-rx} \left(\frac{\Delta \ell_x}{\ell_0}\right) dx \qquad (21)$$

where A_P is the mean age of the stable population. The first term reflects the increase in births produced by decreased mortality, and the second term offsets that by the increase in population from the same cause. Those two terms seem similar in magnitude, and hence the proportional change in b is likely to be small. Preston, in an analysis using the Coale-Demeny "West" stable populations, found that even very substantial declines in mortality usually led to declines in the birth rate of less than 5 per cent.[15]

The change in the intrinsic death rate, the crude death rate of the stable population, is best approached using equation (14). We therefore have

$$\Delta d = \Delta b - \Delta r. \qquad (22)$$

The decline in d from a fall in mortality will thus usually be slightly greater in magnitude than the associated increase in r.

The proportional change in age composition from an increase in survivorship is the net result of three factors. Specifically, Arthur found that the change in the proportion at age y is

$$\frac{\Delta c(y)}{c(y)} = \frac{(A_p - y)}{A_M} \int_0^\omega e^{-rx} \left(\frac{\Delta \ell_x}{\ell_0}\right) f_x \, dx - b \int_0^\omega e^{-rx} \left(\frac{\Delta \ell_x}{\ell_0}\right) dx + \frac{\Delta \ell_x}{\ell_x}. \qquad (23)$$

The first factor on the right-hand side of equation (23) reflects the increase in births brought about by decreased mortality. Its effect is zero at the mean age of the stable population, and it increases the proportion of the population at ages below A_P while decreasing the proportion at ages above A_P. The second factor is negative, as it reflects the increase in the population from lower mortality. The third factor is positive and is the direct effect of increased survivorship. Arthur examined each of those factors, by age, as mortality went from that of the Coale-Demeny "West" model for females with a life expectancy of 62.5 years to a "West" model with a life expectancy of 65 years. He found that the birth effect on the proportion at a given age declined with age, the population effect did not vary with age, and the mortality effect increased with age. The net effect, as reported by Arthur and as found by Preston[15] in an earlier analysis, was that declining mortality (*a*) increased the proportion of the population under a certain age A, where A was close to the mean age at childbearing; (*b*) decreased the proportion from age A to some age B, where B was over 70, and (*c*) increased the proportion above age B.

The effects of mortality declines in model populations

The equations of the previous section provide analytical expressions for the effects of mortality changes in stable populations. It is also useful to examine figures showing what changes would be found in model populations having a range of fertility and mortality levels.

Table II.3 presents such measures for Coale-Demeny "West" model stable populations for females, with selected life expectancies from 25 to 70 years and with GRRs from 0.8 to 3.5. The initial population values are presented, along with the changes that resulted when fertility remained unchanged but mortality declined, yielding a 2.5-year increase in life expectancy.

Let us begin our examination of table II.3 by looking at changes in intrinsic growth rate r. As suggested by equation (20), Δr is sensitive to the initial level of mortality but not to the fertility level. A 2.5-year improvement in longevity increased growth by 1 to 3 units per 1,000. That is a modest but by no means insignificant change in growth rate, particularly when seen in the light of the much larger improvements in longevity that have characterized many third world countries since 1945.

The changes in intrinsic birth rate b were quite small, as suggested by equation (21) and the findings of previous studies. Only when e_0 was 25 years with a GRR of 3.5 did the change exceed 0.5 units per 1,000. As a result, the changes in intrinsic death rate d largely paralleled the changes in r, though they were opposite in sign.

For e_0 values 25 through 60, a 2.5-year increase in longevity slightly lowered the mean age of the stable population. The decrease ranged from .1 to .4 years, and varied with the initial e_0 but not with the level of fertility. Only at a life expectancy of 70 years did the mortality improvements bring about a slight aging of the population, and by an amount that varied inversely with the level of fertility. At such a high life expectancy, improvements in mortality that affect e_0 must come at the older ages.

Table II.3 also examines changes in the proportion of the population aged 0-14, 15-64 and 65 and over. The changes largely reflect the initial level of mortality. Greater longevity generally increased the proportion aged 0-14, especially at lower life expectancies where infant and childhood mortality were high. A model stable population with a GRR of 2.5 had 32.89 per cent of its members under age 15 when e_0 was 25, but 41.71 per cent when e_0 was 70. Of course, the usual pattern observed in populations going through the demographic transition was quite different. A model population with an e_0 of 25 and a GRR of 3.5 had 41.07 per cent aged 0-14, while a model with an e_0 of 70 and a GRR of 1.0 had only 19.24 per cent under age 15. Table II.3 shows that the decrease in the proportion under age 15 observed in post-demographic-transition populations is due to lower fertility, which overrode the compositional effects of lower mortality.

The proportion of the stable population in the presumed labour force ages of 15-64 decreased for all initial e_0 values, especially at the lowest life expectancies. A model population with a GRR of 2.5 had 62.93 per cent aged 15-64 when e_0 was 25, but 54.14 per cent when e_0 was 70. Again, that was not the experience of

TABLE II.3. THE EFFECTS OF A 2.5-YEAR INCREASE IN LONGEVITY ON STABLE POPULATION PARAMETERS, COALE-DEMENY "WEST" MODELS FOR FEMALES

Initial e_0 and values of GRR(29)[a]	Initial value of: Growth rate (per 1,000 population)	Birth rate	Death rate	Average age of population	Percentage aged 0-14	15-64	65+	Change[b] in: Growth rate (per 1,000 population)	Birth rate	Death rate	Average age of population	Percentage aged 0-14	15-64	65+
A. 25 years														
2.0	−8.50	31.28	39.77	30.65	27.67	66.48	5.85	3.19	−.14	−3.31	−.40	.88	−.87	−.01
2.5	−0.63	39.32	39.95	27.55	32.89	62.93	4.18	3.21	−.27	−3.48	−.42	.95	−.93	−.02
3.0	5.88	46.67	40.79	25.17	37.30	59.58	3.12	3.22	−.43	−3.65	−.41	.99	−.96	−.03
3.5	11.43	53.39	41.95	23.29	41.07	56.53	2.40	3.23	−.60	−3.82	−.40	1.00	−.98	−.02
B. 45 years														
2.0	10.08	30.25	20.17	28.42	32.77	61.37	5.86	1.58	−.11	−1.69	−.18	.42	−.43	.01
2.5	18.06	37.47	19.41	25.26	38.37	57.57	4.07	1.59	−.18	−1.77	−.17	.45	−.46	.01
3.0	24.66	43.92	19.26	22.92	42.94	54.09	2.97	1.59	−.26	−1.85	−.18	.47	−.46	−.01
3.5	30.29	49.71	19.42	21.11	46.77	50.98	2.25	1.60	−.33	−1.93	−.17	.46	−.44	−.02
C. 52.5 years														
1.5	4.40	22.06	17.66	32.37	26.99	64.00	9.01	1.32	−.03	−1.35	−.15	.32	−.32	.00
2.0	14.57	29.96	15.39	27.87	34.05	60.11	5.84	1.34	−.08	−1.42	−.17	.37	−.34	−.03
2.5	22.58	36.97	14.39	24.71	39.71	56.26	4.03	1.34	−.14	−1.48	−.16	.38	−.35	−.03
3.0	29.20	43.20	14.00	22.38	44.32	52.77	2.91	1.34	−.20	−1.55	−.15	.38	−.36	−.02
D. 60 years														
1.5	8.10	21.94	13.85	32.01	27.86	63.05	9.09	1.06	−.06	−1.13	−.07	.23	−.29	.06
2.0	18.30	29.70	11.41	27.46	35.04	59.12	5.84	1.07	−.10	−1.17	−.09	.26	−.29	.03
2.5	26.32	36.55	10.23	24.30	40.75	55.25	4.00	1.08	−.14	−1.22	−.09	.28	−.31	.03
3.0	32.96	42.61	9.65	21.99	45.37	51.74	2.89	1.08	−.19	−1.27	−.10	.29	−.29	.00
E. 70 years														
0.8	−9.84	9.58	19.42	43.27	14.88	63.94	21.18	.67	−.12	−.79	.35	−.09	−.68	.77
1.0	−2.20	13.12	15.32	39.15	19.24	64.23	16.53	.68	−.12	−.80	.28	−.06	−.45	.51
1.5	11.93	21.66	9.73	31.89	28.60	61.87	9.53	.68	−.14	−.82	.15	.00	−.35	.35
2.0	22.16	29.29	7.13	27.23	35.92	57.99	6.09	.68	−.15	−.83	.08	.06	−.26	.20
2.5	30.20	35.99	5.78	24.02	41.71	54.14	4.15	.69	−.17	−.85	.04	.08	−.21	.13

Source: Calculated from A. J. Coale and P. Demeny, *Regional Model Life Tables and Stable Populations* (Princeton, New Jersey, Princeton University Press, 1966).

[a] Gross reproduction rate (GRR) based on a mean age at birth of 29 years.

[b] The change is the value at the higher life expectancy less the initial value.

populations undergoing the demographic transition. A model female population with an e_0 of 25 and a GRR of 3.5 had 56.53 per cent aged 15-64, while a population with an e_0 of 70 and a GRR of 1.0 had 64.23 per cent at those ages. The effects of declining fertility more than compensated for those of declining mortality, and increased the proportion aged 15-64.

The proportion of the female stable population aged 65 and over was only slightly affected by a 2.5-year increase in longevity, and the only non-negligible effects found were in the models with an e_0 of 70 years. A model population with an e_0 of 25 and a GRR of 2.5 had 4.18 per cent over 65, while a model with an e_0 of 70 and a GRR of 2.5 had 4.15 per cent, a virtually identical proportion. As has often been reported, the "aging" seen in contemporary populations is a result of declines in fertility, not declines in mortality.

C. Non-homogeneous populations

The basic model

To this point, we have been considering the effect of mortality changes in homogeneous populations, that is, in populations where all those at age x are considered to have an equal likelihood of dying. In reality, of course, some persons aged x are healthier than others, and hence there is heterogeneity with respect to the risk of death. Recognizing heterogeneity can greatly complicate mortality analyses, even when the requisite data are available (which is generally not the case).

One difficulty is that, over time, the less healthy die more quickly, and thus differential mortality works to change the composition of the population with respect to the risk of dying. Keyfitz and Littman[17] looked at a population, undifferentiated by age, that was composed of two groups with different mortality. Let the sizes of the two groups be proportional to a_1 and a_2 (where $a_1 + a_2 = 1$), and let the two groups be subject to death rates m_1 and m_2. The overall death rate in that population, m, is then given by

$$m = a_1 m_1 + a_2 m_2 \tag{24}$$

and the life expectancies of the population and the two subgroups are, respectively, $1/m$, $1/m_1$ and $1/m_2$. However, if a person is picked at random from the population, that person's life expectancy is

$$\frac{a_1}{m_1} + \frac{a_2}{m_2}, \tag{25}$$

a number that Keyfitz and Littman showed was greater than $1/m$. For example, let $a_1 = .8$, $a_2 = .2$, $m_1 = .020$, and $m_2 = .010$. Then from equation (24)

$$m = (.8)(.020) + (.2)(.010) = .018$$

and the total population life expectancy is (1/.018) or 55.56 years. Using expression (25), however, we find that the life expectancy of a person picked at random is

$$\frac{.8}{.020} + \frac{.2}{.010} = 60 \text{ years.}$$

Why? The reason is that, as those alive at the initial time point move through life, the surviving population will have an increasing proportion subject to the lower death rate and a decreasing proportion subject to the higher death rate, simply because those subject to the higher death rate die sooner. When life expectancy is taken to be $1/m$, that process of compositional change is ignored, and the resultant life expectancy is too small. We will call that effect of heterogeneity the *cohort compositional* effect.

Let us now turn our attention to experience in a single year, where the proportions a_1 and a_2 remain constant, and consider the effects of a mortality decline. Let the new death rate be $(1-k)m$. Then, if the population is homogeneous, the new population life expectancy is $1/[(1-k)m]$. The increase in longevity is

$$\frac{1}{(1-k)m} - \frac{1}{m} = \frac{1}{m}\left(\frac{1}{1-k} - 1\right) = \frac{1}{m}(k + k^2 + k^3 + \ldots) \approx \frac{k}{m} \tag{26}$$

with the latter sufficing when k is small. In a heterogeneous population, however, mortality may improve in only one group. Assume that the new death rate in group 1 is $(1-k_1)m_1$, while the death rate in group 2 remains unchanged. To reproduce the above overall death rate we must have

$$(1-k)m = a_1 m_1 (1-k_1) + a_2 m_2$$

which yields

$$k_1 = \frac{km}{a_1 m_1}.$$

Now the increase in life expectancy for the first group is

$$\frac{1}{m_1(1-k_1)} - \frac{1}{m_1} = \frac{1}{m_1\left(1 - \frac{km}{a_1 m_1}\right)} - \frac{1}{m_1} \approx \frac{km}{a_1 m_1^2}$$

while there is no increase in the second group. Since the improvement only affects group 1, the difference in expectations for the population is a_1 times the last expression, which is approximately

$$\left(\frac{m}{m_1}\right)^2 \frac{k}{m}. \tag{27}$$

That result is quite different from the one found for homogeneous populations in equation (26).

To gain a numerical appreciation of the difference between homogeneous and heterogeneous populations with respect to mortality declines, let us continue our numerical example with an assumed overall mortality decline of .05. If the population were homogeneous, the increase in life expectancy from that mortality decline would be

$$\frac{1}{(.95)(.018)} - \frac{1}{(.018)} = 2.924 \text{ years}$$

(or approximately .05/.018 = 2.778). Now if the population were seen as heterogeneous and only the

death rate in group 1 declined, the mortality decrease in that group would be

$$k_1 = \frac{(.05)(.018)}{(.8)(.02)} = .05625,$$

the group 1 increase in life expectancy would be

$$\frac{1}{(.02)(.94375)} - \frac{1}{(.02)} = 2.980$$

and the population increase in life expectancy would be

$$(.8)\ (2.980) + (.2)\ (0) = 2.384 \text{ years.}$$[18]

Thus there is a difference of over half a year in the expected improvement in longevity due solely to heterogeneity and the distribution of the mortality decline. That effect, which emerges in the period experiencing the mortality decline, will be termed the *period distributional* effect. It is conceptually distinct from the cohort compositional effect, and is caused by the differential impact of mortality declines on life expectancy for groups with different initial levels of mortality. Expression (27) indicates that a mortality decline concentrated in the high-mortality subgroup will have a smaller impact on population longevity than a mortality decline that affects both subgroups equally, while a mortality decline in the low-mortality subgroup will have a greater impact than a decline that affects both groups equally.

More advanced models

The most common way of dealing with population heterogeneity is to identify the heterogeneous subgroups and deal with them separately. For example, mortality analyses are usually done separately for males and females, and many studies of mortality in the United States recognize two or more racial groups.

It is also possible to approach heterogeneity using mathematical models, a leading example of which is the work of Vaupel, Manton and Stallard.[19] They assume that frailty, a person's relative susceptibility to death, is fixed at birth. If frailty is assumed to be gamma distributed at birth, they show that frailty among the survivors to any age will continue to be gamma distributed, though the average frailty of the survivors will decrease with age due to differential mortality. A key point that emerges from their model is that the assumption of homogeneity, which is customarily used, leads to results that overestimate the effects of mortality declines on future increases in longevity. That overestimate is because the homogeneity assumption does not consider that after a mortality decline the surviving population, at every age, will be more frail than before, because the lower level of mortality allowed less healthy individuals to survive. The greater the heterogeneity, the greater the overestimate. Vaupel and others calculated that, under 1975 rates, longevity for Swedish females could vary by nearly two years, depending on the extent of heterogeneity.

Although the work of Vaupel and others is an important contribution, it stops far short of being a definitive treatment of heterogeneity. In particular, their model is limited by the assumptions which fix frailty at birth and assume that frailty follows a gamma distribution. While the gamma distribution has a number of desirable mathematical properties, there is no empirical evidence to suggest that it adequately describes how frailty varies in human populations. Moreover, it is known that the nature and extent of period distributional effects are greatly influenced by the choice of distribution.[20] The assumption that frailty is fixed at birth is almost certainly counterfactual, or at best an oversimplification.

The Vaupel and others assumptions must lead to the conclusion that higher mortality promotes "the survival of the fittest". Empirically, it is not at all clear that that is true. Studies which have looked at cohort mortality, that is, the effects of mortality experienced at younger ages on the mortality of the cohort later in life, have often found that higher early mortality is associated with higher—not lower—mortality at older ages.[21] Thus high levels of early mortality may indicate conditions that "scar" a cohort, and leave the survivors subject to increased mortality throughout their lives. Incorporating the possibility of such effects would lead to a more complex model than that of Vaupel and others, which was itself a major advance over previous efforts.

The work done to date leaves little doubt that population heterogeneity can have a significant impact on measures of mortality and mortality decline. None the less, both the direction and the magnitude of the resulting biases remain ambiguous, and more empirically grounded research is needed before effective tools to deal with heterogeneity can be developed.

D. Summary and conclusion

Mortality declines have characterized demographic change over the last century, and have had an enormous effect on all aspects of life. The present paper has focused on the effects of falling mortality on other demographic measures, and has made extensive use of the model populations developed by Coale and Demeny.

From a cohort or life table perspective, actual mortality declines appear to have involved roughly proportional falls in death rates at most ages (cf. figure II.1). As longevity has increased, a larger fraction of all deaths have become concentrated at a few high ages, and life expectancies have shown smaller gains from the same proportional decreases in mortality. Explicit formulas relating changes in mortality to changes in survivorship and longevity are presented in equations (11) and (12).

From a period perspective, mortality declines in stable populations have led to increased population growth and, in most cases, to a younger population. Mathematical relationships between improvements in survivorship and changes in other demographic measures are presented in equations (17) and (20) to (23), and some results for model populations are given in table II.3. In both model and observed populations, mortality effects on population composition are generally small in comparison to fertility effects. In particular, it has been fertility declines that have led to the increased proportion at the high ages in most Western populations.

Population heterogeneity with respect to mortality has been a topic of increased interest, and the evidence suggests that it can play a significant role in determining the nature and extent of mortality declines. Two different effects, the cohort compositional and the period distributional, were discussed, and the additional

complications that can follow when mortality at one age influences mortality at later ages were noted. Much ambiguity remains with respect to the effects of heterogeneity, and analysts are well advised to treat distinct subgroups separately.

The effects discussed here only begin to describe the impact that declining mortality has had on contemporary populations. None the less, they afford a valuable starting place for an appreciation of demographic change in general, and for gaining a better understanding of its larger socio-economic context.

NOTES

[1] S. H. Preston, "Mortality trends", *Annual Review of Sociology*, 1977, pp. 163-178.

[2] C. W. Jordan, Jr., *Life Contingencies*, 2d. ed. (Chicago, Society of Actuaries, 1975), pp. 12-17.

[3] Cf. N. B. Ryder, "Notes on stationary populations", *Population Index*, January 1975, pp. 3-28; and R. Schoen, "Measuring mortality trends and differentials", *Social Biology*, Sept. 1976, p. 237.

[4] E. M. Kitagawa, "Standardized comparisons in population research", *Demography* (1964), pp. 296-315.

[5] R. Schoen, "The geometric mean of the age-specific death rates as a summary index of mortality", *Demography*, August 1970, pp. 317-324.

[6] A. J. Coale and P. Demeny, *Regional Model Life Tables and Stable Populations* (Princeton, New Jersey, Princeton University Press, 1966).

[7] Cf. R. Schoen, "Measuring mortality trends and differentials", *Social Biology*, Sept. 1976, p. 237.

[8] L. Demetrius, "Relations between demographic parameters", *Demography*, May 1979, pp. 329-338.

[9] N. Keyfitz, *Applied Mathematical Demography* (New York, Wiley, 1977), pp. 62-68.

[10] N. Keyfitz, "Linkages of intrinsic to age-specific rates", *Journal of the American Statistical Association*, June 1971, pp. 275-281.

[11] W. B. Arthur, "The analysis of linkages in demographic theory", *Demography*, Feb. 1984, p. 109-128.

[12] For example, see N. Keyfitz, *Introduction to the Mathematics of Population*, 2d. ed. (Addison-Wesley, 1977).

[13] G. J. Stolnitz, "Mortality declines and age distribution", *Milbank Memorial Fund Quarterly*, April 1956, pp. 178-215; A. J. Coale, "The effects of changes in mortality and fertility on age composition", *Milbank Memorial Fund Quarterly*, 1956, pp. 79-114; and A. J. Coale, "How the age distribution of a human population is determined", Cold Spring Harbor Symposia on Quantitative Biology, 1957, pp. 83-89.

[14] A. J. Coale, "Age composition in the absence of mortality and in other odd circumstances", *Demography*, Nov. 1973, pp. 537-542. In this article the author showed that in a female population where every woman had four daughters, less than 1 per cent of the population would be over age 100 even if no one ever died.

[15] S. H. Preston, "Effect of mortality change on stable population parameters", *Demography*, Feb. 1974, pp. 119-130.

[16] S. H. Preston, "Relations between individual life cycles and population characteristics", *American Sociological Review*, April 1982, pp. 253-264.

[17] N. Keyfitz and G. Littman, "Mortality in a heterogeneous population", *Population Studies*, July 1979, pp. 333-342.

[18] Using the approximation in expression (27), the increase in life expectancy would be

$$\left(\frac{.018}{.020}\right)^2 \left(\frac{.05}{.018}\right) = 2.25 .$$

[19] J. W. Vaupel, K. G. Manton and E. Stallard, "The impact of heterogeneity in individual frailty on the dynamics of mortality", *Demography*, August 1979, pp. 439-454.

[20] For example, see J. J. Heckman and B. Singer, "Population heterogeneity in demographic models", pp. 567-599, *in* K. C. Land and A. Rogers, eds., *Multi-dimensional Mathematical Demography* (New York, Academic Press, 1982).

[21] J. Hobcraft, J. Menken and S. Preston, "Age, period and cohort effects in demography: a review", *Population Index*, Spring 1982, pp. 15-19.

III. THE ROLE OF MORTALITY DECLINE IN THEORIES OF SOCIAL AND DEMOGRAPHIC TRANSITION

*John C. Caldwell**

A discussion of the role attributed to mortality in demographic transition theories is important for two reasons. First, the onset of mortality decline is often taken to be the major determinant of all subsequent demographic change or at least the *sine qua non* for decisive or persistent change. Secondly, so much is the primacy of mortality decline taken for granted in a mortality-fertility demographic transition sequence that the assumptions embodied in mortality-transition theory—to the extent that such theory exists at all—are hardly ever subject to the same kind of scrutiny as is frequently the lot of fertility decline assumptions.

However, before focusing on demographic transition, it is necessary to dispose of the role of mortality in more comprehensive theories of major social change. An earlier examination of major theories of social change or "modernization" showed that most of the grand theories sought neither to explain demographic transition nor to assign demographic movements any major role in causing social change.[1] At the most, they accepted the theories put forward by demographers, in which demographic change largely explained further demographic change, and took it for granted that the desire for a small family and its attainment was a necessary characteristic of "modern man".[2] This was true in the heyday of development aid and the publications that paralleled the interest in the conditions of change for traditional societies, as can be seen in the writings during the early 1960s of Lerner,[3] Hagen,[4] Levy,[5] Rostow,[6] Deutsch,[7] although Deutsch does list population growth as one of the seven important aspects of "social mobilization", as it is in the collection of essays edited by Braibanti and Spengler.[8] Nor was the position essentially different by the second half of the 1960s, as is evident from the work of Feldman and Hurn[9] or that of Bendix[10] or Lewis.[11] More surprisingly, mortality decline played no major part in the works of those social and economic theorists of the 1970s who did have strong demographic interests as can be discovered from the writings of Eisenstadt,[12] Crook[13] or indeed the Chicago Household Economists.[14] Nevertheless, all these theorists and everyone else who now writes on development regard high mortality as a major characteristic of underdevelopment and its removal as a necessary and prime target in the improvement of the human condition. In the past this was not the viewpoint even of those who advocated urgent change, largely of course because the potential for mortality decline only slowly became clearer. There is implicit (and occasionally explicit) in their demand for greater social and economic egalitarianism the belief that one section of society should not suffer ill health more than any other, but there is no feeling that societies must necessarily be backward and miserable because of the existing overall mortality level. Thomas Paine envisaged a just and happy society in the *Rights of Man*, given that poverty, illiteracy, unemployment and war were eliminated, even though, at the time of its publication in 1791, the expectation of life at birth in England and France was probably under 40 years[15] and that in the United States little above (a level no longer recorded for any nation and probably now past even in the Sahel).[16] Nor did Karl Marx find high average mortality to be a constraining influence on the human race either in *The Communist Manifesto*[17] or in *Capital*[18] even though when they were published in 1848 and 1867 respectively the expectation of life at birth in England had stagnated at around 40 years[19] while mortality was undoubtedly higher still in Germany.[20]

Among the social and economic theorists there are exceptions. Alfred Marshall, in the *Principles of Economics*, published in 1890, devoted a good deal of attention to mortality decline and consequent population increase,[21] although even at that date he did not relate these changes to sustained fertility decline nor apparently did he realize that the latter had begun. Sometimes the decline in mortality is seen as being the necessary determinant of the passing of a fatalistic acceptance of the dictates of nature and man, an occurrence regarded as necessary in producing a modern society. Inkeles regarded decisive social change as being partly dependent upon "a general abandonment of passivity and fatalism in the face of life's difficulties", although he evidently regards education as being more important than mortality decline.[22]

In contrast, George Foster believed not only that the reduction in the risk of death eroded the fatalistic outlook towards life but that the latter change reinforced the mortality decline in that the population began to search actively for further ways of lessening mortality risk.[23] Frank Notestein expressed the view at its strongest, suggesting that the mortality level determined the nature of much of society:

> "When death rates are high, the individual's life is relatively insecure and unimportant. The individual's status in life tends to be that to which he was born. There is, therefore, rather little striving for advancement. Education is brief, and children begin their economic contributions early in life. In such societies, moreover, there is scant opportunity for women to achieve either economic support or personal prestige outside the roles of wife and mother, and women's economic functions are organized in ways that are compatible with continuous childbearing."[24]

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A. Important questions and influential concepts with regard to mortality transition

There are many answers in the field of mortality transition, but most are provided without clearly formulated antecedent questions. Some basic questions are the following: Before the recent dramatic and conclusive mortality decline, was there some kind of mortality-fertility equilibrium? If so, what caused it and what determined its level? What caused the subsequent mortality transition? Was the mortality transition a necessary precursor of fertility transition and did it determine the fertility transition? How, and after what intervening period? If the mortality decline did not determine the fertility decline (and there are a number of explanations of the fertility decline which do not argue that once mortality transition had occurred fertility transition was inevitable),[25] how does one explain the relative closeness in time of their occurrence?

Demographers have been deeply influenced when answering these questions by two concepts, that of Malthusian equilibrium, which owes its origin in part to Thomas Malthus, and that of a single demographic transition with mortality and fertility transitions as twin components with the onset of the first preceding that of the second, a model most clearly articulated by Notestein.

Malthus, in *An Essay on the Principle of Population*[26] published in 1798, clearly presented the picture of population growth ultimately leading to such pressure on subsistence that mortality rises and population growth ceases, because of a rising proportion of deaths due to starvation or more frequently to other diseases proving fatal because of malnourishment. The underlying mechanism is the propensity of population to outstrip agricultural production, the former, when unrestricted, growing according to geometric progression and the latter by arithmetic progression. Therefore, the picture is one of near-equilibrium, with population increase restricted to the rate of agricultural progress and accordingly with fertility exhibiting only that margin over mortality. Malthus did not claim to be the first to perceive that such an equilibrium situation should exist. Indeed, in the *Second Essay* he attributes the question to Captain Cook on his first voyage in 1770 when ruminating on what would now be called the biomass available to the population of New Holland (Australia): "By what means are the inhabitants of this country reduced to such numbers as it can subsist?"[27] The answer was an old one, probably best understood by the human race in palaeolithic times. In 1695 Samuel Dugard had written in *A Discourse Concerning the Having Many Children,* "Where there are many children there is no likelihood that a plentiful provision can be made for them all . . . where there are more brought into a miserable world, larger food is thereby afforded unto Death."[28]

The strong modern belief in the pre-transitional equilibrium is based also on the observation frequently made that the principle of compound interest (another version of geometric progression) shows that birth and death rates must have been extremely close to each other for all of human history. For instance, it matters hardly at all whether we estimate human numbers 12,000 years ago immediately before the beginning of the neolithic revolution as 1 million or 40 million: with constant growth over those twelve millennia until the beginning of the present century, the former figure implies a crude birth rate one point per thousand above the crude death rate and the latter figure, half a point. In either case there appears to be long-term equilibrium with an insignificant difference between the level of birth and death rates (a conclusion almost equally strong if we confine our attention to growth over the last 2,000 years)—apparent evidence that recent times have been very typical of human history (an argument frequently advanced to show the need for family planning programmes).

Demographic transition theory will be examined later, but there is one aspect of Notestein's formulation which is of great importance for pre-transition demographic theory, and that is the emphasis given to mortality as the prime determinant of demographic change. As early as 1916, Walter Willcox had analysed European and American population trends and had concluded that mortality decline probably induced fertility decline.[29] Notestein, while noting at various times that mortality and fertility were both affected by the "forces of modernization",[30] nevertheless described a mechanism which would make the fertility level dependent upon the mortality level and which would render it almost inevitable that fertility could not change decisively without a prior change in mortality and that mortality decline would be followed, perhaps with a cultural lag, by fertility decline. "Any society having to face the heavy mortality characteristic of the premodern era must have high fertility to survive. All such societies are therefore ingeniously arranged to obtain the required births. Their religious doctrines, moral codes, laws, education, community customs, marriage habits, and family organizations are all focused towards maintaining high fertility."[31] "These arrangements, which stood the test of experience throughout the centuries of high mortality, are strongly supported by popular beliefs, formalized in religious doctrine, and enforced by community sanctions. They are deeply woven into the social fabric."[32]

Malthusian equilibrium and pre-transitional demographic theory

These formulations raise a series of questions. Is there an equilibrium situation in that pre-transitional birth and death rates were usually close together? Was the equilibrium level the same for all societies? If not, was the level for the vital rates determined by the fertility or the mortality level? Is the equilibrium level decided by subsistence and are population numbers usually pressing against this ceiling?

Stable population theory shows that any number of theoretical equilibrium positions can exist. For pre-modern societies these could range from crude death and birth rates of 50 per thousand, with an expectation of life at birth of 20 years and a total fertility rate of 6.6, to vital rates of 30 per thousand, with an expectation of life at birth of 35 years and a total fertility rate of around 4.0.[33] Indeed the range can be extended further in either direction but only by postulating mortality or fertility levels that appear to be implausible. However, the two extremes of the range cited above probably have characterized historic societies: the first, West Africa before the beginning of the present century[34] (and perhaps much of the rest of Africa) and the second, England in the second half of the seventeenth century.[35]

It may well be that the English equilibrium was far less stable than the African one.

What determined the equilibrium level? Malthus had little doubt that it was fertility behaviour, and indeed his *Essay* is largely a homily on the fearful consequences of not observing a proper restraint on marriage (although he recognized that there were other "preventive checks"). He recognized clearly that there were different levels of demographic balance that were consonant with keeping the population down to the numbers which could subsist but which allowed different lengths of life (and implied a better diet and general standard of living when longevity was greater):

> "In a review of the checks to population in the different states of modern Europe, it appears that the positive checks to population have prevailed less, and the preventive checks more, than in ancient times, and in the more uncultivated parts of the world."[36]

That Malthusian view is probably emerging again. There is a growing recognition that the insistence in much of tropical Africa on polygyny and widow remarriage compared with much lower levels of encouragement for either in India arises from the nature of society and social goals[37] and probably allowed the latter to have birth and death rates around five points lower than the former at the beginning of the present century.[38] As examples of rapid fertility decline in the third world become more common, less emphasis is placed on complex social structures enforcing high fertility and needing substantial periods for dismantling, and more attention is given to the probability that large families were not economically disadvantageous before fertility transition and that persistent high fertility following mortality decline is a sign not of the time taken to remove the cultural props to high fertility but of the continuing economic value of a large family.[39] One cannot attribute no role to either fertility or mortality, at least in the extreme situations. Total fertility rates do not climb above 7 when that can be achieved only by methods traditional societies regard as socially and physically dangerous and counter-productive in terms of the number of surviving children,[40] and hence it is fertility behaviour that sets the upper limit of the equilibrium range. In contrast, health conditions determine the lower level, for, in a pre-modern society where many diseases were epidemic and incurable, a reduction of fertility below some minimum level (perhaps the total fertility rate of 4 found in England in the seventeenth century, although this would vary according to the disease level and other factors such as culturally prescribed hygiene practices) would probably find mortality still falling but not sufficiently to reach the low level attained by fertility.

It might be emphasized that Malthus was not necessarily referring to a zero population growth situation but only to one where the margin between birth and death rates was small enough to allow population to grow no faster than the increase in agricultural production or, better still, so small as to reduce the pressure on subsistence.

The evidence is that, in general, birth and death rates do move together and this does suggest some kind of ceiling or constraint imposed by mortality. Between 1550 and 1750 the series compiled by Wrigley and Schofield for England were roughly parallel with the rates of natural increase exceeding two thirds of 1 per cent for only 3 of the 28 quinquennia between 1611 and 1751.[41] It has become conventional wisdom among demographers to argue that fertility is much less variable than mortality and that the level of the latter is usually much lower than the former, with its average being raised by periodic great crises.[42] The Wrigley-Schofield series provide only limited support for the thesis: certainly the annual fluctuations in the death rate were greater than those in the birth rate—perhaps double the amplitude—but the death rate exceeded the birth rate by any substantial margin only about half a dozen times between 1550 and 1750 (and never thereafter).[43]

Several qualifications should be made. Malthus was clearly aware of fertility differentials by social class and knew that, although the rich consumed a disproportionate share of subsistence, the limiting pressure exerted upon the population was experienced in the form of higher mortality rates only by the poor.[44] He took the differential mortality rate to be proof that subsistence pressure was being exerted with mortal effect, but drew the lesson, not that food should be shared more equally, but that the poor could escape their plight only by following the better off and limiting their fertility through postponed marriage. Malthus also realized that the size of the subsistence population depended upon its foodstuffs and that greater numbers could be supported on a predominantly grain diet than if meat were an important constituent.[45]

The greatest doubts have centred on the nature of the Malthusian ceiling to population growth. Malthus believed that the connection with limiting food supplies was usually visible only if a whole series of other mechanisms failed to keep mortality sufficiently high:

> "The positive checks to population include all the causes, which tend in any way prematurely to shorten the duration of human life, such as unwholesome occupations; severe labour and exposure to the seasons; bad and insufficient food and clothing arising from poverty; bad nursing of children; excesses of all kinds; great towns and manufactories; the whole train of common diseases and epidemics; wars; infanticide; plague, and famine."[46]

Yet, many of these other causes merely do the work which famine would otherwise have to accomplish, for he then argues that "these checks . . . form the immediate causes which keep the population on a level with the means of subsistence".[47]

Clifford Geertz concluded from his work in Java that the equilibrium population itself can reduce the carrying capacity of land under a swidden (shifting cultivation) régime but not under paddy rice cultivation. Referring to the latter, he wrote:

> ". . . the sociologically most critical feature of wet-rice agriculture [is] its marked tendency (and ability) to respond to a rising population through intensification; that is, through absorbing increased numbers of cultivators on a unit of cultivated land . . ."[48]
>
> "Because even the most intense population pressure does not lead to a breakdown of the system on the physical side (though it may lead to extreme impoverishment on the human side), such pressure can reach a height limited only by the capacity of those who exploit it to subsist on steadily diminishing per capita returns for their labour. Where swidden 'overpopula-

tion' results in a deterioration of the habitat, in a wet-rice régime it results in the support of an ever increasing number of people within an undamaged habitat."[49]

If Geertz is arguing the ultimate existence of a Malthusian ceiling (and the tenor of much of his discussion suggests this), then the reduced subsistence must mean that rice cultivators had previously either experienced a period of rapid increase in food production, possibly because of the conversion of more sparsely settled land to rice terraces as irrigation was extended, or that the other positive checks, violence and excesses of all kinds as well as disease, especially among infants and small children, had for long allowed the living to feed relatively well. Perhaps in much of South-East Asia the agricultural revolution of the nineteenth and twentieth centuries as the forests were cleared had meant that the Malthusian ceiling had been banished for generations.

These kinds of considerations have been employed to attack the whole concept of a subsistence ceiling. Marston Bates believed that most people in most societies in history appeared to be sufficiently nourished to make it hardly credible that their numbers were limited primarily either by starvation or by malnourishment sufficiently great to lead to a significant rise in disease.[50] That would be the view of nearly all foreigners visiting West Africa from the end of the fifteenth century onward. They repeatedly reported that the Africans looked well fed and that there was plenty of unused land available for cultivation. Bates was sceptical of a subsistence ceiling not only for human beings but also for wild animals:

"I see few signs of organisms living to this possible limit—some other kind of 'limiting factor' seems to come in long before depletion of the food supply starts to operate."[51]

"It seems to me that food supply is the direct limiting factor on population only in rare and catastrophic situations—and that these catastrophic situations, when we examine them, turn out with surprising frequency to involve some direct or indirect form of human activity."[52]

Bates suggested that the explanation lay, at least in palaeolithic times, in the operation of territoriality, but, within each territory, apart from citing some population limitation through infanticide, he sought an explanation in the limits imposed by the food supply.

The potentially most damaging attack on the Malthusian ceiling, although not fully developed because "our inquiry is concerned with the effects of population changes on agriculture and not with the causes of these population changes", has been made by Ester Boserup.[53] She argued that, when population densities threaten a critical diminution of the food supply, the response is to break the subsistence barrier by altering the mode of agriculture—actually the method and intensity of cultivation—thus allowing not an incremental advance in agricultural production by arithmetic progression but a quantum leap. The new techniques have usually been long known but have been little used because the increase in productivity per unit of land means an increase in the labour needed to produce a unit of food (and hence a drop in the individual's real living standard because of the necessity of working longer hours). She concluded that "the low rates of population growth found (until recently) in pre-industrial communities cannot be explained as the result of insufficient food supplies due to overpopulation, and we must leave more room for other factors in the explanation of demographic trends . . . medical, biological, political etc."[54]

Boserup's case can be attacked. Mass innovation is difficult, for all kinds of social reasons, even when an invention or a new technique is known, although perhaps not widely, in a society. Critical population densities might result in an epidemic or a disastrous period of warfare on countless occasions before the historical circumstances were exactly right for the innovation to be employed in such a way that its use would become self-sustaining. Even unused land in Africa has been explained in terms of the vast reserves of temporarily fallow land needed in poor lateritic soils to maintain a system of shifting cultivation without declining productivity.[55] There is evidence from the West African savannah that this thesis might also be suspect, in that rural densities around some towns can continue to rise steeply,[56] although this phenomenon apparently depends on a symbiotic relationship between town and country, where agriculture uses the manure and refuse of the town and may prove possible only as the economic functions of urban populations develop.

Nevertheless, if one abandons the concept of a subsistence ceiling, one must still seek some explanation for the long-term very low growth rate of the human race. The only possible contender seems to be the density of population. It can be shown that epidemic disease is more likely to break out and to spread rapidly in denser populations, and indeed that there are critical minimum densities below which many infections disappear.[57] We have increasingly abandoned the idea that, given a low expectation of life in ancient Rome, longevity in the earlier period must have been lower still;[58] the mortality levels of contemporary isolated hunters and gatherers appear to be only moderate and it appears likely that the neolithic revolution and the later growth of the first cities in turn raised population densities, the level of infectious diseases and the consequent death rate.[59]

We will probably move towards a mortality theory which retains the Malthusian subsistence ceiling, at least for the poorer part of the population, but recognizes that it has been approached in most societies only rarely and then during subsistence rather than population crises. During the greater part of the time the positive checks limiting growth have been disease, violence and some degree of deliberate population control, and most people have not been gaunt with near-starvation. Violence has certainly been a factor and most societies have long held that the sign of a good ruler whose laws were obeyed was that population numbers grew. In recent times we have become aware that population numbers can be raised if food is brought from elsewhere during the great subsistence crises and if individuals are prevented by modern medicine from dying when afflicted even by diseases which struck more easily because of a degree of malnourishment. Sauvy has argued that a downward change in the level of subsistence could reduce population growth not only by raising mortality but also by lowering fertility.[60] We have evidence now that both factors operate at least briefly during intense famines.[61]

Malthusian theory lies at the core of much of modern economic-demographic theory. Harvey Leibenstein argued:

"On the whole, mortality rates seem to depend on the 'standard of life', that is, on the level of consumption. Hence, it is quite reasonable to posit that mortality rates are a monotonically decreasing function of per capita income, given the state of public health measures in existence."[62]

"Rapid mortality declines must mean a rapid expansion of the population and an equal, or almost equal, expansion in aggregate output in order to feed and otherwise maintain the expanding population. That is, even if declines in mortality precede development, some economic expansion in the aggregate sense must occur if these lower mortality rates are to be maintained."[63]

Richard Nelson, when analysing the low-level equilibrium trap, wrote:

"In areas with low per capita incomes short-run changes in the rate of population growth are caused by changes in the death rate, and changes in the death rate are caused by changes in the level of per capita income. Yet once per capita income reaches a level well above subsistence requirements, further increases in per capita income have a negligible effect on the death rate."[64]

It is assumed, of course, that income can be employed to purchase food and other subsistence necessities.

McKeown, writing from a medical viewpoint, strongly supported this stance:

"When death rates are high, as in developing countries today and in all countries in the recent past, mortality is due to a high incidence of infectious diseases. The level of infection is determined mainly by the standard of living, and even modest improvements are reflected rapidly in a lower death rate."[65]

When this widely agreed upon relationship was tested for England by Wrigley and Schofield,[66] they discovered no relationship between the movement of real wages and the mortality level. However, there was a close relationship between the movement of wages and that of marriage and a slightly delayed response from fertility. Thus population did rise with income, and the positive check apparently did not come into operation because the preventive check was operating massively in English society—and not merely among the upper classes—at least as early as the mid-sixteenth century.

B. The causes of mortality decline

Within modern times the high level mortality-fertility equilibrium has disappeared, first with the onset of persistent mortality decline in the West. The long Swedish series of vital statistics appears to show that the decline in that country began around 1750.[67] The same is also true in the longer series compiled by Wrigley and Schofield for England,[68] but the latter shows that the century from 1650 to 1750 exhibited particularly high mortality. Indeed their series indicates that the low mortality of the beginning of the fourth quarter of the sixteenth century was not equalled again until around 1850, and that the unique modern mortality transition was not clearly established as more than a periodic swing until after that date.

Marshall, writing in 1890, attributed mortality decline to "the growth of temperance, of medical knowledge, of sanitation and of general cleanliness".[69] The debate has raged around the balance of these elements ever since, though social scientists, in contrast to social historians, have forgotten the emergence from the era in England, especially in the towns of the eighteenth century, of gin drinking.[70]

The role of medical science has been given even less emphasis, being relegated by Samuel Preston and Etienne van de Walle to the period after the introduction of diphtheria immunization in the 1890s[71] and by McKeown to the years after 1938 when sulphonamides became available.[72] The role of science in general, if not medical science, may be more complex than this. Bellah, emphasizing the rise of the Protestant outlook in the sixteenth and seventeenth centuries, wrote of "an entirely new conception of the relation of science and society which made the conquest of nature a central social goal and the building of a new civilization a scientific endeavour."[73] Colin Clark claimed that "the significant decline in mortality . . . clearly began about 1759 [and] was due to medical improvements, due to better knowledge and application of medical science . . . . Attempts by some historians to show that it was the industrialization of England (and other countries) which came first . . . have been unsuccessful and have been abandoned."[74] The emphasis in recent decades has in fact been on sustained economic growth over several centuries, growth that gave birth to the industrial revolution, and which, like that revolution, owed much to the new sciences. Yet the growth of a scientific outlook certainly affected society and individual behaviour. It probably contributed as much as did fashion and fastidiousness to the movement toward personal and social cleanliness from the late eighteenth century, which David Razzel regards as being a much underestimated aspect of the early mortality decline.[75] That movement may well have been part of a larger transition to regarding a wide range of behaviour affecting health as being an element in man's control of nature. In contemporary rural India attitudes to sickness are in the process of being transferred from the religious and mystical realm to the secular one, with a considerable impact on health;[76] a similar process has been described as beginning in England as early as the sixteenth century.[77] The decline in infant and child mortality with the education of mothers described by John Caldwell and by Preston,[78] and almost certainly a decline later in life in mortality in keeping with an individual's own education, is explained partly by the transmission of secular and scientific attitudes.

Warren Thompson wrote in 1953 that "the great decline in the death rate that has taken place during the last two centuries in the West is due, basically, to the improvement in production and economic conditions. This economic development made better sanitary practices possible and provided the means for research in medicine and for the establishment of good medical education . . . . The importance of the improvement of sanitation in cities can scarcely be overestimated."[79] McKeown dated the impact of sanitation improvements only to the second half of the nineteenth century,[80] agreeing in effect with Winslow that the "Great Sanitary Awakening" began with the publication of Edwin Chadwick's *Enquiry into the Sanitary Conditions of the Labouring Population of Great Britain* in 1842 and the consequent passage of the *Public Health Act* of 1848.[81] For the earlier period he adopted a strict Malthusian explanation that the death rate fell mainly because of an improvement in nutrition due to greater food supplies,[82]

much originating from overseas. Preston and van de Walle have tested these hypotheses for the nineteenth century in three French urban areas.[83] They concluded that sanitation, especially purified water, was more important than nutritional improvement even in the first half of the nineteenth century, and explained their different finding from that of McKeown in that they had "not chosen to date hygienic improvements from the passage of hygienic laws but rather from the implementation of public works, which often antedated legal changes",[84] noting that McKeown, Brown and Record had cited 1884 as the critical date for hygienic improvements because of the passage of a major sanitary act in that year.[85] The demonstration by Wrigley and Schofield that there was little correlation in England from 1751 to 1871 between the movement of either real wages or the price of consumables and mortality trends offers support both to Razzel and to Preston and van de Walle. Caldwell, employing findings from African and Indian studies, has also argued that McKeown placed too much emphasis on the maldistribution of food between social classes and too little (or rather none at all) on maldistribution by age and sex within the family.[86]

Most transition theorists are less interested in Western mortality trends during the twentieth than during the nineteenth century. The reason is that by 1900 it was clear that an unprecedented and irreversible mortality decline had occurred: the expectation of life at birth had reached 50 years in Sweden, Australia and New Zealand and was close to that in the Netherlands, England and France. Nevertheless, the major part of the mortality transition still lay ahead: England, after 150 years of decline, had recorded an increase of life expectation at birth little more than half of the gain yet to be achieved in the first eight decades of the twentieth century. Preston has addressed the nature of the Western as well as third world mortality transition during the present century.[87] He concluded that the Malthusian subsistence ceiling on mortality gains had retreated in a most remarkable way:

> "Factors exogenous to a country's current level of income probably account for 75-90 per cent of the growth in life expectancy for the world as a whole between the 1930s and the 1960s. Income growth *per se* accounts for only 10-25 per cent."[88]

He identified the exogenous factors as being mainly medical technology.[89] As a result of the development of the technology the richest countries could secure a national expectation of life at birth around 74 years by the 1960s, more than five years above the level even the greatest wealth could achieve in the 1930s. Indeed by 1963 increases in per capita income above $US 800 —and some countries had achieved over twice that level—secured no further advantages in reducing mortality.[90]

During the 1930s and 1940s it became clear that mortality was falling faster in a range of colonies than had been the case in the colonial powers themselves when they had achieved the same initial mortality level;[91] Egypt, India, Java and the Philippines were frequently cited. By the 1950s it could be observed that almost the whole developing world was involved in this change.[92] To explain the situation, before the Second World War, stress was placed upon colonial law and order, the carrying out of sanitation projects, and the implementation of action for alleviating famine. By the 1950s medical technology was much more emphasized. George Stolnitz wrote:

> "Quantitative application of the concepts of demographic transitions, if made by analogy to Western experience, is apt to be futile or misleading as a guide to the mortality prospects confronting the underdeveloped world today."[93]
>
> "The primary role of international rather than national health agencies, the use of antibiotics, the development of cheap yet effective methods for combating malaria—each of these is very nearly a mid-century innovation."[94]

Davis drew upon this new information to attack the Malthusian constraints, arguing that Malthus had overestimated the significance of subsistence and had underestimated the separate impact of disease.[95] He pointed out that E. F. Penrose had employed interwar data twenty years earlier to make this case.[96] Thirteen years later, Davis and Eduardo Arriaga employed Latin American mortality data to conclude:

> ". . . in recent decades public health measures have exercised a strong influence on death rates, independently of economic development. In the most advanced countries the improvement in mortality has always depended mainly on economic development, because it is this development that supports public health itself. This is why the rate of improvement in those countries has been gradual and amazingly constant throughout their modern history. In the current underdeveloped countries, on the other hand, the rate of gain in mortality during recent decades has been notably accelerated by the importation of public health techniques, personnel and funds from the industrialized countries, regardless of local economic development or non-development."[97]

Ansley Coale and Edgar Hoover wrote in 1958 that "substantial economic improvement may be a sufficient condition for a decline in mortality, but it is not today a necessary condition".[98] I. Orubuloye and Caldwell showed that there were very marked differences in the mortality level in rural Nigeria according to whether there was access or not to modern medical facilities.[99]

The argument was essentially one of a global society in which technology, especially that with the emotive connotations associated with saving lives, flowed easily. Inevitably a theoretical counter-attack followed and this too was supported by new data. This reaction took two forms: first, a claim that the Malthusian restraint, as measured by income, had been underestimated; and secondly, the proposition that the element of social change had been largely ignored both in recent change and in the first mortality transition. As early as 1962 it was pointed out in the United Nations *Population Bulletin* that "where important gains have been made in the levels of income and education, these also have contributed to the success of efforts to cut down the death rates".[100]

In 1968 Jacques Vallin argued, from a comparative analysis of third world mortality data, that there was still a close relation between average per capita income and the mortality level and that medical technology alone was likely to encounter a ceiling, perhaps around 60 years, beyond which the expectation of life at birth could not be pushed without major breakthroughs in economic development.[101] Preston noted that national data might obscure the nature of mortality determinants

for "studies of mortality differentials among individuals by social or economic class in countries as disparate as India and the United States consistently reveal lower mortality rates among the upper classes".[102] In 1975 Preston had shown a close relationship between expectation of life at birth and national per capita income for countries with national incomes per head below $US500 (constant 1963 dollars)—that is, the great majority of developing countries—and a very sensitive association among the poorest countries.[103] Indeed, the Malthusian effect among the poorest countries appeared to have intensified over the previous 30 years. "Far from becoming dissociated from income, mortality may have become more responsive to it in low-income countries."[104] He thought it possible that either the new health measures were exploitable only by countries which had reached a certain level of economic development or that international technical aid had deliberately concentrated on populations likely to respond most rapidly to their assistance. Recently it has been argued by Davidson Gwatkin and by Lado Ruzicka and Harold Hansluwka that a marked deceleration has occurred in mortality decline in many countries of the third world and that the underlying dependence of health upon economic development has been reasserting itself.[105] Henry Mosley believes that the role of social and economic change in the post-war mortality decline in developing countries was underestimated and that of medical technology overestimated.[106]

At the same time evidence has accumulated that economic development may have a different mortality impact according to the type of social change chosen to go with it, and indeed that development may well be an intricate interrelation between technological and social change with further advances in each being dependent to a considerable extent on movements in the other. The clearest demonstration of the significance of the social element in mortality decline has probably been the strong inverse relation shown between the level of parental education, especially that of the mother, and infant and child mortality.[107] Nevertheless, broader social change is almost certainly involved. Alan Hill, Sara Randall and Oriel Sullivan explained the striking mortality difference between two Sahelian communities in terms of their differential access to the outside world and hence to imported behavioural patterns.[108] John Caldwell, P. H. Reddy and Pat Caldwell showed that the limited impact of modern medicine in a rural area of India was explained by a deficient demand for its services because of alternative traditional explanations of sickness and its cure, and that greater demand depended upon externally imported social change leading to concepts of health and cure being progressively transferred from the religious to the secular domain.[109] Furthermore, the reduction of infant and child mortality was to a considerable extent dependent upon changes in internal family relationships and emotional and material priorities which were the very essence of social change and were only partly determined by economic developments.

Recent research on third world mortality trends has thrown new light on the Malthusian equilibrium. Preston's analysis of the great length of time which is likely to elapse before an increase in income is totally erased by the larger population resulting from the induced decline in mortality—usually a matter of centuries—suggests that, although the low-level equilibrium trap postulated by Leibenstein and Nelson[110] may once have been a cause of economic-demographic equilibrium, it has no relevance to the contemporary world.[111] Hill, Randall and van den Eerenbeemt, in a study of different communities in rural Mali, have shown the highest mortality—and presumably once the highest mortality-fertility equilibrium level—in a comparatively well fed community (where half the births resulted in deaths by five years of age although "almost none [of the children] was below standard when assessed in terms of weight for age or weight for height").[112] Their explanation was a deficiency in specific foods, particularly milk, and (more convincingly) relatively high levels of infectious disease arising from more crowded residential arrangements and from the greater densities of permanently settled deltaic riverine agricultural populations, in close contact with each other and presumably with high levels of pollution of drinking water. The question of a demographic equilibrium resulting from settlement density and infectious disease rather than from subsistence constraints may remain open.

C. The impact of mortality decline on other demographic behaviour

Two major questions remain. Does mortality change lead to other demographic change and is mortality transition the necessary and inevitable precursor of fertility transition?

Demographic transition diagrams in their symmetry, often looking like parallelograms, give an appearance of mathematical certainty. Real diagrams usually look very different from each other. When data are first available, births and deaths are never equal, for the transition gap has already opened (at the start of the Wrigley and Schofield series for England, the gap between the birth and death rates for the 40 years from 1541 averages not much less than 10 points per thousand, while over 200 years later the rate for the last half of the eighteenth century is very similar).[113] In few countries has the gap closed again, although the industrialized world shows signs that this may be happening, as it did once before in the 1930s and as it did in France before the First World War. Our belief in a transition from a near stationary state to that condition once again arises mostly from mathematics and the finiteness of resources. It is sobering to reflect on what estimate might have been made in 1541 (when the population of England was 2.8 million) of the country's ultimate carrying capacity without endangering the achieved standard of living.

Why should fertility fall once sustained mortality transition has been under way for some time? Willcox gave one answer in 1916: "It is the decline in the birth rate, and only that, which has enabled mankind to grip and hold fast the advantages promised by the decline in the death rate." These advantages were a reduced pressure on wealth and food supply and hence a larger share for all.[114] Davis also presented a variant of this theme (although his argument owed much to Arsene Dumont and his social capillarity theory, which explained why he who was least encumbered by dependants could gain promotion faster in middle class employment in nineteenth century France):[115]

> "Under a prolonged drop in mortality with industrialization, people in north-west Europe and Japan found their accustomed demographic behaviour was

handicapping them in their effort to take advantage of the opportunities being provided by the emerging economy. They accordingly began changing their behaviour. Thus it was in a sense the rising prosperity itself, viewed from the standpoint of the individual's desire to get ahead and appear respectable, that forced a modification of his reproductive behaviour."[116]

In fact, in his presentation, which he also described as the theory of *multiphasic response*, Davis did not argue that the response to mortality decline was necessarily fertility decline:

"The process of demographic change and response is not only continuous but also reflexive and behavioural—reflexive in the sense that a change in one component is eventually altered by the change it has induced in other components; behavioural in the sense that the process involves human decisions in the pursuit of goals with varying means and conditions."[117]

Six years later, employing a multiphasic approach, Dov Friedlander published an analysis of the reaction to mortality decline in nineteenth century rural England and Sweden, finding support for the hypothesis that fertility decline had been delayed because of the possibility of migration to urban centres and other industrializing areas.[118] This was the first response to mortality decline, and there was a clear implication that fertility decline in Britain as a whole may have been postponed by the possibility of migrating to the United States or to British colonies around the world. Later, William Mosher re-examined the case of rural Sweden and concluded that the description of the demographic sequence for that population was wrong.[119] The primary response in north-western Europe until the late nineteenth century to declining mortality and resulting increased population pressures and declining real wages has been identified as postponed marriage.[120] Such postponement modified an already low fertility level in England (with the average age of female marriage over 26 years in the mid-sixteenth century)[121] and produced only limited movements in the gross reproduction rate: 2.3 in the latter part of the fifteenth century, down to 2.0 in the mid-nineteenth century, averaging as low as 1.9 for only three successive quinquennia around the 1670s, finally rising persistently above 2.5 from 1771.[122]

All these theories assume that, beyond a certain point, a larger family of surviving children threatens living standards. The problem is that they all deal with north-western Europe, where there is evidence that the proposition may have held good for centuries, but possibly in conditions of land tenure, inheritance and family structure which were specific to that society. Most were also based on an analysis of movements once Europe had been transformed by commercial and agricultural change and even when industrialization was occurring. In these circumstances there may well have been new direct pressures on fertility arising from the kind of new social structure described by Dumont and implied by Davis. Notestein's formulation (described above) was universal and implied that the "arrangements" (Notestein's word—"props"—has been used by some of his followers) to keep fertility as high as mortality were necessary because most families would otherwise have had fewer children, presumably because it would have been to their economic advantage to do so. An analysis of Notestein's theory is rendered more complex by the fact that he also wrote of the direct impact of modernization on fertility, possibly to explain why the gap between mortality and fertility decline was not longer in time. He wrote of the "urban and industrial society" as being a major factor in fertility decline, and also specified the development of technology, the erosion of the traditional family and the growth of individualism, concluding:

"The more rapid response of mortality than of fertility to the forces of modernization is probably inevitable; the reduction of mortality is a universally accepted goal and faces no substantial social obstacles."[123]

A considerable literature has now come into existence attesting to the lack of economic disadvantage, and usually the positive advantages, of the large family in most pre-transitional societies. Caldwell reported from a 1963 survey in Ghana that the old tended to report net lifetime gains from high fertility,[124] and later that the Yoruba of Nigeria equated high fertility with prosperity.[125] Mead Cain showed how Bangladesh families secured net positive returns over time from their children,[126] while the Chicago New Household Economists argued why this would be so.[127] Crimmins, Easterlin, Jejeebhoy and Srinivasan argued that most pre-transitional families were unable to achieve numbers as large as they desired and would find economically beneficial,[128] although, on the first point, others would argue that high-fertility societies with largely uncontrolled fertility do not consciously formulate fertility targets. There is probably a movement towards a theoretical consensus that major social and economic change produced both the mortality and fertility declines with the fact of the mortality decline perhaps bringing the onset of the fertility decline forward in time and certainly steepening it. Caldwell, Reddy and Caldwell, in rural India, have identified a range of demographic and family changes as having common origins rather than as being multiphasic response.[129]

Family size in these discussions is usually that of surviving children. There has been considerable debate, much of it of marginal importance to the theory of demographic transition, about the extent parents replace children who have died.[130] In societies where no fertility control is practised, the main mechanism would seem to be the biological one whereby an infant death leads to the mother ceasing to lactate and ovulating again earlier than would otherwise have been the case. It is also possible that some women wean children earlier than most, thus on average fitting more births into the reproductive span with higher infant mortality levels and so serving a spurious replacement effect. The danger of drawing misleading conclusions from such analyses has long been stressed.[131] John Knodel reported from a study of nineteenth century German village populations that prior to the practice of a significant level of fertility control no decisive answer could be given as to whether there was any replacement behaviour. However, once fertility transition began, efforts to replace children who had died became clearly evident and "couples with the most favourable child mortality experiences were most likely to adopt family limitation and to reduce their fertility."[132] This last finding provides a clear link between mortality and fertility decline, once both transitions are clearly under way, although it might be noted that Balakrishnan, employing macro data, could not establish such a relation in Latin

America.[133] Rutstein's analysis of Taiwan data also fails to demonstrate any strong relation.[134]

D. A FINAL NOTE

There is substantial agreement that economic modernization in the West, with its antecedent and succeeding scientific revolutions, produced the onset first of mortality and then of fertility transitions. In the present century, poorer parts of the world have not been forced to follow the same sequence and hence, as the world has become one, have been able to experience relatively fast mortality decline, at least partly because of the export from industrialized countries of modern medical technology. Yet there is growing evidence that subsistence and other material circumstances may be already placing Malthusian constraints upon continued mortality declines in much of the third world so that the abolition of large national mortality differentials may await global industrialization in the generations or centuries to come. However, much remains to be done before mortality transition theory can be comprehensive. The following are some of the lacunae.

Social change probably played a major role in mortality decline. The work on the effect of parental education suggests as much (little work has yet been undertaken on the impact of the children's education on their own mortality). Consumer demand for modern health services, parental care, the care of individuals for themselves are vast areas for research and theory. There was probably a complex interrelation between technical change, the rise of education and its changing content, and health behaviour. Much remains to be explained.

The onset of mortality decline occurred before the onset of fertility decline but was almost certainly not the major determinant of the latter. What is less frequently noted is that most of the mortality decline occurred after the onset of the fertility decline: four fifths in England, for instance, even though the mortality transition has so far occupied three centuries in contrast to one century for the fertility transition. Almost certainly interactions took place. Davis implies as much in his theory of multiphasic response,[135] although he does not subsequently consider the possibility that fertility decline accelerated mortality decline because of the obligations felt to care more for the smaller family and indeed the desire to do so, or because lower fertility reduced maternal mortality and the incidence of child mortality characterized by high birth orders. Yet evidence of relatively very low levels of infant and child mortality among the deliberately achieved small families in Ibadan City, Nigeria,[136] and apparently of very low mortality amongst the children of those who have signed the one-child certificate in China[137] suggests that this aspect of transition theory needs more attention. Even here, the interaction may not be simple: work in India suggests that the lower mortality among children, the greater care and the relatively lighter work loads assigned to them may all be part of a reversing of emotional and economic priorities in the family,[138] a reversing of wealth flows,[139] although interactions undoubtedly also exist.

Finally, far too little has been done to incorporate into both mortality and demographic transition theory the intervention of national governments and international agencies and the accompanying sentiments and ideologies that have made such action possible. They tend to be treated as exogenous, as something artificial and determined in contrast to the more natural transitions of the West. Nevertheless, comprehensive theory should aim at embracing the whole picture.

NOTES

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[13] Nigel R. Crook, "On social norms and fertility decline", *The Journal of Development Studies*, vol. 14, No. 4 (July 1978), pp. S198-S210.

[14] Theodore W. Schultz, ed., *Economics of the Family: Marriage, Children and Human Capital. A Conference Report of the National Bureau of Economic Research* (Chicago, University of Chicago Press for the National Bureau of Economic Research, 1974).

[15] For England, see E. A. Wrigley and R. S. Schofield, *The Population History of England: A Reconstruction* (London, Edward Arnold, 1981), appendix A.3, pp. 528-529, where an expectation of life at birth of 37.3 years is given for 1791, a level probably reached by India by the late 1950s.

[16] *Demographic Indicators of Countries: Estimates and Projections as Assessed in 1980* (United Nations publication, Sales No. E. 82.XIII.5).

[17] Karl Marx and Frederick Engels, "Manifesto of the Communist Party" *in* David Fernback, ed., *Karl Marx, Political Writings* (Harmondsworth, Penguin, 1973), vol. 1, pp. 67-98 (first published 1848).

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[40] See R. H. Gray, "Birth intervals, postpartum sexual abstinence and child health" *in* Hilary J. Page and Ron Lesthaeghe, eds., *Child-Spacing in Tropical Africa: Traditions and Change* (London, Academic Press, 1981), pp. 93-109. It should be noted that where such methods are no longer dangerous, as for instance the shortening of the lactation period, the total fertility rate can exceed 10 (see Joseph W. Eaton and Albert J. Mayer, *Man's Capacity to Reproduce: The Demography of a Unique Population* (Glencoe, The Free Press, 1954) on the Hutterites in the United States of America) but these are post-equilibrium conditions. The Hutterite total fertility rate was in fact 9.4 in 1936-1940; it would have been higher but for delayed marriage following the twentieth century American pattern (the total marital fertility rate was over 12).

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[45] *Ibid.*, pp. 94-95.

[46] Malthus, *A Summary View* . . ., p. 250.

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[48] Clifford Geertz, *Agricultural Involution: The Process of Ecological Change in Indonesia* (Berkeley, University of California Press, 1963), p. 32.

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[67] Erland Hofsten and Hans Lundstrom, "Swedish population history: main trends from 1750 to 1970", *Urval*, No. 9 (Stockholm, National Central Bureau of Statistics, 1976).

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IV. SOCIO-ECONOMIC CONSEQUENCES OF MORTALITY CHANGE IN PEASANT SOCIETIES

Mario Bronfman, Susana Lerner* and Rodolfo Tuirán**

This chapter explores the relations between demographic changes—particularly the decline in mortality—and changes in agrarian structure. It describes the main transformations in the agrarian sector in Latin America in the past 100 years, with emphasis on the transformation from a non-capitalist economy with a relative lack of labour force into one in which capitalist relations prevail and give way to processes that generate a surplus labour force. It points out the role played by population growth in this transformation, and particularly the effects of the decline in mortality.

It seeks to support, through the scarce empirical evidence available, the hypothesis that in spatial and temporal situations, demographic changes and conditions can impose new arrangements in practices and strategies with a view to ensuring the economic and social reproduction of agrarian production units and of families.

The most relevant and perhaps obvious conclusion is the need to undertake specific studies in different agrarian contexts to allow a deeper analysis of relations between transformations in agrarian structure and demographic dynamics.

A. An historical framework for the study of changes in agrarian structures and population dynamics in Latin America

For an understanding of the relation between agrarian processes and population dynamics in developing societies, it is necessary to delineate the articulation between the different forms of social organization of production and to understand the system of relations linking peasant and capitalist sectors to the overall social system. Peasant production and capitalist enterprise have mutually experienced a:

> "historical evolution process which is characterized by a transition from a situation with a scarcity of labour force with slow demographic growth, to a situation where labour supply is in excess, due to a rapid growth of the rural population. Whereas the peasant earlier had access to sufficient land, maintaining viable production units, the peasant units now face increasing fragmentation and a decrease of the productive capacity."[1]

It is in this context that the transformation of the agrarian sector in Latin America takes place, as a result of successive stages of capitalist penetration and the consequent redefinition of the peasant economy within the context of capitalist modernization.

The transformation of the Latin American agrarian sector has been different in each of the countries of the region. It is, however, possible to distinguish at least two major stages wherein the entire Latin American agrarian structure is affected by these forces of change.

The oligarchic phase

During the first stage, from the last third of the nineteenth century to the first third of the twentieth century, there was a rapid expansion of commercial agricultural production in most of the Latin American countries. This was a result, on the one hand, of the accelerated industrialization of Western Europe and the United States of America, and, on the other, of the gradual enlargement of the internal market in the Latin American economies, promoting an increasing demand for raw material and food. Expansion of commercial agricultural production made necessary the reorganization of forms of land tenure and modalities of work exploitation. In this type of exploitation, the landowner would not himself engage in direct cultivation, but would give all or part of his land to a certain number of landless peasants in exchange for payment in kind or money. These peasants, who were thus "tied" to the land, prevailed in all Latin American countries where the hacienda system existed. In Chile, for example, they were called *arrendatarios* and afterwards *inquilinos*; in Mexico they were named *gananes*, *laborios*, *terrazgueros* and later on *peones acasillados*; in Peru and Bolivia they were *yanaconas* and in Ecuador *huasipungueros*.[2]

With the expansion of the internal market, or of the export market for certain products, the haciendas were gradually transformed into agricultural enterprises, where payments in kind or cash were replaced by payments in labour. The rapid expansion of commercially oriented agricultural production brought with it the opening of new lands, the intensification of production and demand for labour without precedent in the rural sector. However, factors such as slow demographic growth, low population density in the areas where the commercial enterprise operated, the existence of a large agrarian frontier, and the relative strength of the peasant economy, which still controlled a large part of the exploitable land, implied an acute shortage of "free" labour force, which in turn made rapid development of commercial agriculture difficult.

At the end of the nineteenth century, different forms of latifundist organization coexisted within the Latin American agrarian structure. First appeared the *hacienda señorial* unit, which developed in the regions of major peasant density. In the last decade of the nineteenth century, the *hacienda señorial* began a slow transformation into enterprises whose production was oriented, predominantly, to the internal and external market. As growing commercialization of agriculture

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often implied the expropriation of peasants' land, there was constant conflict between the indigenous communities and the haciendas. These conflicts were evident during the first decades of this century. The landowners used many means to ensure the existence of a stable labour force. One of the most frequent was to attract landless peasants by offering them a day-wage and a small plot. The ties to a small plot were reinforced in some cases through related schemes of indebtedness to which the peasants fell victim. By advancing basic goods necessary for survival, the landowner tied the workers to an obligation that became permanent, thus compelling them to remain in the unit of production for an indefinite period of time, and thereby guaranteeing continued attachment to the latifundium.[3] The requirement for additional labour during the cultivation or harvest periods was satisfied by the flow of a seasonal labour force. The subsistence of small neighbouring farming units guaranteed the presence of a pool of seasonal labour whose costs of production and reproduction did not fall completely upon the commercial hacienda.

A second organizational pattern was the latifundia established with a view to penetrating the deserts and the less populated arid lands. This involved the setting up of a structural framework in which the "free" workers who came from the high-density regions or from outside were strictly hired as a wage labour force. In these regions the landowners used intermediaries or recruiters and salary stimulus to contract workers from other regions of the country and even from Western Europe. However, in many cases the responses to these mechanisms were not sufficient, resulting in a continual shortage of labour. For that reason, latifundia often employed more rigorous methods of recruitment—including forced migration—to attract and to retain the labour force.

Finally, a third organizational pattern was represented by the plantation hacienda, mainly located in the coastal regions and in temperate zones of Latin America, where the population density was extremely low. This mode of exploitation required a great amount of labour to work under extremely unhealthy conditions. Obviously, the voluntary candidates for work that involved a high health risk were not plentiful. To solve this problem, the tropical plantations used different systems of forced recruitment from open slavery to less severe forms of coercive work; in the plantation haciendas the use of slavery seems to have been the predominant pattern.[4] In Mexico, for example, vagrants captured in the cities, Indian prisoners or the slaves imported direct from the British possessions in the Caribbean constituted the traditional source of labour for the plantations located along the coast of the Gulf of Mexico.[5]

These organizational forms of regulating land and work in a coercive way were the common answers to the relative shortage of "free" workers. In fact, the decline and re-creation of semi-slave forms in the development of the agrarian capitalism in Latin America was an essential component of the agrarian latifundist structure and not an isolated phenomenon. Non-economic mechanisms capable of retaining the working population in the mine, the hacienda or the plantation lasted for a long time. The strength of such an agrarian structure permitted its existence until recently; the haciendas in Bolivia continued until 1952 (*haciendas de pegujaleros*); in Peru until 1972 (*haciendas de peones feudatarios*); in Ecuador until the end of the 1960s (*haciendas de huasipungueros*); in the south of Colombia until the 1950s (*haciendas de terrajeria*) and in Chile until 1965 (*fundos de inguilinaje*).[6]

The capitalist modernization of agriculture

Since the decade of the 1930s, the oligarchic domination system has been in a state of crisis.[7] The great depression of 1929-1933 delivered a hard blow to the agricultural export-based economies of the region. In the years that followed, a reorganization of the agrarian sector began. The international situation and internal political and economic conditions stimulated the implantation of an urban-industrial economic structure. The development of this pattern tended to modify the relations between the agrarian and the industrial sectors: the former was increasingly subordinated to the accumulation needs of the latter. All this affected the reformulation of social relations of production and, in general, of the capitalist organizational forms in Latin American agriculture. Thus, the latifundist system based on the hacienda initiated a gradual modernization process, which resulted in profound changes in land tenure systems, in land use and in the forms and modalities of labour exploitation.

During this stage the agrarian sector was expected to supply goods and food at stable prices that were low and perhaps even decreasing in relation to industrial prices, and simultaneously to generate a surplus of goods transferable to the industrial market through the fiscal, banking and price systems. Likewise, this sector was responsible for generating a large part of the necessary foreign exchange through its exports, so as to finance the import of capital goods. Finally, it was expected to supply the large cheap labour force demanded by urban-industrial expansion. This implied, among other changes, the redefinition of agrarian production, large investments in irrigation and in communications and transport networks, as well as the implementation of ambitious programmes of agrarian reform. The State, representing basically the interests of power groups from the emerging industrial bourgeoisie, became the most important promoter of these transformations. The redistribution of land, the formation of institutions to provide credit, agricultural inputs (irrigation, fertilizers, improved seeds, machinery and information), commercialization channels and the differential definition of policies to regulate basic wages in the rural and urban settings are clear examples of the growing intervention of State power. The gradual abolition of the labour-rent (*renta en forma de trabajo*) system and other work servitude that were the basis of the traditional hacienda system opened the way for establishing and expanding the wage labour economy. In some regions, the opportunity opened by the expansion of the internal market for agricultural products forced the haciendas to introduce important changes in the technical and social relations of production. The great increase of work and land productivity made evident the advantages of direct cultivation of the plots rented by the hacienda. This stimulated the landowners and the agrarian entrepreneurs to abandon the semi-slavish practices in order to ensure a cheap labour force reserve and to turn instead to the use of wage labour.

During this phase, substantial modifications in the demographic dynamics of the population of Latin America took place. There is no doubt that the decline of mortality was the fundamental reason for the rapid increase in demographic growth, far more than any substantial change in fertility, especially between 1940 and 1960. The use of modern medical technology, the expansion of health programmes, the accelerated construction of a health infrastructure and the improvements achieved in other areas such as nutrition, housing and water supply were salient elements closely linked to the mortality decline. Such changes were especially important in the rapidly growing cities but even in rural areas such innovations were carried out through health programmes which accompanied the penetration of capitalism.

A good example of these changes is found in the evolution of malaria. In relation to this pathology, Franco states:

> "It is not an occasional epidemic in only some of the countries of the continent, but an endemic extending throughout almost all the region (except Chile and Uruguay), and that because of its magnitude and negative impact on the interests of capitalism, its expansion has attracted the states' interests who have devoted for a long time a good part of their efforts toward sanitary improvement actions."[8]

A proof of the lethality of this pathology is seen in the rate of 26.2 deaths per 1,000 inhabitants in Surinam, British Guyana and Trinidad in 1919, as well as in the epidemics in the same year in the states of Veracruz, San Luis Potos and Tamaulipas in Mexico, and in the epidemic that killed 32 per cent of the population of the malarial area in Peru between 1932 and 1934. When a follow-up analysis of the Peru case was undertaken, it was demonstrated that the principal interest of those fighting the disease was to "protect and promote the agriculture and international commerce of certain basic agricultural products in the power centre market: sugarcane, rice, bananas and other fruits, cotton etc.",[9] as well as the interests in strategic areas of oil and mineral extraction. Hence, at a time when information on health statistics was deficient, the United Fruit Company offered, through annual bulletins of their technical department, the only data that would permit an estimate of the extent and magnitude of malaria. Also in the first decades of this century, the Rockefeller Foundation started collaborating with the United Fruit Company in the solution of the problem, and later promoted the creation of independent units devoted to the eradication of malaria. It is certain that the health activities accompanying capitalist penetration in the rural areas of Latin America played an important role in the decline of mortality.

The intense demographic growth was a factor that stimulated the proletarization of one sector of the peasant population: that which had small plots of cultivable land. At first, the survival of a large number of children worsened the problem of fragmentation of land.[10] The size of the plot was smaller when divided among the children according to the cultural idea of giving each child a piece of land—however small. In the circumstances, non-farm income was of fundamental importance for the reproduction of an important number of small productive units. An enormous reserve of labour force was thereby constituted. At the same time, the greater survival of adults brought about the postponement of land distribution among children, thus tending to reinforce conditions demanding that peasant families develop strategies of occupational diversification and spatial mobility.

The accelerated construction of a transportation system ended the traditional isolation of the rural areas and had a spectacular effect on the spatial mobility of the labour force, giving way to the emergence of regional work markets. Rapid demographic growth, increasing proletarization of the rural population and greater integration of regional units helped bring about a great restructuring of the labour force. This situation provided strengthened impetus for landowners to abandon coercive methods of contract and subjugation of the labour force.

In the first three decades of this developmental stage, the increase of large cultivated landholdings constituted the prime basis for agricultural growth, with the peasant economy gradually being displaced to marginal lands of low productivity. This led to a rural exodus, predominantly to expanding urban industrial settings.[11]

However, there was a sharp decline in the opportunities for salaried work in the 1960s, in both the agrarian and the industrial sectors. The principal sources that had permitted the impressive expansion of agricultural-commercial production began to falter owing to technical and financial difficulties and, sometimes, to substantially increasing costs. As a consequence, in many countries of the region there was a decline in harvested areas that was compensated only by an improvement in the yield and composition of crops. The modernization of capitalist agricultural enterprises brought about the reduction in demand for a permanent labour force, while the need for non-farm income meant that agricultural workers became more dependent on migratory seasonal work. Various types of rural migration of a temporary nature began to gain importance, including seasonal, pendular and circular movements.[12]

B. Mortality changes and their interrelation with socio-economic processes in agrarian societies: evidence from studies of family units of production

Because of the complexity and wide scope of the issue, theoretical approaches to the study of demographic dynamics and agrarian structure have met with particular problems in operating with arguments and hypotheses based mainly on generalizations involving universal assumptions. Some of the traditional approaches, incorporating many variables with no hierarchization or articulation among them, if not inadequate, are of little relevance in explaining interrelations or in establishing frameworks for theoretical analysis. Although common dimensions that define the features of agrarian structure (land tenure, size of land, technological levels, work processes etc.) are important in themselves and allow for the very general description of aspects of the structure, they have gained significance and relevance when studied as part of a specific social and historical context. The same argument applies when analysing demographic events.

Neither agrarian nor urban societies are homogeneous categories. Their particular geographical, political, institutional and socio-economic features vary over time and space, and therefore their processes and stages of transformation assume different forms of concrete

expression. Therefore, the patterns of settlement of population, the patterns of social and labour mobility, health and medical practices and the prevalence of changes in values and norms related to reproductive behaviour, among other socio-demographic phenomena, respond not only to the particular features conferred by their social specificity, but also to the sequences and contexts in which these "events" occur.[13]

The complexity of this issue has led much recent research towards the identification of specific agrarian contexts. The family or domestic group, according to its class position, is defined as a social context or "social space" where the processes of production and/or reproduction of the population take place, therefore becoming a relevant level of analysis.[14]

Recent studies have contributed some empirical evidence on this interrelation, questioning theoretical assumptions taken for granted in the literature, enriching our knowledge of the state of the art, and opening new priorities as regards research topics in this area. Studies on the family structure, its composition and organization within agrarian contexts are a good starting-point for illustrating the way in which the increase in population that has characterized a large number of agrarian societies in the past few decades has affected families, both in their own space and in the social contexts in which they are found.

Effects of mortality decline on family structure

Studies carried out in some agrarian micro-regions of Mexico[15] have shown the way in which the present family "space" has been extended and transformed (within the larger coexistence of different vertical and collateral nuclear groups[16]) as a result of the rapid decline of overall mortality, especially the fall in infant mortality, and the continued prevalence of high levels of fertility. Though a vertical pattern currently dominates in the extended groups in the Mexican regions of the study,[16] it would seem obvious that under high-mortality conditions, such as the ones that prevailed in the past, this vertical pattern has not been prevalent.[17] This example will demonstrate the way in which high mortality in the past influences: (*a*) the reduction of common residence time among two or three related generations, and (*b*) the decreasing number of generations of siblings that would have actually succeeded the corresponding generation of their parents, or the limited number of married children of their descendants living with their parents. (A more detailed discussion on this aspect is given by C. Young in chapter X of this publication.

From this extremely limited "familial time", the existing household "space" in the past could easily have been identified and confused with the residential space, that is, with the so-called residential domestic groups defined by traditional census criteria (having a common residence and sharing the same budget); also in the case of the father's absence, it is possible to assume that children separated into nuclear units and that there was little relation among them. On the contrary, in low-mortality conditions, the survival of the father and/or his partner allows for a wider family space, with the increasing multiplication of nuclei integrated with siblings and with the persistence of social relations among them and their groups of origin. In this case, given a larger "familial time", the family space exceeds the residential space of the parent's domestic group: in the majority of cases, this family space includes the vertical pattern, that is, a group comprised of the parent's central nucleus and of at least one descendent nucleus and an increasing number of nuclear groups of descent living in different residential units, among which different relations of co-operation and reciprocity prevail.

The findings of the Mexican study mentioned above demonstrate that at 30 years of age, more than 70 per cent of the heads of domestic groups interviewed have living parents.[18] In another study on Africa, Locoh estimated that at 30 years of age, 85.3 per cent of men have lost their parents under the hypothesis of high mortality levels (e^m_0 + 30.07 years of age), against 51.2 per cent according to the hypothesis of lower mortality (e^m_0 + 65.47 years of age). More interesting are the conclusions about the number of male births a peasant man requires to replace him at his 60th anniversary: with the high level of mortality, four male births are necessary in order to have at least one of his sons replacing him, and eight if he wants two sons; in the case of higher life expectancy, the number is three male births for one son and five male births for two sons in his place.[19]

Some findings have questioned the apparently increasing nuclearization observed in certain agrarian societies or in specific social groups within them. The Mexican evidence shows that nearly 50 per cent of the heads of nuclear groups do not have surviving parents, and at least 28 per cent of them are in a stage of their life cycle in which there are no possibilities of forming extended groups with descent nuclei (that is, with the heads of nuclear groups younger than 30 years of age). This leads to a decrease in the proportion of nuclear families (from 54.9 per cent to 28.3 per cent), nuclear families being considered to be those where the head has a surviving father.[20] A similar conclusion was reached in another study that shows that during the eighteenth century in the Haute-Provence, in France, the relative proportions of nuclear families ranged from 16 per cent to 53 per cent.[21] It seems even more important therefore to attempt to explain the significance and relevance of the process of nuclearization or extension in the formation of family arrangements, as well as the modifications which this process brings about in the social relations among groups in peasant societies.

Taking into account the demographic influences, one conclusion should be that before arguing for the existence of an increasing proportion of nuclear domestic groups, it is necessary to determine, first, whether nuclearization arises from the fact that these family heads have no surviving parents, or whether they are themselves in the stage of their demographic life-cycle where their children are neither forming their own nuclear group nor remaining within the extended arrangements.

However, this distinction should also be underlined when introducing other elements such as age of family head, class condition and possibilities of supporting an extended family. According to the above-mentioned study in Mexico, it appears that under the impossibility for a large number of descent nuclei of a common coexistence within the group of origin, the greater possibilities of forming nuclear groups were found among family heads of younger generations whose parents had no access to land (salaried or self-employed workers) or those whose parents had limited access to land. Similar results are found in other studies where

prevalence of the extended family in traditional societies has been analysed. The level of economic resources necessary to support this family pattern and the complex domestic relations within it are strongly determining factors. Only a minority of families conform to this type of arrangement.[22]

In the same sense, it is interesting to add that in the case of extended domestic groups directed by young family heads, the extension is partly a result of the demographic events occurring in the family of origin: widowed mothers, young collateral members whose family head or parents have died, orphans and divorced or other isolated members of their family of origin are integrated into extended groups. Again, this pattern of family structure reflects the difficult conditions of survival prevailing in some socio-economic contexts that inhibit or reduce the possibilities for nuclear arrangements. At the same time, it implies a greater complexity of extended family arrangements directed by young family heads. In some of the Mexican agrarian microregions, more than 80 per cent of the extended groups of young family heads, and also the same figure for all such families belonging to the proletariat or paid worker class, are composed of members of the head's family of origin (mainly a widowed mother with her own siblings).[23] A similar situation is described in Togo agrarian society, between native and migrant populations subject to different demographic conditions.[24]

Changes in the life-cycle of the family and its extension in time can also lead to a transformation and multiplication of the events occurring within it. For example, children enter and leave the family group a greater number of times, the duration of marriages increases or the proportion of divorced families increases. That is, different practices correspond to different periods and sequences of events or, at least, different ways of following the traditional rules and practices that govern society.

The results and arguments mentioned support our hypothesis of the presence of a new practice in the formation of residential domestic groups as a result of mortality decline. Today new generations form their nuclear cells and separate from their parents' domestic groups, and only one child remains within the group of origin. This new practice means the multiplication and dispersal in space of the related nuclear groups.

Different formations can be produced in the residential irruption of the family space, as a result, *ceteris paribus*, of the increasing probability of survival of parents, children and grandchildren, and according to the conditions and options given in each society. At least two different patterns can be recognized: on the one hand, the maintenance of the same family space through multiplication of groups outside the community; on the other hand, as is the case in one of the Mexican regions under study, extension of the family space within the locality, that is, in the same community.[25] It is important to stress that in the latter case, the simple residential family concept is insufficient to explain the real family space and can lead to erroneous conclusions about important family arrangements. Therefore, emphasis is placed on the need to consider and redefine the family, as an analytical category, according to the given social relations among related domestic groups.[26]

What seems more important is the possibility of identifying, through structures and patterns of family arrangements found in specific contexts, their correspondence to residential and marital patterns, different working processes and productive relations and biological and reproductive practices, among others. All these are produced by changing social and demographic conditions. Without prejudging for the moment the weight of one or other of these previous conditions or changes, it is important to emphasize how, in specific situations—spatial and temporal—demographic conditions can impose a new articulation in social practices, thereby exerting an influence on other structures or levels of society.

In this sense, Godelier[27] has demonstrated how the rules of marital exchanges in an Australian aboriginal population can either disappear or acquire a different form if a demographic shortage occurs, and how the return to previous demographic conditions does not necessarily mean that the rules and social practices can be revived in the same manner. According to him, the complexity of demographic analysis lies in the fact that "each type of social relation, each structural level, is subject to specific demographic conditions in its functioning and its reproduction in time".[28]

Along the same line, another author has underlined the place of the aleatory (stochastic) demographic events in marital strategies. In the case of the Bearn communities, he points out how these strategies are designed around the preservation of patrimony. It is through these strategies that they seek to face chance events occurring within the family, which can jeopardize their fundamental principle: the transmission and prevalence of patrimony.[29]

In his analysis of some aspects of the relationship between the life-cycles and the economic mobility of households in rural Bangladesh, Cain[30] examines the sequence and timing of events in elements such as the number of living children and the timing of male births and death of household heads. These are considered uncertainties (or aleatory demographic events) that people face in maintaining or losing the familiar patrimony, and, in general, these are related to the economic welfare of the social unit. Finally, in his study on the Polish peasants of the eighteenth century, Kula[31] illustrates the control and direction that feudal lords exerted over the reproduction of the families dependent on them. He demonstrated thereby how the demographic structure and its reproduction could be controlled from outside, according to specific objectives.

The above-mentioned examples illustrate the relevance of reintroducing the notions of specific temporalities of population processes through the demographic conditions experienced by the population or certain groups. They also demonstrate and support our hypothesis that it is enough to incorporate changes in the timing of demographic events to alter certain social practices. This is the case of the timing and pattern in mortality decline and its sequence with fertility decline or with other demographic events. Nevertheless, this is not meant to ignore the fact that we are dealing with events that are, above all, subject to transformation by other material survival conditions, as well as to superstructural influences. These events not only lead to modifying the familial space, but also influence other "records" of society.

This may be illustrated by the characteristics of the *ejidatarios* (mini-fundia or farmers that have the right

to use and bequeath the land they have been granted) in the agrarian zones of Mexico. The increase of life expectancy of these peasants, particularly of the father or head of the domestic group that gained access to the land during the agrarian distribution, implies the maintenance in his hands of the power over the means of production for a longer period. At the same time, the increased survival of children that reach adulthood, that is, the age when they form their own families and obtain or share the father's rights, represents an increase in the number of persons who can occupy a similar social position within the household. Therefore, the timing and sequence of at least two demographic events—increased survival and maintenance of fertility levels—lead to a transformation and questioning of the power and property structure, as well as to the control of means of production and practices of reproduction within the family.

Among the specific conditions that have characterized land distribution and agrarian development in countries such as Mexico are the limited size of plots originally granted to the great majority of *ejidatarios*. There is also a concentration of large tracts of land in only a few hands and the problem of land fragmentation. This means that replacement conditions of access to land for a good number of peasant children is absolutely impossible. It may be also that plots are drastically reduced in size and/or strongly modified. All this is accompanied, as has been emphasized, by a semi-proletarization process among peasant producers.

A very good example of this process of fragmentation and of limited access to land has been demonstrated by Arizpe[32] in two Mexican communities. The author notes that by 1928 in one of the communities the original endowment did not exceed an average of 2.5 hectares per family—this figure being smaller than the estimated area needed to guarantee the simple reproduction of a productive unit. This low endowment reflects, in part, the original high density of population. In contrast, the size of plots in the other community was substantially larger, reaching an average of approximately 6.2 hectares. In the long term, the survival of a greater number of children affected the inheritance practices and the fragmentation of land: in the first community, by 1956, the average land extension had been reduced to only 1 hectare, whereas in the second, in spite of the in-migration of a large family group, the plots reached an average size of 2.5 hectares. When analysing the possibilities for some Mexican peasants and their collateral relatives to recreate an important part of the conditions of their parents' social reproduction (that is, to have access to land or to the "sistema ejidal"), the greater semi-proletarization process observed is partially the result of a demographic and generational effect. The fact that the youngest peasants are much more involved also in salaried activities is due to the physical requirements for such activities. Moreover, there is a saturation of the production system (for example, the incorporation of other peasants into the *sistema ejidal*) and the survival and active presence of the older peasant generation (the one that received the land during the agrarian reform in the case of Mexico).[33]

As we have mentioned, the greater survival probabilities of parents, children and grandchildren leading to modification of the household space is not inconsistent with or independent of the particular conditions of the social context in which it is found. Extended family arrangements in agrarian zones of Mexico arise out of difficulties experienced in the creation of autonomous groups, such as limits on access to land or salaried permanent jobs, lack of sufficient remunerated income as a means of securing the group's essential survival conditions and the availability of housing. These factors, among others, are more important in determining the family structure than the self-will or "traditional practice" of such family organization. In the Mexican agrarian context it is not the need on the part of the members of the descent or extended nucleus for a greater or additional family labour force that leads to the formation of extended arrangements; it is the rotation in the use of family labour of the head's nuclear group that enables him to satisfy the working requirements of his economic unit of production.[34] The reduced proportion of family groups in a stage of disintegration (because of the couple's breaking up or the children's departure) would seem to be another element contributing to the great difficulties in the maintenance of this type of arrangement.

Moreover, most of the social structures, such as the type of family arrangements, are not homogeneous among the population. There is a different degree of access to the means of production, to the opportunities to enter into other social relations within and outside the agricultural sector and, in general, to economic and social services (credit, commercialization channels, educational and health services, among others). This implies that modifications of different "social spaces" do not necessarily lead to different structures and modes of behaviour, but always have a different significance and structure both in themselves and in relation to other processes.

In this sense, it should be recognized that in agrarian contexts, characterized by an intensive process of social differentiation, different social groups do not participate or benefit equally from a mortality decline. Different studies of Mexico and other Latin American countries explain this situation of inequity.[35] Specific social class position implies a difference in access to sanitary infrastructure, health system, diseases, nutritional levels, technological advances and the like. These aspects obviously relate to other conditions. All these facts, as mentioned in the studies, express at the same time the differential impact of the various actions and policies developed among geographical areas and social groups. Polarization has intensified since the initiation of mortality decline and has reached a limit that is not being overcome by a substantial increase in the welfare of the majority of the pauperized population living in agrarian zones.

In the preceding paragraphs, we have pointed out the importance of considering the impact of the demographic transition and especially the impact of the rapid decline in mortality on family structure. This has produced a proliferation of nuclear family units leading to the expansion of the household space and to the modification of social practices within and outside this space.

Effects of mortality decline on other behaviour

The system of social relations among groups that constitute the real family space can develop both within and outside communities and can flow beyond the rural

limits or remain within them. When the division of one or more of the nuclear components appears to be accompanied by a migratory movement outside the community, nuclearization with respect to the group of origin does not necessarily mean a rupture with the original family space, especially when both parents, or at least one of them, survive. On the contrary, the case could arise where nuclear components leave their original place and settle in the same community and maintain, extend or restrict their relations with the group of origin. Also, both trends can be represented. In any of the cases, it would mean an extension of the family space, a wider network of exchange and reciprocity, expressing above all one of the principal features of the agrarian change and development: the coexistence of different types of economic organization, the greater link between the domestic economy and the market economy, as well as the influence of the latter in the former. It should be understood that the practices, and resulting exchanges, between the residential and interaction groups are different according to whether the interaction groups are inside or outside the community.

This thesis emphasized the importance of considering two closely interrelated processes: the spatial mobility and the occupational diversification of the members in the domestic unit. Both processes are an essential part of the strategies of the domestic group to guarantee the survival and reproduction of the economic unit of production as well as the family group's survival.

Different studies have suggested that spatial mobility and occupational diversification among members of the domestic unit form part of the adaptative mechanisms which the peasant economy utilizes to adjust the availability of labour to the working requirements of the family unit.

Proletarization thereby becomes a mutable procedure during the individual and family life-cycle, in so far as domestic economies can combine both strategies in rural and urban settings. In this sense, one of the most relevant findings in the Latin American region is the fact that the changing processes in the agrarian sector have not necessarily led to the definite proletarization of the labour force, but that this process has adopted different modalities that go from the semi-proletarization, the peasant restructure, to a total proletarization. In a certain way, these modalities respond to the tendency observed in the rural labour markets with respect to the increasing and accelerated replacement of permanent labourers for temporary ones, as well as the lack of dynamism of the urban-industrial sector, which resulted in a lower capacity to absorb the labour force. Therefore, owing to the fact that the capitalist sector has not been able totally to assume the reproduction of the rural labour force, there still remains an important area for the development of multiple forms of domestic economy.

Some authors have advanced the thesis that the pervasiveness of the peasant economy has been functional with respect to the logic of reproduction of dependent capitalism. For example, it has been suggested that the preservation of small holdings permits the presence of an important labour force reservoir that the capitalist sector utilizes only at specific times of the year, thereby saving the cost of production and part of the cost of reproduction of this labour force. Likewise, the reproduction of one of the largest sectors of the population has been supported by the peasant economy, thereby avoiding, from a social point of view, the waste of productive forces owing to the inability of the capitalist sector to integrate them productively.

In the peasant economy, these trends have reinforced the link between the family group and the land, in spite of the exhaustion and deterioration of the productive conditions of their land. The occupational diversification process thus serves to maintain part of the family group as a productive force within the confines of its unit while, at the same time, the rest of the family undertakes non-farm activities in order to obtain additional income needed by the domestic group to maintain conditions conducive to reproduction of the productive unit and subsistence of the family group.

In this process, migration has been a fundamental mechanism and a strategy. The earning of an off-farm salary and the search for alternative sources of income have generally resulted in spatial movements of the population. It is important to stress that both spatial mobility and occupational diversification of the family members are not independent of the conditions that allow for an increase in the survival of children and in the life expectancy of parents.

As regards the different patterns that characterize migratory movements in Latin America, there is a degree of consensus that these patterns have not only responded to specific forms that the transformation processes of the agrarian structure assume in different contexts, but that they also conform to certain elements of the family environment which explain why specific groups or individuals migrate whereas others, with similar characteristics, do not. The relation between structural conditions and migration or between the family and migration is not unilateral. Each of the units implements particular reproduction mechanisms according to the material resources available and to the type and intensity of the external pressures. These strategies can, at the same time, assume different forms and nuances according to the size and demographic dynamics of the family groups on which the reproductive unit is based.

Recent studies have demonstrated how the selectivity of migration—as a survival strategy of the domestic economy—is linked with the stage of the vital cycle in which the family group is found. In her study of population movements, Arizpe observes the manner in which different members of a group, during the life cycle, replace one another in obtaining additional income. This task usually results in spatial movements. These movements are defined by Arizpe as "replacement migration". In the *minifundista* unit, the father is the first one to migrate. He is then replaced by the elder sons and daughters, who tend to remain in the areas of destination since they have almost no chance of inheriting a piece of land, owing to its fragmentation and to the institution of inheritance rights, such as those of the "last-born". These migrants regularly send a certain amount of money to the family group of origin. Younger sons and daughters who remained in the unit at the beginning, taking care of agricultural chores, as they grow older assume the responsibility of providing the domestic group with supplementary income, thus relieving their parents and elder siblings of this duty. Because of their future assurance of inheriting a patrimony according to the right of the "last-born", the youngest children make only temporary moves, to guarantee the essential survival of the family nucleus.

Similar conclusions have been reached through a different study, in which it has been demonstrated that migration is a mechanism that permits the reproduction of the domestic unit through the acquisition of complementary income, and helps diminish the costs of consumption through the departure of some of the members of the family group.[36]

None of the studies undertaken in Latin America and perhaps other regions have, to date, explicitly analysed the interrelation between mortality changes and the processes mentioned as part of the peasant economy. Nevertheless, when studying the migration patterns, as is the case of the replacement movements found, it is implicitly possible to envisage that a general and different replacement process is going on in which, undoubtedly, the increasing life expectancy of parents and their offspring plays an important role.

In a recent study[37] of temporary movements in a sugar-cane-economy area in Mexico, the following became evident: (*a*) the very young ages found among the migrants involved in the seasonal group (almost half of them were between 14 and 24 years of age);[38] (*b*) the still younger age at which they made their first temporary move (more than 70 per cent were 15 years old and 18 per cent made their first move between 0 and 9 years of age),[39] and also the young age at which they formed their own families (53 per cent had their first union between the ages of 15 and 19 and 90 per cent before they were 24 years old);[40] and (*c*) the close relation found among these migrants as regards the way in which they supported their family unit of production (*minifundia* plots worked during the rainy season), where, because of their age, less than half of the temporary sugar-cane workers with access to land were family workers without payment in their units of production at their places of origin.[41] These observations support the replacement or changing process that is taking place both at the family level and at the economic and social levels, which influences the semi-proletarization of a majority of the younger members, the maintenance or recreation of wider and different family arrangements and relations and, in general, the persistence of the peasant economy in many societies. Moreover, the decline in mortality coupled with high levels of fertility has played an important role in the widening and redefinition of this replacement process as well as in many other processes of change in these societies. The most important conclusion to be derived from this chapter is the need for major efforts in empirical research with regard to the social dynamics of peasant communities, taking into account demographic changes as well as the specific socio-economic processes of each society and giving priority to the economic unit of production and the family as levels of analysis.

NOTES

[1] C. Aramburú, "Estructura agraria y migraciones rurales", paper submitted to the Congreso Latinoamericano de Población y Desarrollo, Programa de Investigaciones Sociales sobre Población en America Latina (PISPAL), (Mexico, 1983), pp. 2-3.

[2] Cristobal Kay, *El sistema señorial europeo y la hacienda latinoamericana* (Mexico, Serie Popular ERA, 1980), p. 45; Antonio García *Reforma agraria y desarrollo capitalista en América Latina* (Mexico, UNAM, 1981), p. 30; Enrique Florescano, *Origen y desarrollo de los problemas agrarios en México, 1520-1821* (Mexico, ERA, 1983), p. 103.

[3] In the Mexican haciendas, the salaried worker was literally tied down to the land through a system of advanced payments that gradually resulted in his high indebted condition, until he and his family ended up living permanently in the hacienda. Besides the salaried workers, there were other workers who performed a number of non-remunerated tasks (*faenas*) in exchange for board and lodging.

[4] From the sixteenth century, when the traffic in slaves to America began, until the nineteenth century, when it ceased and slavery was abolished, almost 9.5 million black people were transported from Africa. From this figure, 17 per cent were taken to the Spanish colonies; 38 per cent to Brazil; 6 per cent to the United States of America; 17 per cent to the British Antilles and 17 per cent to the French colonies in the Caribbean (Octavio Ianni, *Esclavitud y capitalismo* (Mexico, Siglo XXI, 1976), pp. 15-16).

[5] F. Katz, *La servidumbre agraria en México en la época porfirista* (Mexico, ERA, 1982), pp. 15-55; V. C. Dahl, "Alien labour in the Gulf Coast of Mexico, 1880-1900", *The Americas*, No. 17, 1960, pp. 21-35.

[6] García, *op. cit.*, p. 30.

[7] It is difficult to determine when the end of the oligarchic phase occurred in Latin America owing to the diversity and heterogeneity of the experiences of the various countries. In spite of these differences, the end of the oligarchic system in the majority of Latin American countries began after the great depression of the 1930s and was accelerated with the Second World War.

[8] S. Franco, "El paludismo en América Latina", unpublished master's thesis, Universidad Autónoma Metropolitana-Unidad Xochimilco, Mexico, 1980, p. 35.

[9] *Ibid.*, p. 87.

[10] Rosero shows that in 1910 in Costa Rica, infant mortality rates were higher than 200 deaths per 1,000 born alive. With such levels, only 4.9 children from the 7.7 born to a typical couple reached the age of five. However, between 1910 and 1960 infant mortality registered a spectacular reduction. In 1960, the rate was 40 deaths per 1,000 born alive. With these levels, 6.6 from the 7.4 children born to each couple reached the age of five. (L. Rosero, "Determinantes de la fecundidad en Costa Rica", *Notas de Población*, Latin American Demographic Centre (CELADE), vol. XI, 1983 (32), p. 85.)

[11] In this respect, Lourdes Arizpe points out that in the case of Mexico there was a substantial increase in employment opportunities. Thus, for example, in the 1940s approximately 503,000 jobs were generated; 686,000 in the 1950s and 670,000 in the 1960s. "Migrants could easily find a formal job. The requirements for their insertion in the labour market were few and they could be trained in the various activities. For those migrants who sought temporary income, the housing and urban infrastructure construction industry offered plenty of job opportunities." (Lourdes Arizpe, "El éxodo rural en México y su relación con la migración a Estados Unidos", *Estudios Sociológicos*, vol. I, No. I (Mexico, El Colegio de México, 1983), p. 15.

[12] The seasonal migrations depend on the agrarian specific cycles; the pendular migrations are those which tend to be repeated annually, between specific areas, and the circular migrations include an itinerary related to the harvest of one or more commercial crops. (C. Sabalain and C. Reboratti, "Vendimia, zafra y alzada: migraciones estacionales en la Argentina", *Migración y Desarrollo-6*, A. Lattes, comp., Serie Población (Buenos Aires, Consejo Latinoamericano de Ciencias Sociales (CLACSO), 1983).

[13] Several authors have discussed and illustrated some of the theoretical and methodological problems regarding sequences and contexts of events and variables in socio-demographic analysis (T. K. Hareven, "Family time and historical time", *Daedalus* 106 (2), Spring 1977; H. Zemelman, "Problemas en la explicación del comportamiento reproductivo (sobre las mediaciones)", *in Reflexiones teórico-metodológicas sobre investigaciones en población* (Mexico, El Colegio de México, 1982); A. Quesnel and S. Lerner, "Problemas de interpretaciones de la dinámica demográfica y de su integración a los procesos sociales", Seminario PISPAL sobre Problemas de la Integración del Análisis Demográfico en la investigación social, Brazil, 1983.

[14] The relevance of the family as an economic unit of production and as a theoretical category in socio-demographic analysis is being emphasized in many recent studies. See, among others, S. Wargon, "The study of household and family units in demography", *Journal of Marriage and the Family*, 35 (3), August 1974, pp. 560-564: T. Burch and others, *La familia como unidad de estudio demográ-*

fico (San José, Costa Rica, Latin American Demographic Centre (CELADE), 1976); W. Brass, "Co-operative research project on demography of the family", (Committee for International Co-operation of National Research on Demography (CICRED), 1980) (mimeographed); S. Lerner, "Población y familia o grupo doméstico", II Reunión Nacional de Investigación Demográfica en México (Mexico, Consejo Nacional de Ciencia y Tecnologia (CONACYT), 1980); S. Torrado, "Sobre los conceptos de 'estrategias familiares de vida' y 'proceso de reproducción de la fuerza de trabajo' ", Taller PISPAL sobre Estrategias de Sobrevivencia, Buenos Aires, 1980"; M. C. Olivera, "Notas acerca da familia nos estudos demográficos", VII Reunión del Grupo de Trabajo sobre Proceso de Reproducción de la Población, Mexico, 1982.

[15] S. Lerner and A. Quesnel, "La estructura familiar como expresión de condiciones de reproducción social y demográfica", VII Reunión del Grupo de Trabajo sobre el Proceso de Reproducción de la Población, CLACSO, Mexico, 1982.

[16] The vertical pattern in extended families comprises the central nucleus (father and/or mother and unmarried children) and at least one nucleus of descent (children of the central nucleus and/or their partners and respective children). Of the total number of domestic groups 45 per cent conform to extended arrangements and more than 80 per cent of these correspond to this pattern (Lerner and Quesnel, *loc. cit.*, pp. 26-27). Similar results have been reached in other studies with regard to the proportion in extended arrangements in agrarian areas (M. Torres, "Familia, trabajo y reproducción social", Campesinos en Honduras, PISPAL, El Colegio de México, 1982; M. Cain, "The economic activities of children in a village in Bangladesh", *Population and Development Review*, vol. 3, No. 3 (September, 1977), among others). The collateral or horizontal pattern in extended families will include, aside from the central, another nucleus composed of brothers or sisters of the family head or the spouse. When reference is made to a *vertical or collateral nuclear* group, the structure is by definition nuclear and the composition has the same meaning as described above.

[17] In the zone under study, located in the state of Yucatan, it was observed that general mortality at the state level had declined from 34.2 per 1,000 in 1930 to 8.3 per 1,000 in 1975 in the entire state. The birth rate until 1976 had been estimated at approximately 44 per 1,000 but has declined slightly since then. (CONAPO, Breviarios, México Demográfico, 1981-1982.)

[18] *Ibid.*, p. 18.

[19] T. Locoh, "Conséquences de la baisse de la mortalité sur l'évolution des structures familiales africaines" (Mexico, International Union for the Scientific Study of Population, 1977), pp. 2-3.

[20] Lerner and Quesnel, "La estructura familiar . . .", pp. 29-30.

[21] A. Collomp, "Familles nucléaires et familles élargées en Haute-Provence au XVIIIe. siècle (1703-1734)", *Annales*, ESC, 1972, Nos. 4-5.

[22] M. Levy, "Aspects of the analysis of family structure", in A. Coale and others, *Aspects of the analysis of family structure* (Princeton, New Jersey, Princeton University Press, 1965), quoted by M. Torres, "Cambios en el comportamiento reproductivo y su vinculación con los cambios en la estructura agraria en América Latina". Congreso Latinoamericano de Población y Desarrollo, Mexico, 1983.

[23] Lerner and Quesnel, "La estructura familiar . . .", p. 28; S. Lerner and P. Livernais, "Fecundidad y diferenciación social", (El Colegio de México, 1984) (mimeographed), p. 54.

[24] A. Quesnel, "Déplacements, changements sociaux économiques en économie de plantation: le Plateau de Darges" (Togo) (Office de la recherche et technique outre-mer (ORSTOM)), 1981; D. Benoit and others, "Household structures in rural populations of South Togoland", X Congreso Mundial de Sociología, Mexico, 1982.

[25] Under the mortality and fertility conditions of the region mentioned (see note 15), the average number of possible surviving descendants would be 6, equal to the achieved number of living descendants.

[26] For example, in our study in Mexican agrarian contexts, two approaches or redefinitions were identified. The first one, the *residential domestic groups*, corresponds to the conventional practice in socio-demographic censal studies; the second one, the so-called *interaction domestic groups*, includes the domestic-related groups living in separate housing units within or outside the community (head's and wife's family of origin, collateral family of both, and the descent groups).

[27] M. Godelier, "Modos de produción, relaciones de parentesco y estructuras demográficas", in *Economía, fetichismo y religion en sociedades primitivas*, Siglo XXI, Mexico, 1974, pp. 123-256.

[28] *Ibid.*, p. 226.

[29] P. Bourdieu, "Les stratégies matrimoniales dans le système de reproduction", *Annales*, ESC, No. 4-5, 1972.

[30] Cain, *loc. cit.*

[31] W. Kula, "La seigneurerie et la famille paysanne en Pologne au XVIII siècle", *Annales*, ESC, No. 4-5, Paris, 1972.

[32] L. Arizpe, "Migración por relevos y reproducción del campesinado", *Cuadernos del CES*, No. 26 (Mexico, El Colegio de México, 1980).

[33] Lerner and Quesnel, "La estructura familiar . . .".

[34] These results lead one to question the direct and mechanical relation that is generally assumed between the size of the group and the labour force requirements of the descent nucleus; this relation would function only in certain nuclear families.

[35] H. Behm, "Determinantes socioeconómicos de la mortalidad en América Latina", Reunión de UN/WHO sobre Determinantes y consecuencias de la mortalidad, Mexico, 1979; Lerner and Quesnel, "La estructura familiar . . ."; E. Menéndez, *Poder, estratificación, salud* (Mexico, Ediciones de la Casa Chata, 1981); M. Bronfman and R. Tuirán, "La desigualdad social ante la muerte: clases sociales y mortalidad en la niñez", Congreso Latinoamericano de Población y Desarrollo, PISPAL, Mexico, 1983.

[36] M. E. Negrete, "La migración en una localidad campesina del estado de Morelos", documento presentado en la II Reunión Nacional de Investigación Demográfica en México (Mexico, CONACYT, 1980).

[37] S. Venegas, "Economía campesina y migración temporal", unpublished master's thesis (Mexico, El Colegio de México, 1983).

[38] *Ibid.*, p. 22.

[39] *Ibid.*, p. 24.

[40] *Ibid.*, pp. 27-28.

[41] *Ibid.*, p. 25.

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M. Margulis, "Contradicciones en la estructura agraria y transferencia de valor", *Colección Jornadas* (Mexico, El Colegio de México, 1979).

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V. EFFECT OF CHANGING CHILD MORTALITY ON VALUE OF CHILDREN TO PARENTS

*Augustine O. Okore**

In relation to the theory of demographic transition, changing infant and child mortality and the changing value of children have consistently featured in both micro- and macro-analyses as crucial factors in the taxonomy of determinants of fertility.[1] In a recent analysis of the transition of the value of children, Bulatao listed these two variables among seven explanatory factors of fertility transition. He visualizes these variables as intervening between socio-economic development and fertility decline, but goes on to argue that they may operate independently of large-scale societal transformations.[2] Be this as it may, child mortality and the value of children are important demand factors and therefore changes in them invariably affect the demand for children. Furthermore, the two variables are interdependent. This latter consideration, which is central to our analysis, has been discussed by Retherford, who hypothesized that "parents' gratification from and demand for children relate primarily to surviving children rather than children ever born".[3] For the large part, children are not produced merely because it is the thing to do. Nor are they merely the "unintended outcome of sexual activity".[4] Couples are assumed to balance the costs and benefits (both pecuniary and non-pecuniary) of children and to choose the family size (large or small) of living children which they anticipate would maximize the family well-being.[5] Given this assumption, child loss is therefore clearly undesirable since it impinges on the attainment of parents' reproductive goals. It also involves the loss of pecuniary and non-pecuniary investments already made for the dead child in anticipation of future returns. By and large, both the value placed on children and the response of parents to child losses largely depend on the socio-economic circumstances to which parents are exposed. As Schultz has aptly pointed out, we require adequate knowledge of those "aspects of parents' environment that determine the relative attractiveness of having many versus few children".[6] This is important because parents' exposure to circumstances influences their view of the world. Parents' perceptions of social reality, their aspirations and hopes and fears, and their notion of the desirable are predicated on their experience.[7] Thus, in regard to the family formation process, parents' reproductive goals tend to correspond with their conception of what is desirable in life. High child mortality risks could, therefore, induce parents to have more children than they otherwise would have as a hedge against child loss. Still-fertile parents could also make conscious efforts to replace their dead children. These two aspects, which respectively come under the rubric of "insurance" and "replacement" strategies, will be elaborated in the next section, while the third section examines the value of children as a factor in the demand for children. The fourth section will then analyse some of the effects of changing child mortality on the value of children.

A. Child mortality and the demand for children

The effect of child mortality on the demand for children has attracted considerable theoretical and empirical research attention.[8] At the individual or family level, both persistent high mortality risk and declining mortality are seen to affect the demand for children.

Persistent high mortality: First, in a high-mortality régime, parents' reproductive responses to child death or the fear of it are visualized in terms of the following strategies:

(*a*) The death of a child induces a desire to replace the lost child and hence increases the probability of having an additional birth. Where sex preference is emphasized, the death of a male child also induces a desire for a male replacement (replacement strategy);

(*b*) Fear of the death of a child (or a male child) induces couples to have more children than they otherwise would have as a hedge against possible child loss (insurance strategy).[9]

These strategies are themselves predicated on a few basic assumptions:

1. That parents have a target demand for a particular number of surviving children;
2. That still-fertile parents would sequentially decide to make an added effort to have an additional child when they lose one;[10]
3. That a mechanism exists through which couples can cease childbearing after attaining the target number of surviving children.[11]

It is pertinent to note, however, that various opinions have been expressed concerning the effect of these strategies on the demand for children. With particular reference to the replacement strategy, Knodel, for instance, has noted that "in the absence of deliberate limitation of family size there could be no replacement effect since childbearing would continue until the couple was no longer physiologically capable of reproduction, regardless of their experience with child mortality".[12] This, however, represents a theoretical limiting case since few couples, in any society other than the Hutterites, have been known to reach their biological limits of childbearing. On the contrary, most societies in the early stages of transition have some normatively regulated controls that militate against reaching the biological limits of childbearing.[13] Knodel himself recognizes this fact when he argues that "couples with low previous child mortality may react by stopping childbearing

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before they actually become sterile while those who have experienced higher mortality may continue . . .".[14] Of course, some parents may continue childbearing even when all their children survive, and this would also suggest an insurance effect.[15] Moreover, the fact that those who have experienced higher child mortality may continue to bear children is suggestive of the presence of the replacement effect.[16] However, the more fundamental issue raised in regard to the replacement hypothesis relates to the level of replacement of dead children. Questions arise as to whether parents respond to child losses directly and whether parents really have a particular target number of surviving children[17] or whether in fact their desired family size is framed in terms of a range. It has been suggested that "in no population are as many as 50 per cent of child deaths replaced by additional births".[18] Various explanations for the incomplete replacement have been suggested. These include fecundity impairment, and the fact that multiple child losses might encourage a couple to stop childbearing rather than risk yet another disappointment. Also, there may already have been an overproduction of children in anticipation of child mortality. The sex of the dead child and uncertainty as to the precise outcome of a further attempt at childbearing may also inhibit the attempt to replace child losses.[19]

In the final analysis, regardless of whether one is examining the replacement effect or the insurance effect of child mortality on fertility, the ultimate issue is child survivorship and the demand for surviving children. It is important to note, however, that although the train of analysis so far also supports the notion of a positive relationship between child deaths and fertility, it has been observed that at the early stages of transition the positive relationship "is not isolated from the reverse effect of fertility on mortality".[20] Accordingly, Scrimshaw observed that "mortality may sometimes be a response to high fertility instead of a stimulus to it".[21] Yet the theory of demographic transition suggests that at the early stages both mortality and fertility are high. Mortality decline eventually sets in, followed—after a lag—by fertility decline. This pattern has been explained in terms of the lag in perception of the fall in mortality.[22] It also suggests that fertility tends to respond to mortality rather than the reverse. However, whatever the causal direction, available evidence has tended to validate a positive relationship between child mortality and fertility. Interestingly enough, evidence from a study in Sierra Leone in which age was controlled for was still supportive of the positive relationship. Ketkar thus reported that "for women aged 45-60, the average number of children ever born to families experiencing no child loss is found to be 3.46 per married woman. In the same age group, the average number of children ever born in families that have experienced child loss is 6.14", with an average of 3.49 surviving children per woman.[23] These findings suggest that all the women covered in the study had similar targets of surviving children and that those of them who had experienced child loss produced more births than was necessary either as a hedge against continued losses or as replacements for their dead children.

If high child mortality induces higher fertility, then it is to be expected that child mortality decline should lead to a reduction in fertility. The pattern of this relation has equally attracted considerable attention. It has been argued, for instance, that child mortality decline affects only the demand for births but has no effect on the demand for surviving children since individual or couple targets for surviving children need not be affected.[24]

The mechanism of the effect of mortality reduction on the demand for children and fertility has also been analysed. Bulatao, for instance, has identified three possible effects.[25] First, a lower and more predictable level of mortality would reduce the frequency with which couples have to replace lost children. It would equally reduce the need for parents to have extra children early in their marriage in anticipation of future mortality. Secondly, it is hypothesized that with mortality decline, fewer births would be required to produce the desired number of surviving children and the cost per survivor should decline. Yet, according to Retherford, cost reduction involves both income effect and substitution effect, both of which may act to increase the demand for surviving children. "Child cost reduction, *ceteris paribus,* effectively increases real income. At the same time, it may cause people to substitute children for other goods whose cost has not changed."[26] This situation reflects conditions during the early stage of transition when mortality declines sharply and fertility may rise before a lagged decline. With further declines in mortality, parents accept the mortality régime as being more predictable. Children become less valued for economic reasons and are increasingly regarded as costly dependants and the demanded number of surviving children declines so fewer births are required to achieve the new demanded number of surviving children. Thirdly, it is probable that under low mortality conditions, parents may favour investing more (both financially and emotionally) in each child, and therefore have fewer potential resources to raise additional children.[27]

It is apparent from the second and third considerations that child mortality decline can have an important effect on the cost of raising surviving children. It is also clear that the demand effect of both factors could be positive or negative, depending on the stage of demographic transition and parents' perception of the needs served by children.

B. The value of children and the demand for surviving children

In the foregoing section, an attempt was made, within the context of socio-demographic transition, to establish the relationship between child mortality and the demand for surviving children—a relationship which invariably influences, and is reflected in, the demand for births. It is important to note that each response depends not only on the level of parents' perception of the chances of child survivorship but also on their perception of the value of children to them. In this regard, the demand for children is a derived demand and depends on the socio-economic and demographic experiences to which parents are exposed.

For the purpose of analysing the observed tripartite relationship between child mortality, the value of children and the demand for children, two hypotheses are noteworthy. "Children are a source of satisfactions to their parents and the value of these satisfactions depends on an array of psychological, social and economic needs . . . . Reproductive behaviour (fertility) is largely a response to the underlying preferences of parents for children."[28] It therefore follows that "parents would

want an extra child if the satisfactions derived from that child are greater than the costs that are involved".[29]

The fertility-related analysis of the value of children in terms of a cost-benefit calculus is not new. In 1957, Leibenstein hypothesized that children were economically valuable to parents as consumption goods, productive agents and a potential source of old age security. On the other hand, parents incur both the direct cost of feeding and clothing the child until he or she becomes self-supporting and the indirect cost involving opportunities for labour force participation and mobility which the mother would forgo owing to the presence of an additional child.[30] He further noted that changing economic circumstances affecting parents (including a rise in income, increased specialization and economic mobility) operated to increase the cost of children and reduce the benefits derivable from them.

In 1960, Gary Becker proposed an economic theory of fertility using the conventional theory of consumer choice to explain the demand for children. He described children as consumer goods, the demand for which was a function of taste, income and price (cost).[31] Becker's analysis is most applicable to the conditions prevalent in the developed countries, where the value of children as productive agents is no longer important.

These micro-economic models of fertility do not take account of the complex matrix of social and psychological factors that go into the fertility decision-making process. From the early 1970s, systematic research efforts have been directed towards the development of value schemes which incorporate "the many values that children provide in various cultures".[32] The various values identified in these researches may be summarized as follows:[33]

Positive general values

1. *Emotional benefits.* Happiness, love, companionship, fun; also viewed negatively as relief from strain and avoidance of boredom or loneliness.

2. *Economic benefits and security.* Benefits from children's help in the house, business or farm, from care of siblings, and from sharing of income; old-age security for the parents, including economic support, physical care and psychological security.

3. *Self-enrichment and development.* Learning from the experience of childrearing; becoming more responsible and mature; incentive and goals in life; being viewed as an adult, a grown woman or man; self-fulfilment; feeling of competence as a parent; being needed and useful.

4. *Identification with children.* Pleasure from watching growth and development of children; pride in children's accomplishments; reflection of self in children.

5. *Family cohesiveness and continuity.* Children as a bond between husband and wife; fulfilment of marriage; completeness of family life; continuity of family name and traditions; producing heirs; having grandchildren.

Negative general values

1. *Emotional costs.* General emotional strain; concern about discipline and moral behaviour of children; worry over health; noise and disorder in household; children as nuisance.

2. *Economic costs.* Expenses of childbearing; educational costs.

3. *Restrictions or opportunity costs.* Lack of flexibility and freedom; restrictions on social life, recreation, travel; lack of privacy; restrictions on career or occupational mobility; lack of time for personal needs and desires.

4. *Physical demands.* Extra housework; caring for children; loss of sleep; general weariness.

5. *Family costs.* Less time with spouse; disagreements over rearing of children; loss of spouse's affection.

Large-family values

1. *Sibling relationships.* Desire for another child to provide companionship for existing children; enriching the lives of children; avoiding an only child.

2. *Sex preferences.* Specific desire for a son or daughter; desire for a certain combination of sexes among children.

3. *Child survival.* Concern that existing children may die; need for more children to have enough survive to adulthood.

Small-family values

1. *Maternal health.* Concern that too many pregnancies, or pregnancy when the mother is beyond a certain age, may be bad for the mother's health.

2. *Societal costs.* Concern about overpopulation, belief that another child would be a burden to society.

It is important to note that different values are salient in different social structures and in different subgroups within a structure.[34] The identification of the motivational contexts for childbearing is important for the development of causal models of family size choices within various social structures.

C. The value of children in the social context

From the categories presented above, it is evident that the multiplicity of meanings attached to childbearing involves conflicting (positive versus negative) values. Some of these values tend to favour having a child, an additional child, or many or few children, while others tend to operate against these. A crucial dividing line, in terms of family size choice, may be drawn between the industrialized societies where the value of children is predominantly psychological and the developing societies where it is largely economic and social. The common denominator seems to be that, regardless of the cost of having children, childbearing is a socially prescribed role expected of couples in every society. The difference then lies in the number of children considered by parents to be adequate for the attainment of their valued goals. Thus in every society, "the first birth signifies for parents such factors as adulthood, parenthood, virility or femininity, fulfilment of marriage",[35] as well as personal motivations such as the desire to experience childbirth, the excitement of creating a new life and nurturing it, the urge to reproduce the self and so on. The first child is therefore crucial in every culture. The first birth, in turn, engenders other motivations for a second child, such as the desire to provide a companion for the good of the first child and balancing

the sexes in the interest of each of the spouses. According to Fawcett, at least in developed societies, "the peak of childbearing motivations occurs between the first and the second birth".[35] This fact indeed marks the point of departure between the developed societies, where the two-child family easily fulfils the needs served by children, and the developing societies, where more children are often required to meet the pressing demands on the family to eke out a living on land, where more than two children are required to fulfil the social values, and where the family system offers substantial relief against the burden of many children.

In examining the value and cost of children to parents, it is therefore important to take account of both the economic and the non-economic (emotional and psychological) components as they apply to various cultural settings.

D. Child mortality and value of children to parents

In the preceding sections, the conceptualization of the relationship between child mortality, the demand for children and the value of children rests on the following train of reasoning: the demand for children is a derived demand and a given mortality condition generates appropriate responses relative to the number of surviving children which parents perceive to be adequate to fulfil the needs served by children. In order to shed further light on these relationships, table V.1, at the end of this chapter, relates indices of mortality and fertility to the perceived values attached to children by parents. In this analysis, use has been made of the comprehensive presentation by Bulatao of data on the advantages and disadvantages of having children from 29 independent surveys conducted between 1963 and 1978 in 26 countries of the world.[36] Although comparisons in the table are made within the context of the demographic transition theory, there are a few deviations from the known pattern of relationship between mortality and fertility.[37] For instance, Turkey has a very high infant mortality rate while the total fertility rate and the gross reproduction rate reflect moderate fertility. For analytical purposes, the countries have been classified into the following four categories—high mortality, high fertility; moderate mortality, high fertility; moderate mortality, moderate fertility; and low mortality, low fertility.

It is evident from the table that in the low-mortality, low-fertility countries, the economic, social and religious values of children are insignificant in the hierarchy of values and that greater emphasis is placed on the emotional and psychological values. There appears, therefore, to be a congruence between mortality reduction, fertility decline, the vanishing economic role of children and the emergence of a different set of values of children to parents. Fewer children are required to fulfil the predominantly emotional and psychological values placed on children. At the other extreme, parents in the high-mortality, high-fertility countries emphasize the economic and social needs served by children. It can, therefore, be reasonably argued that the response of fertility to mortality is predicated on the desire to ensure that enough children shall survive to fulfil these needs, given the difficult economic climate and the social systems based on kinship that prevail in this region. Emotional considerations (such as companionship) feature less significantly while psychological factors are hardly mentioned.

In terms of costs, it is curious that parents in high-mortality, high-fertility countries appear to worry more about the financial costs of having children than those in the low-mortality, low-fertility countries. The expression of concern about costs in the former is indeed an indirect expression of concern about the general level of poverty which often dampens parents' hopes and aspirations for high-quality children (even if they have few children). Another notable aspect of the cost consideration is that emotional costs and concern about restriction on parents predominate in the low-mortality, low-fertility countries. The moderate-mortality, moderate-fertility countries, which fall in between, tend more towards the value patterns observed for the low-mortality, low-fertility countries. The cases of Malaysia and Costa Rica (moderate-mortality, high-fertility countries) tend to reflect a situation in which the onset of mortality decline has not generated a corresponding downward movement in fertility, presumably because of a lag in parental perception of increased survivorship. The value placed on children is also largely economic and follows closely the pattern observed for the high-mortality, high-fertility countries.

Within the above framework, it should be expected that "given higher infant and child mortality, the values attached to having children should include security against mortality".[38] Yet Bulatao noted that, with the exception of the Thai survey, in which 11 per cent of 2,950 husbands mentioned the lack of security against mortality as a disadvantage of a small family, the security factor in the demand for children has hardly been mentioned.[39] He noted, however, that with regard to an only child, some respondents in five countries were more specific in expressing the fears "that an only child might die, and that if he died there would be no one to replace him, or that they would be more secure with more children".[40]

This seemingly obscure position of the security factor on the score-board of value categories does not necessarily detract from the fact that child survivorship is a significant factor for the eventual attainment of whatever value parents in various cultures place on children. The observed obscurity of the security-against-mortality risk in the value scheme in high-mortality, high-fertility countries may be explained by the fact that, given their personal experiences of child mortality and their perception of mortality levels in their communities, parents tend to assume the security factor as a natural response mechanism rather than an overt personal strategy.

Overall, regardless of the values placed on children and the perceived cost of children, child loss involves not only a loss of parents' time, energy, emotion and income already invested in the child but also a loss of the anticipated returns from the child. Mortality decline reduces the risk of these losses. At the same time, child mortality reduction implies that, in the long run, fewer births would be required to obtain some desired number of surviving children to fulfil a new set of values (largely psychological) placed on children. The cost per survivor should also decline.[41] As Leibenstein points out, the effect of child mortality reduction at the early state of transition would be to increase the number of surviving children. Many more children therefore survive to productive ages, and begin to earn their keep, thus

reducing the cost of their upbringing while also contributing to their family's production efforts.[42] Accordingly, Schultz argued that "the reduction in death rates increases the returns from having a child; indeed, all forms of human investment would appear to grow more attractive as human life is prolonged and morbidity is reduced".[43] This observation is double-edged in that both parents and children must survive in order for parents to enjoy the benefits from their children long enough.

However, this initial impact of child mortality reduction based on the improved chance of child survival would eventually be neutralized by the limitations on the resources of parents to maintain the increased number of surviving children. Parents may therefore increasingly consider investing more in the quality of children relative to the returns from a large number of children.[44] Similarly, "the non-pecuniary returns associated with the psychological needs that children fulfil may diminish sharply after a certain number of children have been born".[45] Parents would, in turn, prefer to invest their limited emotional resources on fewer children than spread them over many children with the attendant strains involved.

In the final analysis, therefore, the effect of child mortality reduction on the value and cost of children is such that parents cannot afford to be indifferent to family size for an indefinite period of time. The critical point at which the change occurs seems to lie in the transition from the moderate-mortality, high-fertility stage to the low-mortality, low-fertility stage. Child mortality reduction may not only affect the values and costs attached to children but may in fact operate to modify the types of values and costs considered. The combined effect of both forces of change would be reflected in changes in family-size goals. The complexity of these relationships calls for greater research, especially in terms of supportive data.

E. Summary and conclusion

Within the context of the theory of demographic transition, various régimes of births and deaths can be associated with different hierarchies of values and costs of children. Although the direct effect of child mortality on the value of children is not immediately obvious, it is at least clear that under high-mortality, high-fertility conditions, parents emphasize economic, social and, to a lesser extent, emotional values of children. In contrast, greater emphasis is placed on psychological and emotional values and costs under low-mortality, low-fertility conditions. There is, therefore, a rather complex matrix of interrelationships involving mortality and fertility with the value of children as an intervening factor. Thus, at the early stage of transition, child mortality reduction increases the number of surviving children. At this stage, the adjustment in the demand for children and in births in response to declining mortality would not immediately be of such magnitude as to prevent the growth in family size. At the same time, the economic motives for childbearing still predominate and the increase in the number of surviving children constitutes an advantage to parents since many more children survive to productive ages. On the other hand, the later stage of transition is characterized by sustained reductions in child mortality. Parents feel less pressure to have many children as a security against child loss as children also become less valued for economic reasons and are increasingly regarded as costly dependants. Under such conditions, parents prefer fewer children in whom they can make greater emotional investment. Children become increasingly valued for psychological reasons, and child quality rather than the number of children becomes a predominant consideration in family size choices. It therefore follows that family sizes are smaller when the need to compensate in advance for possible child loss diminishes. This involves both changes in child mortality and in the value placed on children.

It is important to note that the mechanics of this complex interrelationship have not been given adequate research attention. It is true, as Bulatao has pointed out, that "as a factor involved in fertility decline, mortality reduction has complex effects, not all of which appear in value-of-children data".[46] While there is an urgent need for further investigation of the direct effect of child mortality on the value of children, the observed relationships between the various mortality régimes and different hierarchies of values have important policy implications. This is particularly so in regard to the developing countries where the "progress made in the betterment of health and the reduction of mortality rates" has been described as "outstanding".[47] While this may be so in relative terms, this progress has registered little effect on the number of children demanded by parents in many developing countries. Nor have there been any significant deviations from the known hierarchies of values attached to children in these regions. The present level of mortality change cannot be expected to affect parents' perception of the improving chances of child survival. It has not been pervasive enough to have an influence on the number of children desired and actually demanded, with the attendant reordering of the hierarchy of values attached to children.[48] Such magnitude of change would necessarily accompany sustained and widespread socio-economic transformations that would weaken extended family links and de-emphasize the reliance on children as the major source of family labour and parental security. This should be the ultimate policy focus if changing child mortality is to affect the contexts in which family size decisions are made.

Notes

[1] See, for example, Frank W. Notestein, "The economics of population and food supplies: economic problems of population change", *8th International Conference of Agricultural Economists, 1953* (London, Oxford University Press, 1953), pp. 15-18; Rodolfo A. Bulatao, *On the nature of the transition in the value of children*, papers of the East-West Population Institute, No. 60-A (Honolulu, Hawaii, March, 1979), pp. 1-4; T. Paul Schultz, "An economic perspective on population growth", *Rapid Population Growth* (Baltimore and London, The Johns Hopkins Press, 1971), pp. 148-174.

[2] Bulatao, *On the nature of the transition . . . ,* p. 3.

[3] Robert D. Retherford, "The influence of child mortality on fertility: a review of mechanisms", background paper prepared for the Seminar on Infant Mortality in Relation to the Level of Fertility, New Delhi, 21-27 January 1975, p. 6.

[4] Schultz, *loc. cit.*, p. 149.

[5] Akbar Aghajanian and Amir H. Hehryar, "Community characteristics, economic status and fertility in the Iranian villages", *Genus*, vol. 37, No. 1-2 (Gennaio-Giugno, 1981), p. 137.

[6] Schultz, *loc. cit.*, p. 171.

[7] M. L. Kohn, "Social class and parent-child relationships", *in* Michael Anderson, ed., *Sociology of the Family* (England, Penguin Books, 1971), pp. 323-325.

[8] See, for example, Shea Oscar Rutstein, "The influence of child mortality on fertility in Taiwan", *Studies in Family Planning*, vol. 5, No. 6 (June 1974), pp. 182-188; Samuel H. Preston, ed., *The Effects of Infant and Child Mortality on Fertility* (New York, Academic Press, 1978); J. Knodel, "Child mortality and reproductive behaviour in German village populations in the past: a micro-level analysis of the replacement effect", *Population Studies*, vol. 36, No. 2 (July 1982), pp. 177-200; Susan C. M. Scrimshaw, "Infant mortality and behaviour in the regulation of family size", *Population and Development Review*, vol. 4, No. 3 (September 1978), pp. 383-403.

[9] Rutstein, *loc. cit.*, pp. 182-183. See also Knodel, *loc. cit.*, p. 177.

[10] Schultz, *loc. cit.*, p. 157.

[11] Knodel, *loc. cit.*, p. 177.

[12] *Ibid.*, p. 177.

[13] In Africa, for example, the two to three years' child-spacing practice that has existed over time in the traditional sector is designed to keep fertility within reasonable limits. Similarly, the fact that a woman who has a childbearing daughter is not expected to continue bearing children (in competition with her daughter) places constraints on the mother even if she wishes to have more children.

[14] Knodel, *loc. cit.*, p. 177.

[15] Scrimshaw, *loc. cit.*, footnote 2, summarizes the child survival hypothesis (after Omran) as follows: "It is unlikely that parents will consider limiting the size of their families if they have become accustomed to high childhood mortality and expect some of their children to die no matter what they do."

[16] Scrimshaw, *op. cit.*, referred (p. 385) to the analysis by Chowdhury and others for Pakistan and Bangladesh, which showed that women with fewer living children had shorter birth intervals. Chowdhury and his colleagues doubted that this pattern was reflective of the conscious effort on the part of the women to replace their dead children. They felt that it could well reflect a shorter lactation amenorrhoea following infant death. It should, however, be noted that a shorter lactation amenorrhoea, in itself, does not necessarily result in another pregnancy immediately.

[17] Bulatao, *On the nature of the transition* . . . , p. 9; Scrimshaw, *loc. cit.*, p. 385.

[18] Scrimshaw, *loc. cit.*, p. 385, referring to Preston.

[19] Scrimshaw, *loc. cit.*, p. 385; Knodel, *op. cit.*, p. 178.

[20] *World Population Trends and Policies, 1981 Monitoring Report*, vol. 1, *Population Trends* (United Nations publication, Sales No. E.82.XIII.2), p. 33.

[21] Scrimshaw, *loc. cit.*, p. 383.

[22] Retherford, *loc. cit.*, p. 44.

[23] S. L. Ketkar, "Determinants of fertility in a developing society: the case of Sierra Leone", *Population Studies*, vol. 33, No. 3 (November 1979), p. 480.

[24] Bulatao, *On the nature of the transition* . . . , p. 9.

[25] *Ibid.*, pp. 9-10.

[26] Retherford, *loc. cit.*, p. 7.

[27] Bulatao, *On the nature of the transition* . . . , p. 10; Schultz, *loc. cit.*, p. 156.

[28] Schultz, *loc. cit.*, p. 149.

[29] Harvey Leibenstein, *Economic Backwardness and Economic Growth* (London, John Wiley, 1957), p. 159.

[30] Leibenstein, *op. cit.* Espenshade has, however, observed that the opportunity cost of the presence of an additional child on the mother's participation in the labour force can be negligible for two reasons. First, "if the presence of one child in the family precludes the wife's participation in the labour force, then her lost earnings that can be attributed to subsequent children are negligible". This condition would, however, apply on the assumption that the mother had decided to adopt a concentrated childbearing pattern and had decided to stay out of work until the last child went to school. Secondly, in the developing countries, the female roles of mother and worker are not always incompatible because of the presence of house-help and help from relatives in looking after children, which release parents for more lucrative activities. See Thomas J. Espenshade, "Estimating the economic cost of children in less-developed countries: some methodological issues", paper presented at the session on "Value and cost of children to parents" at the Seventh General Conference of the International Union for the Scientific Study of Population, Mexico City, 8-13 August 1977, pp. 4 and 9.

[31] Gary Becker, "An economic analysis of fertility", *Demographic and Economic Change in Developed Countries* (Princeton, National Bureau of Economic Research, 1960), pp. 209-241.

[32] Lois Wadis Hoffman and Martin L. Hoffman, "The value of children to parents", *in* James T. Fawcett, ed., *Psychological Perspectives on Population* (New York, Basic Books, 1973), p. 44.

[33] J. T. Fawcett, "The value and cost of children: Converging theory and research", *Proceedings of a Conference held in Canberra, 16-18 November 1976*, L. T. Ruzicka, ed., *The Economic and Social Supports for High Fertility* (Canberra, Department of Demography, The Australian National University, 1977), pp. 98-99. For a summary of other value schemes, see A. O. Okore, *The Value of Children Among Ibo Households in Nigeria*, unpublished doctoral dissertation in demography (The Australian National University, 1977), pp. 27-29.

[34] Lois Wadis Hoffman, "A psychological perspective on the value of children to parents: concepts and measures," *in* James T. Fawcett, ed., *The Satisfactions and Costs of Children: Theories, Concepts and Methods* (Honolulu, East-West Population Institute, December 1972).

[35] Fawcett, *op. cit.*, p. 104.

[36] Rodolfo A. Bulatao, *Further Evidence of the Transition in the Value of Children*, Papers of the East-West Population Institute, No. 60-B (Honolulu, November 1979), pp. 68-71.

[37] Infant mortality rates for the 26 countries have been used as indices of mortality, while total fertility rates and gross reproduction rates are used for fertility measures.

[38] Bulatao, *Further Evidence of the Transition* . . . , p. 45 and table B.2, p. 75.

[39] *Ibid.*, p. 49.

[40] Rodolfo A. Bulatao, *On the nature of the transition* . . . , p. 87. In only five countries or areas did respondents mention the security factor, as follows: Philippines, 17 per cent wives, 16 per cent husbands; Turkey, 41 per cent wives, 27 per cent husbands; Indonesia, 12 per cent wives, 12 per cent husbands; Thailand, 33 per cent wives, 31 per cent husbands; Taiwan, province of China, 8 per cent wives, 12 per cent husbands.

[41] Bulatao, *On the Nature of the Transition* . . . , p. 9.

[42] Leibenstein, *op. cit.*, p. 164.

[43] Schultz, *loc. cit.*, p. 156.

[44] T. Paul Schultz, "Determinants of fertility: A micro-economic model of choice", *in* Ansley J. Coale, ed., *Economic Factors in Population Growth* (London and Basingstoke, Macmillan, 1976), pp. 101-102.

[45] Schultz, *loc. cit.*, p. 156.

[46] Bulatao, *Further Evidence* . . . , p. 45.

[47] Concise report on *The World Population Situation in 1979* (United Nations publication, Sales No. E.80.XIII.4), p. 17.

[48] Despite the substantial transfer of medical technology to the developing countries, medical facilities are still outside the reach of millions in the rural population. Medical personnel per population unit is still very low.

TABLE V.1. ADVANTAGES AND DISADVANTAGES OF CHILDREN IN VARIOUS SAMPLES BY INFANT MORTALITY AND FERTILITY LEVEL

Percentage based on selected single responses

Mortality and fertility classification and sample	*National infant mortality per 1 000 births*[a]	*TFR* By country[b] (medium variant) 1970-1975	*GRR* By country[b] (medium variant) 1970-1975	*Advantages*[c]						*Disadvantages*[a]			
				Economic practical help	*Family name, prestige*	*Religious, social obligations*	*Companionship, happiness*	*Marital bond*	*Psychological appreciation*	*Financial cost*	*Emotional strain*	*Other childbearing demands*	*Restriction on parents*
High mortality, high fertility													
Kenya (Akamba)	83 (1977)	7.59	3.74										
Female				21	41	0	32	3	0	. .	. .	. .	. .
Male				15	55	0	30	0	0	. .	. .	. .	. .
Nigeria (Ibo)	178 (1965/1966)	6.49	3.20										
Female				34	37	13	16	0	0	51	8	42	0
Male				28	42	12	18	0	0	53	10	37	0
Nigeria (Yoruba)	. .	6.49	3.20										
Rural				. .	. .	. .	. .	. .	. .	89	0	4	0
Urban				. .	. .	. .	. .	. .	. .	82	0	9	0
Nigeria (Western—Lagos)	. .	6.49	3.20										
Female				38	41	2	15	0	0	94	0	5	0
Male				37	43	2	15	0	0	96	0	5	0
Ghana (Rural)	115 (1970)	6.70	3.30	64	26	5	5	0	0	63	36	1	0
Ghana (Sisala)	115 (1970)	6.70	3.30	62	36	0	2	0	0	. .	. .	. .	. .
Bangladesh (Parkait)	153 (1969-1974)	6.83	3.33										
Female				54	27	12	6	0	0	0	13	86	0
Male				41	38	16	5	0	0	0	33	67	0
Iran (Shiraz)	112 (1973-1976)	3.19	3.19										
Workers				35	0	0	65	0	0	69	22	5	4
Shopkeepers				47	13	27	13	0	0	80	20	0	0
Sierra Leone	. .	6.50	3.20	69	7	13	10	0	0	58	18	22	0
Colombia	77 (1973)	4.78	2.33	82	2	4	10	0	0	71	0	25	2
Mexico	70 (1972-1974)	6.19	3.02	72	2	9	16	0	0	57	0	33	6
Peru	130 (1970-1975)	5.84	2.85	83	1	6	9	0	0	81	0	15	1
Philippines	80 (1970)	5.49	2.68										
Female				53	1	1	38	3	4	25	15	55	4
Male				51	3	0	38	4	4	25	12	59	4
Turkey	125 (1974-1975)	2.59	2.59										
Female				42	5	12	26	7	8	32	12	48	7
Male				31	9	22	20	6	12	59	5	28	7
Indonesia (Java)	114 (1975)	5.69	2.78										
Female				62	15	1	17	2	3	24	7	62	7
Male				51	24	1	12	4	7	41	7	50	2
Thailand	76 (1974-1975)	5.56	2.71										
Female				75	3	1	16	3	3	29	7	50	14
Male				69	10	2	12	3	4	41	8	42	9
India	134 (1969)	5.64	2.75										
Rural				48	32	11	4	0	5	. .	. .	. .	. .
Urban				21	34	9	8	2	6	. .	. .	. .	. .
Chile (Santiago)	61 (1975)	3.32	1.62										
Low income				28	0	0	38	20	14	69	14	17	0
Middle income				0	0	0	57	34	9	59	33	8	0

TABLE V.1. (*continued*)

Mortality and fertility classification and sample	National infant mortality per 1 000 births[a]	TFR By country[b] (medium variant) 1970-1975	GRR By country[b] (medium variant) 1970-1975	Advantages[c]: Economic practical help	Family name, prestige	Religious, social obligations	Companionship, happiness	Marital bond	Psychological appreciation	Disadvantages[c]: Financial cost	Emotional strain	Other childbearing demands	Restriction on parents
Moderate mortality, high fertility													
Malaysia (West)	32 (1975)[d]	5.23	2.55										
Female				65	5	0	22	3	3	29	10	44	
Male				63	7	2	20	3	5	30	10	50	
Costa Rica	28 (1977)	4.26	2.08	82	1	4	10	0	0	66	0	30	
Moderate mortality, low fertility													
Korea, Republic of	47 (1970)	2.16	2.16										
Female				19	7	2	44	7	21	24	12	44	
Male				16	12	3	38	9	21	39	9	33	
Taiwan province of China	25 (1977)	. .	. .										
Female				14	14	2	62	4	4	18	42	34	
Male				17	26	3	47	4	3	28	43	26	
Low mortality, low fertility													
Singapore	13 (1978)	2.61	1.27										
Female				14	8	1	65	7	5	26	29	29	
Male				13	12	2	54	13	6	49	23	20	
Japan	9 (1977)	2.07	1.01										
Female				7	1	2	42	14	34	10	16	26	
Male				6	4	2	44	12	32	18	16	29	
Australia	12 (1977)	2.53	1.23										
Female				2	0	4	44	20	30	20	18	27	
Male				2	0	5	40	20	33	26	16	20	
Netherlands (female)	9 (1978)	1.97	0.96	6	0	1	32	16	45	4	21	13	
United States of America	14 (1977)	1.97	0.96										
Female				4	1	7	47	15	26	27	10	13	
Male				4	4	6	40	21	25	35	10	10	
Belgium	12 (1978)	1.94	0.94										
Female				6	0	1	47	16	30	6	24	33	35
Male				5	0	0	42	17	36	7	23	29	39
Germany, Fed. Rep. of (Bavaria)	15 (1978)	1.62	0.79										
Female				4	1	10	43	13	29	5	20	8	67

Sources:

[a] United States Bureau of Census, *World Population 1979: Recent demographic estimates for countries and regions of the world* (Washington, D.C., 1980).

[b] *Demographic Indicators of Countries: Estimates and Projections as assessed in 1980* (United Nations publication, Sales No. E.82.XIII.5).

[c] Rodolfo A. Bulatao, *Further evidence of the transition in the value of children*, papers of the East-West Population Institute, No. 60-B (Honolulu, Hawaii, 1979), pp. 68-71.

[d] United States Bureau of Census, *World Population 1977: Recent demographic estimates for countries and regions of the world* (Washington, D.C., 1980).

TFR = Total Fertility Rate.

GRR = Gross Reproduction Rate.

. . = not available.

Percentages for responses on advantages and disadvantages have been adjusted (see Bulatao). Non-response/don't know were excluded in percentage calculations.

VI. DYING AND MOURNING: THE ENGLISH CASE

*James Walvin**

One of the seminal facts of English history in the course of the nineteenth century was the decline in the death rate. Whereas from 1840 to 1875—the peak years of industrial and urban growth—the average death rate was between 22 and 25 per 1,000 population, by 1914 this had fallen below 15. There nevertheless persists a popular image of the debilitating squalour of urban England in those years, a squalour which is widely assumed to have been responsible for a marked deterioration in the quality of life of the English people. Set against the irrefutable evidence for improvement—none more convincing than mortality rates—there remains however an abundance of information on substantial strata of urban life locked into the most abject of material and social conditions. Indeed some of the most influential pieces of evidence upon which historians have relied has been that corpus of social investigation, both empirical and fictional, by writers, beginning with Sir Frederick Eden and continuing through Engels, Dickens, Mayhew, Booth and Rowntree. And yet, to admit the existence of widespread urban poverty as late as 1914 (and of course beyond) is not to challenge the case that the English people found their collective urban conditions progressively improved from the 1840s onwards.[1]

The exceptions to this general rule are well known but it is none the less worth repeating them. Death—with the ailments which preceded it—was suffered unevenly among the social classes. Infant mortality among all classes, it is true, remained inflexibly high throughout the century but the poor suffered its ravages more than others. The national figures for infant mortality reached their peak in 1899 (though presumably because the data collection had become progressively more sophisticated and accurate over the century). Even then, however, infant mortality was better (that is, lower) than in most European countries. But when the English national figures are broken down it is possible to appreciate the wide spectrum of social experiences they represent. In Bath in the 1830s and 1840s, 1 child in 2 from working-class homes died before the age of five. In middle-class homes the figure was 1 in 11. In Liverpool, in 1899 the infant mortality rate in more prosperous wards of the city was 136 per 1,000. In the poorer areas it stood at 274 and in the meanest of streets, it was a catastrophic 509 per 1,000.[2]

It is now perfectly clear why death rates among infants and young children remained so high, at a time of falling rates in the population as a whole. The new-born and the young were endangered by complex natural and social problems which nineteenth-century man seemed incapable of countering. The squalor of the home, the physical conditions of the cities, the cumulative impact of poor diet, bad water, poor ventilation, dangerous sewage and a lack of personal hygiene, all these and more, in conjunction with the relative inadequacies of paediatrics and domestic child-rearing practices, worked themselves out in the fearful infant and child mortality statistics. Whatever the local—or class—variations, infant and child mortality remained apparently immune to the overall social improvements which characterized English urban society from 1840 to 1914.[3]

In the face of this demographic evidence it becomes clearer why Victorians seemed to devote so much time and effort (in literature, painting, iconography and worship) to the death of the young. Indeed it seems perfectly clear that the literary discussion of young deaths (especially in literature aimed at the young themselves) was designed as a preparation for the unavoidability of death in the real world. What appears, at first glance, to be a Victorian obsession with the morbid and the bizarre, becomes more comprehensible and acceptable when set in the context of prevailing mortality rates among the young. Unusual as it may now seem (to Western eyes at least) the young were prepared for death from the earliest days of their exposure to contemporary literature.

> "Ah, little one, with us 'tis so,
> We know that soon we all must go;
> And so we wonder, whispering low,
> 'Whose turn next?' "[4]

In the homes of more prosperous children (where in any case the incidence of young deaths was lower than among the poor), contemporary children's literature—of all sorts and conditions—invariably returned to the theme of death and dying, and of the need to prepare for it. A boys' magazine of 1867 noted:

> "Death has been busy among us. The great leveller, with his keen scythe, has been doing his harvest work sparing neither the good grain nor the worthless tares."[5]

It had long been a literary convention to use death and dying (often in ghastly forms) as cautionary tales for children's instruction. An early moral tale, Mrs Sherwood's *History of the Fairchild Family,* continued to be a popular Victorian children's book; it described three deaths, the most unpleasant being the incineration of a disobedient girl.[6] Of course many cautionary tales were understandable: the lessons against the risks of fire, water and accidents, which all parents worry about. Victorians however spelt out the realities in a form which the modern Western reader might find unnecessarily ghoulish:

> "Remember Kate Morris—poor, dear little girl—
> So merry, so active and bright;

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So happy and full of gay spirits one morn,
A scorched, blackened corpse the same night."[7]

Tales of accidents, death, suffering and mutilation were commonplace throughout Victorian children's literature and in the most graphic and often nauseating detail.[8]

Religious and sectarian children's literature understandably dwelt on death; it was after all that rite of passage (for the godly) to eternal salvation. Used as an instrument to inculcate the qualities of obedience and religiosity, such literary devices—in hymns, prayers and stories—lingered on death (especially the death of a child) as a means of gaining salvation.

"There is an hour when I must die,
Nor do I know how soon 'twill come;
A thousand children, young as I,
Are called by death to fear their doom.
Let me improve the hours I have,
Before the day of grace is fled;
There's no repentance in the grave,
Nor pardons offered for the dead."[9]

It is, of course, impossible to assess how effective such literature was in disciplining children; none the less, it was a ubiquitous theme in writings for children.

"Child Tell me, mamma, if I must die
One day, as little baby died;
And look so very pale, and lie
Down in the pit-hole by his side?
"Mamma 'Tis true, my love, that you must die,
The God who made you says you must;
And every one of us shall lie,
Like the dear baby, in the dust."[10]

The treatment of death in children's literature changed as the century advanced but the changes seem to be much more a response to altered literary genres and devices than to any alteration in the demography of death. And right to the end of the century, death was a central theme in children's literature. Of course what we need to grasp is that this literature, although written for children, was penned by adults. It therefore provides us with a number of idealized images of adult perceptions of death, images fostered among the young in the full knowledge that they would, almost certainly, face the social realities of death (in ways very uncommon indeed for modern Western children). And here lies the nub, for as ghastly or even bizarre as this literature of death may seem (today at least), the significance of death for the Victorian young lay, not in its literary representations, but in its reality, its regularity, and its inescapability.

Victorians—and Victorian children—were influenced not so much by descriptions of death as by seeing it within their own homes. There is for instance a plethora of accounts of the sudden and unexpected death of the young—in all social classes. Indeed so commonplace were they that undertakers' cabs were designed so that a small coffin could fit beneath the driver's seat.[11] From the highest to the humblest, families experienced the sudden and unexpected death of a child (and of course of adults, notably women in childbirth). Today, in the West at least, so rare are such deaths that they are normally traumatic in the extreme—among the most difficult of personal and family tragedies. Indeed the death of the young in Victorian England is more akin (statistically and in its morphology) to deaths of the young in third world countries. There is however an unfortunate tendency, when viewing such commonplace deaths, to imagine that their frequency, their ubiquity, necessarily meant that survivors responded in a qualitatively different fashion than in the modern West. It is in fact a variation on the hackneyed theme that the "cheapness of life" elicits a colder, more rational, less emotional response. There is, however, powerful evidence to the contrary.

"There are griefs so gentle in their very nature that it would be worse than false heroism to refuse them a tear. Of this kind are the deaths of infants."[12]

These words, by the radical Leigh Hunt, provide an entrance to the complex world of emotional responses, in this case to death, a problem all the more acute when one studies the experiences of people who left few literary survivals. Indeed, the relative muteness of the documentation has led some historians to impute to the poor and the dispossessed a lack of sensibility when faced by death. And yet the poor did grieve—however constrained their grief by the harshness of their economic circumstances—and they did mourn—however pressing the need to return to their daily labours in order to keep for themselves a bare sufficiency. For obvious social and economic reasons, poor people were generally unable to afford the costly and time-consuming rituals of bereavement that formed so highly structured a feature of the world of the prosperous. Few working men or women could spare the time to grieve extensively in public; few could afford the costly trappings of bereavement or the expense of elaborate interment. For legions of—perhaps most—working people, it was all they could do to raise the money for the coffin and the grave-digger's handcart to transport the dead child to the graveside. It would be quite absurd, however, to conclude from the simplicity—the starkness—of many plebeian burial and mourning patterns—and from the survivors' need to survive in a harsh world—that this provides evidence of a lack of emotion.[13]

Among working people, the celebrations of death were shaped by the needs (and limitations) of the living. The determination to secure a "decent" funeral for members of one's family was in fact a striking feature of all strata of Victorian society; among the poor it took the form of subscriptions to burial clubs and friendly societies (a tradition going back to the eighteenth century). As the nineteenth century advanced, propertied commentators denounced the plebeian "obsession" with saving for a burial. Sir Edwin Chadwick noted in 1843:

"The desire to secure respectful interment of themselves and their relations is perhaps the strongest and most widely diffused feeling amongst the labouring classes of the population. Subscriptions may be obtained from large classes of them for their burial when it can be obtained neither for their own relief in sickness nor for the education of their children nor for any other object."[14]

The need for a respectable funeral was not created by the conditions of early nineteenth-century urban life. None the less the distinctive problems of urban growth, and some of the political responses to those difficulties, accentuated the cultural commitment to a decent funeral. Among the poor, the determination to set aside

money for a funeral was reinforced by the Poor Law Amendment Act of 1834—and its threat of a pauper's grave. Thereafter generations of the English poor took inordinate steps to avoid such a fate. To be buried "on the parish", to be consigned to the anonymity of a pauper's grave, was the ultimate social disgrace, for such burials transgressed all the traditional values associated with a proper and respectable burial. It was the ultimate act of deracination, for the pauper's burial plucked a person from that web of social customs and practices that formed a value system from birth to death. By consigning the body to the cheapest of anonymous burials, with the minimum of ceremonies, and by decreeing that the body's final resting-place should be recorded communally and should have no personal marking whatsoever, the pauper's funeral transgressed the most important of all plebeian burial customs and ceremonials. It allowed no opportunity for family or communal mourning; no occasion for the paying of friendly, neighbourly or familial respects; no opportunity—and no location—for those rituals of remembrance—on birthdays or anniversaries—so important in society at large. The efforts to avoid the pauper's grave not only provide an insight into the contemporary fear of the Poor Law itself but also help to reinforce the importance and significance contemporaries attached to their burial customs and ceremonials.

What made the death—as opposed to the burial—of a pauper so unpleasant and unusual was the fact that it took place outside the home. And it is at this point that we encounter one of the major, qualitative shifts in social customs between Victorian society and our own. Victorians almost always died in their homes. Today, the great majority of English people die in institutions. But in a society where public institutions—whether hospitals or workhouses—were, for various well-known reasons, places to avoid, to die outside the home and within the bleak walls of such institutions was to destroy important and time-honoured customs. In the home one would, for instance, be cared for as well as material circumstances allowed. In one's last troubled and possibly painful days and hours, there was comfort to be had from loved ones and friends. In the workhouse this was absent. Moreover the varied ceremonies of bereavement were overwhelmingly domestic. Whether in a squalid slum or the grandest of homes, Victorians died surrounded by their families, friends and neighbours. Dying was a family and, in many cases, a communal affair in a way which is perhaps difficult to grasp today when the old and sick tend to die in institutions, hospitals and homes, and the corpse is then transported to a commercial funeral home.

Keeping the body in the home posed serious problems, notably among the poor. In overcrowded homes family life—of necessity—continued around the body. The cultural emphasis on keeping a corpse at home was widely recognized as a health hazard, more especially in times of contagious diseases and epidemics. "The sides of a wooden coffin, often imperfectly made, are at best all that divides the decomposition of the dead from the respiration of the living".[15] Indeed the insistence, backed by law, upon immediate burial in the cholera epidemics of the 1820s and 1840s was fiercely resisted because it transgressed the traditional observances associated with keeping a body in the home. This problem was accentuated when a poor family was unable to afford a burial on the first Sunday (the traditional day for funerals) but needed another week to raise the money. Thus there was a great deal of prudence in saving for funerals—and hence the obsession with burial clubs.

To make matters worse, family, friends and neighbours often insisted on peering at and even touching the decomposing body. This was perhaps understandable in a period before medical certification of death and when it was important to confirm both the person's identity and that he was indeed dead. According to the memoirs of a man who lived in various villages in East Yorkshire in the 1830s and 1840s: "At that time it was a custom, when a person died, for most of the villagers to go and see the dead body after it had been laid out."[16]

Such events were much more commonplace in a Victorian family than would be the case today. The death of a relative, friend or neighbour was a common occurrence. The case of the radical Samuel Bamford was perhaps extreme, but it none the less illustrates a wider point. As a child, Bamford lost a brother, sister, grandfather and finally his mother in a smallpox epidemic.

Whereas death and dying among the poor were inescapable, in more prosperous homes the dying and the dead could be removed to a separate room, but even then death and dying were unavoidable because of the insistence on family gatherings around the deathbed. The iconography of the death of Prince Albert clearly shows the royal family, including small children, gathered at the deathbed. Death, then, not merely took place in a domestic setting but was primarily a family affair, not left to distant and remote specialists or institutions but handled and absorbed by all members of the family.

The most common death which Victorian and Edwardian families had to endure was the death of a baby or young child. For the prosperous, the attendant costs were no real problem but for the poor, where infant mortality was, as has been seen, disproportionately common, these deaths could involve a crippling financial burden. Hence the need to save for a funeral (although many benefit clubs refused to cover the very young—a clear indication of the frequency of such deaths). As late as 1911 Mrs Pember Reeves, in her study of the poor, remarked:

> "A working man and his wife who have a family are confronted with the problems of burial at once. They are likely to lose one or more of their children. The poorer they are, the more likely they are to lose them. Shall they run the risk of burial by the parish, or shall they take Time by the forelock and insure each child as it is born, at the rate of a penny a week? If they decide not to insure, and they lose a child, the question resolves itself into one of borrowing the sum necessary to pay the funeral expenses, or of undergoing the disgrace of a pauper funeral."[17]

The young not only died in large numbers but they also saw death around them in a fashion and at a proximity which would be unfamiliar in the modern West—though not in third world countries. Our difficulty is to judge what effect this contact with death had on the young. In poor homes children shared the room and even the bed of a dying sister or brother. Even in more prosperous homes children were, as we have seen, ushered to the deathbed. The results of such experiences were varied: sometimes scarcely remembered, sometimes utterly traumatic. Research conducted in the 1960s among children in hospital wards who were

confronted by the prospects of death of other children, or even of their own deaths, reveals a number of interesting points. By and large children's perceptions of death are "unrealistic" until about the age of seven. Thereafter a more adult mentality seems to set in, and death comes to be appreciated in a more adult and understanding way.[18] Of course there is a fundamental problem here. In the West, modern medicine is now thought to provide a cure and prevention for many natural ailments. On the whole, modern Western children do not die when they are ill, and they (and their parents) can reasonably expect medical assistance to cure them. However, would Victorians have placed a similar faith in contemporary medicine, more especially those lower on the social scale who, at least earlier in the century, might not have encountered a doctor at all?[19]

What sick children (and of course adults) often encountered when they were dangerously ill was not a person summoned to cure them, but a person intent on securing their entry into the next world. The ministers and priests called to the bedside were normally at great pains to talk about the imminence of death and the need to prepare for the next life. However resistant a sick person might have been, he or she was often faced not merely with a battle against an ailment but also with a religious descant on mortality.

Speaking to children in an area afflicted by an epidemic of whooping cough, the Reverend Carus Wilson declared:

> "My dear children, the whooping cough is spreading fast; several little ones have died of it. Day after day I hear the bell tolling, and one little child after another has been buried here . . . . I see your little faces swelled, and hear you coughing; but I am pained to think how few of you would be found ready were you called to die of it."[20]

Of course we need to recognize that the Victorian obsession with "a good death" and the need to be prepared to enter paradise was, at its simplest, a personal and collective necessity in the teeth of such ubiquitous and apparently unflinching levels of mortality—especially among the young. Not until infant mortality began to decline (in the West, in the twentieth century) did this religious obsession give way to a more secular approach to death and dying. Faced by the inescapability of young deaths—and by the inability of medicine (folk or formal) to prevent it, Victorians resorted to their various faiths. By the mid-twentieth century, modern Western people had come to invest their primary faith in the technology of modern medicine to prevent or to cure.

Perhaps the most obvious transformation in Victorian celebrations of death was the quite dramatic change in burial-grounds. The emergence and proliferation of the Victorian urban cemetery was not only a new architectural form (which survives of course to this day) but it created new patterns of celebrating death which form a qualitative break with more traditional patterns. A simple example will suffice. In 1908, 4,000 people visited the Blackpool cemetery each Sunday at the height of that town's remarkable tourist season. They went to pay their respects, to place flowers on the graves of loved ones and generally to stroll round the pleasantly designed and landscaped gardens of the cemetery. It was, in fact, very much like a visit to an attractive park. A mere century before, however, English urban cemeteries were places to avoid. At worst they were pestilential, at best merely unpleasant. The early nineteenth-century burial-grounds were a source of social concern, a matter of medical alarm and a political outrage, which demanded municipal, private and, ultimately, national intervention.[21] Some measure of the problem—and the successful efforts to tackle it—can be gauged from the fact that between 1852 and 1899 some 45 Acts of Parliament were passed regulating the various problems of burial.[22] Like the towns and cities which they served, and which initially they fringed, the cemeteries were cleaned up, as part of that general amelioration of English social life which itself had profound effects on levels of mortality.

It is a central theme of this present argument that, of all the changes that affected the English celebrations of death, none were so dramatic or far-reaching as the reform of the English urban burial-ground. The rapid increase in population—and its concentration in urban areas—created, by the early nineteenth century, serious problems about the disposal of the dead. By the 1820s and 1840s urban burial-grounds were, quite literally, full up; so too were the churches. The national epidemics of those decades served merely to highlight the already distressing and at times gruesome conditions prevailing in the churchyards and burial-grounds.

What was needed, above all else, were more cemeteries. Sponsored by various burial acts (and, revealingly, sometimes inaugurated by private companies), cemeteries were opened by the thousands. In the 30 years up to 1863 an estimated 2,928 new ones had been opened.[23] This proliferation of new cemeteries actually broke the traditional links between the old burial-ground and the church. For all their religious imagery and connections, the new cemeteries were distant from the traditional places of worship. The consequences for the rituals of mourning and remembrance are clear. For those worshippers who attended church, it was a simple matter to pay respect to dead relatives and friends buried in the churchyard. Henceforth, except for those buried in the graveyards of the new Victorian churches, a visit to a burial-ground involved a conscious journey: a deliberate and separate effort, quite distinct from the act of worship and church attendance.

For a variety of obvious hygienic and financial reasons the cemeteries were developed on the edges of the towns and cities, though in time they were, of course, to be engulfed by further urban encroachment. The new Cemetery Company in York, for example, opened for business in 1837 on eight acres outside the city. In York, no less than in London, the horrific problems of burial were brought into sharper focus by the impact of the cholera epidemics in the 1830s and 1840s. Before 1837 the existing York churchyards were crammed with bodies, and the churches themselves were filled with the stench of the dead buried inside. Corpses were often buried merely inches below the surface and in many graveyards soil and rubbish had to be dumped on top in order to provide more burial space.[24]

Even as the new cemeteries were developed, they became bigger and fuller. In York the original 8 acres of 1837 had by 1904 grown to 14 acres. By 1958 the cemetery covered over 50 acres and was almost full.[25] By then it was often a long walk from the entrance to the grave. Thus the cemetery organizations and munici-

pal authorities began to keep detailed logs and plans in which they recorded the location of each grave. In fact, Victorians began their first effective efforts at town planning not for the living, but for the dead. The new cemeteries were as rational as their urban hinterlands were *ad hoc:* as planned and as landscaped as the former were confused and jumbled (notwithstanding some notable efforts at town-planning). At its most extreme—and this is clear to anyone visiting a surviving Victorian cemetery—the Victorian architecture of death and bereavement became high art in itself. Some of the most outstanding designers, landscapers, architects and builders put in their best efforts to commemorate and accommodate the dead. Nor was this peculiar to the best known cemeteries in the bigger cities. In essence, if not in such grandiose form, much the same was true of many of the new municipal cemeteries.

If we examine the location and geography of the new cemeteries, it is clear how they altered the patterns of bereavement and burial. Cemeteries on the edge of town were often distant, in contemporary terms, from the centres of population. Funerals at these cemeteries invariably involved a lengthy and therefore costly procession, thus increasing funeral costs for the poor and the prosperous. Typically Victorian however, the cemeteries charged different rates for the various social classes. At Tiverton, the cost of the hand-hearse was "for an adult labourer 2/6. The like for a tradesman or any other person 5/-".[26]

Thus, the late Victorian burial-ground was a neat, attractive parkland, a place to be visited for pleasure as much as for family ceremonies. But the cemeteries also created a new phenomenon; the procession to the graveside. By the late nineteenth century, there was a myriad of new organizations that turned out to follow the coffin on its route to the grave. In addition to the relatives, neighbours and friends, the processions were now joined by members—or representatives—from those various (though relatively new) institutions that had emerged in the course of the century. Friendly Societies—perhaps the most widely supported of working-class institutions by the 1870s—normally instructed members to attend a member's funeral. In Campsall, Yorkshire, the relevant rule insisted that officials and members of the local Friendly Society

> "shall attend the funeral of every free member of the same, who shall die within three miles of Campsall aforesaid, and shall follow the corpse from the house where he lies deceased to the place of interment in a decent and orderly manner."[27]

By the last quarter of the century there was, quite simply, a profusion of organizations—notably among working people—represented at the funeral. And of course these organizations were themselves a reflection of other transformations in society at large. Funerals attracted representatives from churches, chapels, Sunday schools, ragged schools, unions, football clubs, musical organizations and more. Brass bands in full dress, with their own local supporters, invariably followed a member to the graveside. Indeed, this, in conjunction with the emergence of church music, organ music and choral singing, had transformed many funerals into a notably musical occasion. At its most elaborate, a working-class funeral reflected the broader social and economic culture of the locality; a distinct change from the basic and bleak functionalism of the early century. It may seem an odd point to make, but the collective plebeian celebrations of death were a reflection of the colour and variety of late Victorian working-class life. There is no doubt that working-class funerals had become more elaborate. But this was not so much a reflection of the changing demography or mortality rates as of the enhanced economic positions of large numbers of working people. For all the undeniable residual layers of poverty, there were many working people with a little extra cash for a range of leisure activities and material consumption (however simple). Funerals were, in essence, a reflection of the proliferation of leisure activities and the wider diffusion of free time and spare cash, among large sectors of the male working-class community.

The extravagance of the mourning patterns among the prosperous is well known. From the monarchy and aristocracy—where bereavements were sometimes high points of national extravagance—through to the humble and recently emergent middle classes, death and bereavement were the occasion for remarkably elaborate celebrations. A complex calendar of mourning—which changed with the family distance between the survivors and the deceased, strict adherence to colour and types of dress, limitations on the types of social activity permitted to the mourners, all these and more provided a web of behaviour which determined most facets of social life. It was to be found at its most elaborate in the Royal Court and among those most under its influence.

It was, obviously, an expensive and time-consuming affair in which the great bulk of the common people could have no part. Once more, the celebrations of death were primarily a reflection of economic power and status. In the process, the propertied celebrations of death created their own economic activity.

The degree to which patterns of mourning were economically important is well documented. Courtauld's, for instance, effectively cornered the expanding market for black crêpe, its employees sworn to silence about production methods. Indeed that company's production figures and the numbers of people they employed in the manufacture of crêpe provide a revealing index to formal mourning patterns. Equally significant, however, is the fall in demand for crêpe in the 1890s—coinciding with the first shift away from the high point of vigorously observed upper-class Victorian mourning. There are other indicators of the economic ramifications of death. The small Yorkshire seaport of Whitby, its whaling heyday long past, was in obvious decline by the early nineteenth century. Then the growing demand for mourning jewellery made from local "jet" transformed that town's economy. In 1832 there were only 25 men working in jet; twenty years later this had grown to several hundreds and by the early 1870s, the apogee of the town's jet-based fortunes, there were some 1,400 in the industry. Thereafter there was a rapid decline, due largely to competition from artificial materials in mourning jewellery.[28] There was a veritable army of people employed directly or indirectly in the Victorian business of death. In London in the 1840s—where some half a million funerals took place in the decade—there were 275 undertakers, dominated by a core of 60, and perhaps upwards of another 3,000 people dependent on them: drapers, tailors, publicans, carpenters, cabinet-makers, upholsterers and auctioneers. Such costs, in addition to the burial fees charged by ministers (in 1838 the vicar of St Giles-in-the-Fields earned 764 pounds in

one year),[29] led to constant complaints. It seemed quite wrong that so much money was simply tipped into the grave. From 1834 those purse-proud guardians of the workhouses were able to impose an element of economy—in the funerals of those (the paupers) who in any case had no prospects of an expensive burial.

* * *

The central problem in writing a generalized account of English patterns of mourning is that in practice those customs were primarily local—even parochial—and often defy any national generalization. Despite the degree of urbanization throughout much of rural England, social life continued more or less as it had for centuries. Folklorists of the mid-nineteenth century tabulated the remarkable varieties of village burial and mourning customs. In certain localities, custom dictated that the dying should be moved away from mattresses stuffed with pigeon-feathers. Death in a household often led to the draping of mirrors and clocks; windows were flung open. There were large numbers of local customs using bees in mourning customs; black crêpe was hung over local beehives. Black remained the overwhelming colour for mourning, though other more muted colours could also be used; in certain localities white was used for the young or the unmarried. Flowers too were common, an antidote to the smell of death but also a reminder of freshness in the midst of death. Food and feasting were universal fixtures of mourning customs. Relatives and neighbours, attending the coffin the night before interment, were provided with cheese and ale. Meals were often provided after the burial. Of course for people who had travelled long distances, food was clearly important. Ultimately, the lives and the deeds of the deceased were captured in obituaries, notices, dedications, headstones and plaques. For the poor however—who had a primarily oral culture—the work of a lifetime was remembered in those nightlong vigils of friends, neighbours and relatives gathered around the coffin.

Even as late as the turn of the century, it was these primarily local customs which were as striking as the intrusion of "modern" celebrations of death. The most striking change, by then, had been the establishment of a national system of modern cemeteries—all minutely regulated—which reshaped a number of public celebrations of mourning. There was, it is true, a reduction, from the 1890s, of the more lavish mourning expenses incurred by the upper reaches of society (for purely economic reasons), although the most lavish of mourning episodes was still to come—following Victoria's death in 1901. That represented the high point of nineteenth century celebrations of death, but the turning-point towards more recognizably modern celebrations had to await the slaughter of the First World War. It was quite impossible to accommodate the unprecedented numbers of deaths—so far away—with the old customs and calendar of bereavement. The consequences of that war on subsequent mourning patterns have not yet been fully explored. Suffice it to say that the catastrophic casualty levels rendered totally inadequate and inappropriate the more lavish, costly and protracted ceremonials so widespread only a few years before.

Until 1914, however, the changes in mourning customs had been slow and had left a host of traditional practices intact. What changes had taken place had emerged not so much from shifts in demography as from the amelioration—and "modernization"—of urban England. The establishment of civilized burial-grounds, the improvement (for most, if not for all) of the domestic environment, the changes in the economy, which yielded more disposable income for a widening section of the population—all these and more insulated late Victorians from the harsher and sometimes more grotesque aspects of death and bereavement unquestioningly endured by earlier generations. Rural England persisted in its traditional parochial celebrations of death. But it was in the urban world—now a home for 80 per cent of the people—that recognizably "modern" customs had evolved. And their evolution was primarily a function of the transforming nature of modern urban life itself.

This was mainly a Western phenomenon, for the nature of that urban development was primarily regulated and controlled, to an increasingly minute degree, and monitored by local (later national) bureaucratic agencies, which could insist on compliance with regulations agreed on by health and medical authorities. Medicine itself had, it is true, made important improvements by the end of the nineteenth century—notably against epidemic diseases—but it seems likely that the English people were healthier, not in proportion to medical improvements, but in proportion to urban amelioration. The changes in mourning were primarily a function of this complex process of modernization. In the long term these changes were furthered by the proliferation of institutions, private and public, which were themselves a function of a prosperous modern society, and which gradually took over the varied activities traditionally conducted by the family and community. Hospitals for the sick, undertakers' parlours and mortuaries for the dead—all of these slowly but effectively came to divorce death and dying from the home and the family. The degree to which this remains a Western phenomenon can be seen in the persistence of family- and community-based celebrations of death throughout much of the non-Western world.

NOTES

[1] P. J. Waller, *Town, City and Nation, 1850-1914* (Oxford, 1983), p. 315.

[2] James Walvin, *A Child's World. A Social History of English Childhood 1800-1914* (Harmondsworth, Penguin Books, 1983), p. 23.

[3] F. B. Smith, *The People's Health, 1830-1910* (London, Croom Helm, 1979).

[4] Quoted in E. and M. Evans, *The Victorians at Home and Work* (New York, 1973), p. 75.

[5] E. J. Brett, ed., *The Boys of England. A Young Gentleman's Journal of Sport, Sensation, Fun and Instructions* (1967), III, p. 268.

[6] Walvin, *op. cit.*, p. 31.

[7] *The Children's Friend*, May 1865.

[8] Gillian Avery, *Nineteenth Century Children* (London, 1965), p. 213.

[9] T. Bilby, *A Course of Lessons* (1823 ed.), p. 123.

[10] Quoted in S. Yudkin, "Death and the Young", *in* A. Toynbee and others, eds., *Man's Concern with Death* (London, 1968), p. 50.

[11] I. Strickland, *The Voices of Children 1700-1914* (Oxford, 1973), pp. 204-205.

[12] "Death of little children", *Essays of Leigh Hunt*, A. Symons, ed. (London, 1903), p. 44.

[13] See James Walvin, "Dust to Dust. The Celebration of Death in Victorian Britain", *Historical Reflections*, Spring, 1983.

[14] Sir Edwin Chadwick, "Supplementary report", *in* E. Royston Pike, *Human Documents of the Industrial Revolution* (London, G. Allen and Unwin, 1966), p. 354.

[15] Sir John Simon, "Medical Report", *in* E. Royston Pike, *Human Documents of the Victorian Golden Age* (London, 1967), p. 286.

[16] J. D. Hicks, ed., *A Victorian Boyhood on the Wolds* (Beverley, 1978), p. 9.

[17] Mrs Pember Reeves, "Round about a pound a week", *in* P. Keating, ed., *Into Unknown England* (Manchester, Manchester University Press, 1976), pp. 305-306.

[18] S. Yudkin, "Children and death", *The Lancet*, January 7, 1967, pp. 37-41.

[19] Smith, *op. cit.*

[20] Quoted in Avery, *op. cit.*, p. 215.

[21] A. E. Hargrave, *The Baneful Effects of the Custom of Interment in Towns* (York, 1847); G. A. Walker, *Gatherings from the Graveyards* (London, 1839); Mrs. B. Holmes, *The London Burial Grounds* (London, 1896).

[22] Walvin, "Dust to dust", *loc. cit.*, p. 1.

[23] *Parliamentary Papers, Accounts and Papers* (London, 1863), vol. 46.

[24] Hargrave, *op. cit.*

[25] T. P. M. Tillot, ed., *The City of York, The Victorian County History, The History of Yorkshire* (London, 1961), p. 466.

[26] "Burial Fees", in *Parliamentary Papers, Accounts and Papers* (London, 1854-1955), vol. 45.

[27] P. H. J. H. Gosden, *The Friendly Societies in England, 1815-75* (New York, 1967), pp. 121-122.

[28] J. Morley, *Death, Heaven and the Victorians* (London, 1971), p. 72.

[29] Owen Chardwick, *The Victorian Church* (New York, 1966), vol. I, p. 327; vol. II, pp. 205-206.

VII. GENETIC AND BIOLOGICAL CONSEQUENCES OF MORTALITY CHANGES

*Yoko Imaizumi**

This chapter concerns the effect of reduced mortality rates on the genetic and biological characteristics of the survivors. It relates therefore to human genetics or population genetics. As the subject is not familiar to many demographers and sociologists, it is dealt with in layman's terms.

The patterns of age-specific mortality rates have changed dramatically in many developed countries since the Second World War. Before 1950, most persons with a weak constitution died early in life, giving rise to a form of "natural selection". This situation has changed recently because of medical advances and better public health measures, and it has become possible for such weak persons to survive and procreate. Therefore, it is important to consider the genetic and biological consequences of mortality changes, that is, whether deleterious gene frequency will increase or not in future generations.

A. Trends in the mortality rate for congenitally malformed infants

Table VII.1 and figure VII.1 show the trends in infant mortality rates for all causes and for the congenitally malformed in Japan during the period from 1947 to 1981. The overall infant mortality rate was 76.7 per 1,000 live births in 1947 and gradually decreased year by year to 7.1 in 1981. On the other hand, the infant mortality rate for the congenitally malformed was 146.7 per 100,000 live births in 1947, rising to 197.0 in 1949 and thereafter remaining almost constant each year. The proportion of infant deaths with congenital malformations among all causes of infant deaths was only 1.9 per cent in 1947 but increased steadily to reach 26.9 per cent in 1981. Wilson[1] estimated the causes of congenital malformations based on survey and case reports in medical literature. His results are as follows: known genetic transmission (20 per cent), chromosomal aberration (3-5 per cent), drugs and environmental chemicals (4-5 per cent), infections (2-3 per cent), maternal metabolic imbalance (1-2 per cent), ionizing radiations (under 1 per cent), and unknown, or multifactorial, causes (65-70 per cent). Therefore, only 20 per cent of congenital malformations are due to genetic transmission and 65-70 per cent to multifactorial causes.

The following sections deal with the factors influencing the genetic and biological consequences of mortality changes.

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B. Changing patterns of parental ages

Maternal age and chromosome aberrations

The distribution of maternal age at childbearing in Japan during the period 1948-1978 is shown in table VII.2. The proportion of mothers aged 35 or over declined from 19.3 per cent in 1948 to 4 per cent in 1978. This is important because, according to Matsunaga[2] and Penrose[3], the frequencies of chromosome aberrations (Down's syndrome (trisomy 21), Klinefelter's syndrome (XXY) and triple X female (XXX)) increase with maternal age. Following Matsunaga's computation, the incidence of Down's syndrome can be calculated for 1948-1978. Using the computed incidence of Down's syndrome for 1948 as a base (=100), the relative incidence fell to 70 in 1958, 64 in 1968, and 62 in 1978 (see table VII.2). Similarly, the relative incidences for XXY and XXX were computed in these years and are also shown in table VII.2. The incidences were 100 in 1948, 75 in 1958, 70 in 1968 and 71 in 1978, respectively. Thus, the incidence for these chromosomal aberrations was reduced by 30-40 per cent in Japan during the past thirty years, and similar reductions in the incidence of Down's syndrome were reported in the United States during 1936-1968 (reduction of 18 per cent), in Hungary during 1949-1969 (26 per cent), and in Ireland during 1955-1969 (14 per cent).[4] Patients with these chromosomal aberrations exhibit mental retardation. Therefore, a younger maternal age distribution brings on a reduction in the proportion of the mentally retarded.

Survival rate of Down's syndrome children

Let us consider the survival rate of Down's syndrome. Most patients with Down's syndrome have congenital heart disease, leukemia or other illnesses, and as a result patients with the syndrome frequently die in childhood. In the studies of Record and Smith[5] and Carter[6] for the Down's children born from 1942 to 1955 in England, only 40 per cent of the cases were alive by age 10. The corresponding rate was 65 per cent in Massachusetts for cohorts born in the period 1950-1966[7] and 87 per cent in Japan for cohorts born in the period 1966-1975.[8] On the other hand, Masaki and others[9] estimated life expectancy at birth for Down's syndrome patients born between 1966 and 1975 at 48.9 years. Hence while the incidence of Down's syndrome has declined in Japan and other countries, the life expectancy for Down's syndrome patients appears to have been prolonged. In the case of chromosome aberrations, then, a beneficial effect is expected from the lowering of maternal age at reproduction. However, as a consequence of improved survivor-

TABLE VII.1. SECULAR TRENDS IN INFANT MORTALITY RATES FOR ALL CAUSES AND FOR CONGENITAL MALFORMATIONS (CM) IN JAPAN, 1947-1981

Year	Congenital malformations		All causes		Proportion of CM[c] among all infant deaths (percentage)
	Deaths	Mortality rate[a]	Deaths	Mortality rate[b]	
1947	3 929	146.7	205 360	76.7	1.91
1948	4 560	170.0	165 406	61.7	2.76
1949	5 312	197.0	168 467	62.5	3.15
1950	5 540	237.0	140 515	60.1	3.94
1951	4 854	227.1	122 869	57.5	3.95
1952	4 218	210.4	99 114	49.4	4.26
1953	3 937	210.8	91 424	48.9	4.31
1954	3 466	195.9	78 944	44.6	4.39
1955	3 564	205.9	68 801	39.8	5.18
1956	3 301	198.2	67 691	40.6	4.88
1957	2 961	189.0	62 678	40.0	4.72
1958	3 217	194.6	57 052	34.5	5.64
1959	3 213	197.6	54 768	33.7	5.87
1960	3 056	190.3	49 293	30.7	6.20
1961	3 100	195.0	45 465	28.6	6.82
1962	3 385	209.1	42 797	26.4	7.91
1963	3 319	200.0	38 442	23.2	8.63
1964	3 368	199.2	34 967	20.4	9.63
1965	3 610	197.9	33 742	18.5	10.70
1966	3 082	226.5	26 217	19.3	11.76
1967	3 717	192.0	28 928	14.9	12.85
1968	3 928	209.8	28 600	15.3	13.73
1969	3 973	210.2	26 874	14.2	14.78
1970	3 914	202.4	25 412	13.1	15.40
1971	4 284	214.1	24 805	12.4	17.27
1972	4 344	213.1	23 773	11.7	18.27
1973	4 507	215.4	23 683	11.3	19.03
1974	4 461	219.8	21 888	10.8	20.38
1975	4 072	214.2	19 103	10.0	21.32
1976	3 891	212.3	17 105	9.3	22.75
1977	3 843	219.0	15 666	8.9	24.53
1978	3 752	219.6	14 327	8.4	26.19
1979	3 323	202.3	12 923	7.9	25.71
1980	3 131	198.6	11 841	7.5	26.44
1981	2 927	191.4	10 891	7.1	26.88

Source: Ministry of Health and Welfare, Statistics and Information Department, *Vital Statistics.*
[a] Per 100,000 live births
[b] Per 1,000 live births
[c] CM = congenital malformations

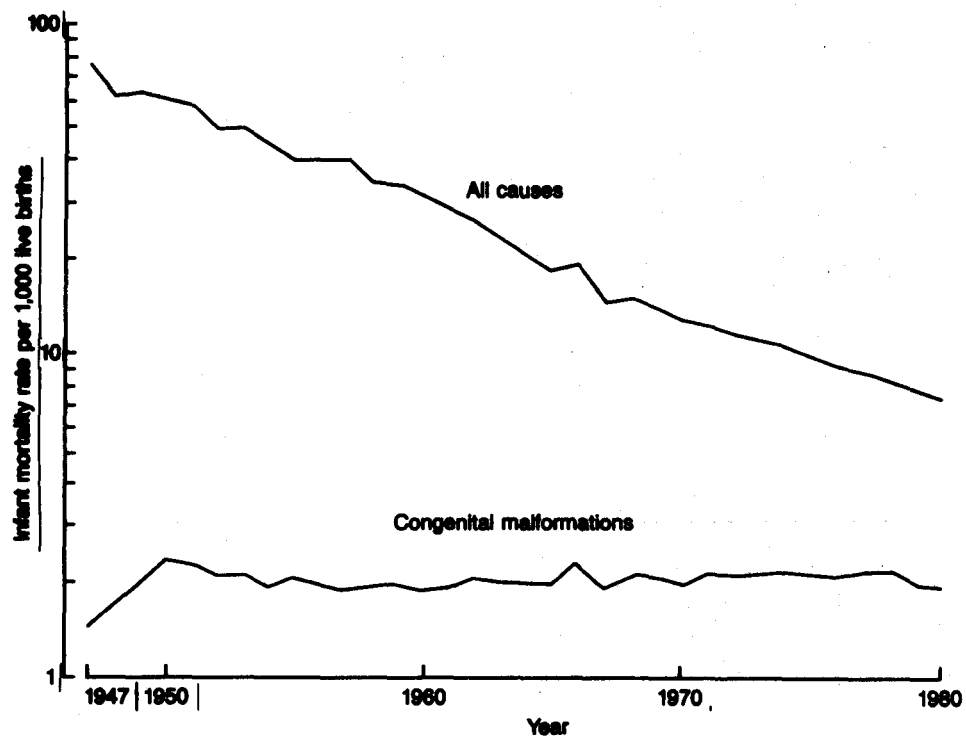
TABLE VII.2. CHANGING MATERNAL AGE PATTERNS IN JAPAN AND RELATIVE INCIDENCES OF CERTAIN TRISOMY SYNDROMES, 1948-1978

	Maternal age									Relative incidence	
	-19	20-24	25-29	30-34	35-39 (percentage)	40-44	45-49	Mean	Variance	Down's syndrome	Chromosomes XXY and XXX
Proportion of births											
1948	2.7	25.7	30.5	21.8	14.3	4.6	0.4	28.7	37.8	100	100
1958	1.1	27.6	44.4	19.6	6.0	1.2	0.1	27.3	21.9	70	75
1968	1.2	25.2	49.2	19.6	4.3	0.5	0.0	27.1	17.8	64	70
1978	0.8	20.0	55.1	20.1	3.6	0.4	0.0	27.3	15.2	62	71
Relative incidence											
Down's syndrome	0.40	0.61	0.55	0.82	2.33	5.20	10.1				
XXY and XXX	0.57	0.44	0.75	0.91	1.71	5.28	11.0				

Source: Modified from Matsunaga (1982).

ship, reproduction chances of victims are, on average, increased. It should be noted, however, that Down's syndrome victims only rarely reproduce. Adult males are sterile and only 13 cases of pregnancy among female Down's syndrome victims have ever been recorded. Further, in countries where abortion is legal, prenatal diagnosis of risk and preventive abortion have helped to reduce the incidence of the disease.

Figure VII.1. Secular trends in infant mortality rates for all causes and for congenital malformations (CM) in Japan



Paternal age and mutation rates

It is well known that the survival rate is lower in mutants than in normal individuals. According to Vogel,[10] the mutation rates increased with paternal age for a number of autosomal dominant conditions and X-linked[11] recessive conditions. Therefore, the changing paternal age patterns may increase or reduce the frequency of mutants.

Matsunaga[12] computed the relative risk for dominant mutations using Japanese data. Table VII.3 shows the results. Taking a base relative risk of 100 in 1952, the risk was 82 in 1958, 77 in 1968 and 78 in 1980. Thus, the dominant mutations were reduced by 22 per cent in Japan during the past three decades. Therefore, a beneficial effect is expected from the lowering of paternal age at reproduction in the case of genetic diseases.

C. Consanguineous marriages[13] and mortality

Frequency of consanguineous marriages

Table VII.4 shows the inbreeding coefficients[14] for various mating types. The inbreeding coefficient in a population is defined by the quantity F, where

$$F = c_i F_i.$$

Table VII.3. Changing paternal age patterns in Japan and relative risks of autosomal dominant mutations, 1952-1980

	Paternal age									*Relative risk*
	-19	*20-24*	*25-29*	*30-34*	*35-39*	*40-44*	*45+*	*Mean*	*Variance*	*Dominant mutations*
					(percentage)					
Proportion of births										
1952*	0.3	9.8	31.2	26.6	18.1	9.5	4.6	32.0	45.4	100
1958*	0.1	7.2	40.7	34.4	11.3	4.2	2.1	30.6	28.8	82
1968*	0.1	7.0	38.6	39.2	12.3	2.2	0.6	30.3	21.2	77
1980	0.2	6.7	36.0	42.9	11.8	2.0	0.5	30.4	19.7	78
Relative risk		]0.5[			1.0		3.0			

*Source: After Matsunaga (1973).

TABLE VII.4. MATING TYPES AND INBREEDING COEFFICIENTS

Degree of relationship	*Inbreeding coefficient (F)**
Unrelated	0
Uncle–niece, Aunt–nephew	1/8
First cousins	1/16
First cousins once removed	1/32
Second cousins	1/64
Second cousins once removed	1/128

* For definition of F, see text.

Here c_i is the relative frequency of inbred individuals with inbreeding coefficient F_i. Table VII.5 shows the frequency of consanguineous marriages and the inbreeding coefficient in various countries. Frequencies of first-cousin marriages ranged from 45.3 per cent in Egypt to 0.08 per cent in the United States of America. These values show remarkable variations throughout the world. The average inbreeding coefficients are 0.0332 in Egypt, 0.0023 in Brazil, 0.0018 in Japan, 0.0022-0.0002 in Europe and 0.0001 in the United States. However, the frequencies of consanguineous marriages decreased from year to year. For example, in Japan, a nation-wide study of consanguineous marriages was conducted in 1972 through questionnaires[15] answered by 9,385 couples, chosen at random. Table VII.6 shows the frequency of consanguineous marriages according to the year the couple in Japan were married; the mean frequency of first-cousin marriages decreased as the year of marriage became more recent. This tendency was also observed in France,[16] Italy[17] and Spain.[18]

Still-birth and mortality rates in consanguineous and non-consanguineous marriages

The effects of consanguineous marriages on pre- and post-natal mortality have been studied by numerous investigators.[19] The dependence of the mortality of infants in the first year of life on F among children of consanguineous marriages in Hiroshima, Nagasaki, Fukuoka and Shizuoka is shown in table VII.7. According to Yamaguchi and others,[20] cumulative mortalities in the first twelve years after birth are significantly higher in the consanguineous than in the non-consanguineous groups, and the rates of still-births and perinatal deaths are also significantly higher in the consanguineous than in the non-consanguineous groups. Therefore, the decline in consanguineous marriages brings about a reduction in the rates of pre- and post-natal mortality. Therefore, the decline in the mortality rate depends not only on success in surgical operations and medical treatment but also on the reduction of consanguineous marriages. What genetic and biological consequences can be expected following the decline in consanguineous marriages? The effects of inbreeding on the autosomal recessive diseases will be discussed in the next section.

Consanguineous marriages and autosomal recessive diseases

If we consider a system with two alleles "A" and "a", there will be three possible genotypes[21] "AA", "Aa", and "aa". If we represent the proportion of "A" genes in the population as p and the proportion of "a" genes as q, we can write $p + q = 1$. If the two genes in the population are in the proportion p and q, the sperms and eggs will contain them in the same proportions and with random mating[22] the various gametic (sperm and egg) combinations can be represented as follows (gene frequencies are given in parentheses):

		Male gametes	
		A (p)	a (q)
Female gametes	A (p)	AA (p^2)	Aa (pq)
	a (q)	Aa (pq)	aa (q^2)

The frequencies of the various offspring from such matings are therefore $p^2(AA)$, $2pq(Aa)$ and $q^2(aa)$. If F is the inbreeding coefficient, the frequencies of the genotypes are as follows:

Genotype	*Frequencies*
AA	$Fp + (1-F)p^2$
Aa	$2pq(1-F)$
aa	$Fq + (1-F)q^2$

The ratio of recessive homozygote (aa) in first-cousin marriages is $(q_1 + 15q)/16 : q^2$, which becomes $(1 + 15q)/16q$. If the gene frequency is 0.01, the ratio is 7.19. Table VII.8 shows the ratios of the frequency of recessive homozygotes in consanguineous marriages to those in non-consanguineous marriages according to gene frequency. The ratio of the frequency in first-cousin marriages to that in non-consanguineous marriages is extremely sensitive to the gene frequency q, being much greater if q is lower. Table VII.9 shows some actual examples of recessive diseases for which the frequency among progeny of first-cousin marriages is much higher than that for non-consanguineous marriages. Therefore, if consanguineous marriages were avoided throughout Japan, autosomal recessive patients would decrease by 20-65 per cent in the future. However, the number of carriers of the recessive gene would increase because of dysgenic[23] selection.

D. EXPECTED EFFECTS OF THE REDUCTION IN MORTALITY RATES

Generally speaking, survival rates for patients with genetic diseases, chromosomal aberrations and congenital malformations have been much lower than those for normal individuals. These handicapped individuals were eliminated from the population through a process of natural selection. This situation is changing now. Increasing success in surgical operations and medical treatment has made it possible for genetically handicapped patients to survive and procreate. It is therefore expected that the deleterious gene frequency will rise from generation to generation. According to Crow[24] and Cavalli-Sforza and Bodmer,[25] the rising pattern of genetic diseases varies substantially according to the mode of inheritance, the gene frequency of the disease, and the improvement in fitness[26] brought about through treatment. In the following argument, only the cases of severe genetic diseases are considered because that will make it possible to determine the extreme degree of genetic consequences of the effect of relaxed selection.

TABLE VII.5. CONSANGUINEOUS MARRIAGES IN HUMAN POPULATIONS

Country	Period	Total number of marriages	Uncle–niece, aunt–nephew marriages	First-cousin marriages	First-cousin-once-removed marriages	Second-cousin marriages	Total consanguineous marriages	F (Inbreeding co-efficient)	Author
			(percentage)						
Brazil	1956-1957	212 090	0.06	2.63	0.81	1.32	4.82	0.00225	Freire-Maia (1968)
Egypt	1967-1968	1 782	-	45.29	14.03	4.26	75.76	0.03320	Badr (1972)
France	1911-1953	243 859	-	1.02	0.39	2.01	3.42	0.00110	Sutter and others (1955)
Ireland	1959-1968	190 557	0.003	0.14	0.04	0.35	0.53	0.00022	Masterson (1970)
Italy	1956-1960	1 646 612	0.01	0.77	0.23	0.89	1.90	0.00070	Moroni (1969)
Japan	1972	9 385	-	2.13	0.83	1.26	5.72	0.00179	Imaizumi and others (1975)
Mexico	1956-1957	28 292	-	0.17	0.15	0.95	1.27	0.00031	Freire-Maia (1968)
Spain	1922-1964	65 555	-	2.56	0.63	2.58	6.08	0.00221	Valls (1967)
United States of America	1959-1960	133 228	-	0.08	0.02	0.11	0.21	0.00009	Freire-Maia (1968)

TABLE VII.6. FREQUENCY OF CONSANGUINEOUS MARRIAGES IN JAPAN ACCORDING TO YEAR OF MARRIAGE OF THE COUPLE

Year of marriage	Unrelated	Related				Unknown	Total	Percentage of first-cousin marriages
		First cousin	First cousin once removed	Second cousin	Other			
–1 June 1947	536	46	16	24	18	30	670	6.87
2 June 1947 –1 June 1952	1 038	59	9	22	27	67	1 222	4.83
2 June 1952 –1 June 1957	1 314	37	16	22	28	60	1 477	2.51
2 June 1957 –1 June 1962	1 712	24	19	25	21	77	1 878	1.28
2 June 1962 –1 June 1967	1 934	14	10	14	16	61	2 049	0.68
2 June 1967 –1 June 1972	1 848	17	7	10	29	56	1 967	0.86
Unknown	95	3	1	1	2	20	122	2.46
TOTAL	8 477	200	78	118	141	371	9 385	2.13

Source: After Imaizumi and others, 1975.

Frequency of genetic diseases and natural selection

Over 1,600 genetic diseases have been identified, and the number known is continually growing.[27] Some of these diseases are relatively minor; others are very serious. According to McKusick, 934 autosomal dominants (achondroplasia, Huntington's chorea etc.), 588 autosomal recessives (albinism, phenylketonuria etc.) and 115 X-linked (haemophilia, Duchenne muscular dystrophy etc.) traits have been confirmed. In the cases of dominant inheritance, each affected person has at least one affected parent, unless the condition has arisen as the result of a new mutation. The normal children of an affected parent, when they in turn marry normal persons, have only normal offspring. The affected parent will pass on the defective dominant gene, on the average, to 50 per cent of the children. On the other hand, in many cases of recessive inheritance, affected persons are derived from marriages of two heterozygous carriers. Therefore, of the offspring from these marriages, one is affected and three have normal phenotypes. Of the latter, one is normal homozygous and two are heterozygous carriers. In X-linked or sex-linked inheritance, the X chromosome plays an important function in the inheritance. A normal female carries two X chromosomes whereas a male carries one X chromosome. Table VII.10 shows the frequency of genetic diseases by the mode of inheritance. Incidences of

TABLE VII.7. STILL-BIRTH AND INFANT MORTALITY RATES FOR NON-CONSANGUINEOUS AND CONSANGUINEOUS MARRIAGES *(percentage)*

Mortality indicator/location	*Unrelated marriages*	*First-cousin marriages*
Still-birth rate		
Hiroshima and Nagasaki	1.48	1.64
Shizuoka	3.38	4.23
Neonatal mortality rate		
Fukuoka	1.70	2.64
Hiroshima	2.64	3.56
Nagasaki	2.87	3.50
Infant mortality rate		
Fukuoka	3.88	6.19
Hiroshima	4.50	6.25
Nagasaki	5.16	6.67
Shizuoka	5.11	6.31

TABLE VII.8. FREQUENCIES OF RECESSIVE HOMOZYGOTES IN CONSANGUINEOUS AND NON-CONSANGUINEOUS MARRIAGES, AND RATIO OF BOTH HOMOZYGOTES

Type of marriage		*Frequency of recessive gene(q)* 0.1	0.01	0.005	0.002	0.001
First-cousin marriage						
Frequency of recessive homozygote	$\frac{q}{16}(1+15q)$	0.015625	0.000719	0.000336	0.000129	0.000063
Ratio of recessive homozygote in the first-cousin marriage to that of the non-consanguineous marriage	$\frac{1}{16q}(1+15q)$	1.56	7.19	13.44	32.25	63.4
First-cousin-once-removed marriage						
Frequency of recessive homozygote	$\frac{q}{32}(1+31q)$	0.012813	0.000409	0.000180	0.000066	0.000032
Ratio of recessive homozygote in the first-cousin-once-removed marriage to it in the non-consanguineous marriage	$\frac{1}{32q}(1+31q)$	1.28	4.09	7.20	16.50	32.0
Second-cousin marriage						
Frequency of recessive homozygote	$\frac{q}{64}(1+63q)$	0.011406	0.000255	0.000103	0.000035	0.000017
Ratio of recessive homozygote in the second-cousin marriage to it in the non-consanguineous marriage	$\frac{1}{64q}(1+63q)$	1.14	2.55	4.12	8.75	16.6
Non-consanguineous marriage						
Frequency of recessive homozygote	q^2	0.01	0.0001	0.000025	0.000004	0.000001

TABLE VII.9. FREQUENCY OF RARE AUTOSOMAL RECESSIVE DISEASES AMONG THE PROGENY OF NON-CONSANGUINEOUS AND FIRST-COUSIN MARRIAGES IN JAPAN

Disorders	*Frequency of affected among the progeny of* Non-consanguineous marriage	First-cousin marriage	*Proportion of first cousins among parents of patients*
Phenylketonuria	1 : 15 000	1 : 7 000	0.35
Xeroderma pigmentosum	1 : 23 000	1 : 2 200	0.40
Albinismus universalis	1 : 40 000	1 : 3 000	0.46
Microcephaly	1 : 77 000	1 : 4 200	0.54
Wilson's disease	1 : 87 000	1 : 4 500	0.55
Ichthyosis congenita	1 : 1 000 000	1 : 16 000	0.80

Source: After Tanaka (1968).

TABLE VII.10. FREQUENCY OF GENETIC DISORDERS PER 100 LIVE BIRTHS (ESTIMATES)

Mode of inheritance	*BEIR (1972)*	*UNSCEAR (1962, 1966)*	*Trimble and others (1974)*
Autosomal dominant	1	0.95	0.08
Autosomal recessive	0.15	0.21	0.11
X-linked	0.04	0.04	0.04

Sources: National Academy of Sciences – National Research Council, BEIR report, *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation* (Washington, D.C., Government Printing Office, 1972); Report of the United Nations Scientific Committee on the Effects of Atomic Radiation *(Official Records of the General Assembly, Seventeenth Session, Supplement No. 16* (A/5216), pp. 84-88; *ibid., Twenty-first Session, Supplement No. 14* (A/6314), pp. 98-99, 126-127; B. K. Trimble and J. H. Doughty, "The amount of hereditary disease in human populations", *Annals of Human Genetics, London,* vol. 38 (1974), pp. 199-223.

genetic disorders per 100 live births were 1 for autosomal dominant, 0.15 for autosomal recessive, and 0.04 for X-linked traits.[28] However, these incidences can vary greatly from ethnic group to ethnic group.

Consideration should be given also to the selection coefficient or selective disadvantage of a mutant phenotype, which may be defined as the loss in fitness relative to that of the normal phenotype. Table VII.11 shows the selection coefficients by mode of inheritance. They range from 0.37 to 1, but as populations achieve relaxed selection, the coefficients approach 0. Following relaxed selection, there can be rising patterns for autosomal dominant and autosomal recessive diseases, X-linked recessive diseases, and multifactorial disorders.[29] These will be discussed in the following sections.

The rising trend in dominant diseases

Let q be the frequency of dominant deleterious allele "a" and p the frequency of the recessive normal allele "A". Under random mating, the genotype frequencies are as follows:

Genotype	*Frequencies*
AA	p^2
Aa	$2pq$
aa	q^2

Affected homozygotes aa can be neglected because q^2 is very small. Let u and s be mutation rate per locus per generation and selection coefficient to heterozygotes (Aa), respectively. Then, u will be:

$$u = sq$$

where s is the selection coefficient. From the above equation, the following conclusion can be derived. If there is complete selection ($s = 1$) against a dominant disease, that is, if this phenotype is eliminated or fails to reproduce, the population in the next generation will be composed entirely of normal homozygotes, except new mutations. In this case, one generation of selection is enough to eliminate the deleterious type from the population. However, if selection is relaxed as a result of successful treatment of a disease, thus allowing victims to survive and reproduce, the frequency of the disease will increase in future generations. Consider the extreme case: a formerly dominant lethal condition ($s = 1$) changed to completely repaired ($s = 0$). Following relaxed selection, the frequency of dominant mutant genes in the next generation will be some $q- + q$, because the previous frequency was caused entirely by new mutants. If $q-$ and q are about the same, the frequency will be doubled in the next generation. The frequency will be tripled in two generations, and so on where the mutation rate at this locus remains unchanged. Table VII.12 and figure VII.2 show the expected rising pattern of autosomal dominant diseases after completely relaxed selection. The dominant deleterious diseases increase linearly from generation to generation. Therefore, for completely relaxed selection the expected effects on autosomal dominant diseases are very detrimental. For milder effects or where treatment is less complete in allowing reproductive survival, the increase is correspondingly less.

The rising trend in recessive diseases

Taking as an example phenylketonuria, q_0 is the gene frequency at the initial generation. Under random mating, the frequencies for the patients and carriers are given by q_0^2 and $2q_0\ (1 - q_0)$, respectively. For untreated patients of phenylketonuria, fertility is zero (the selection coefficient equals unity in Table VII.11). Let u be the mutation rate per locus per generation. Then, u will be:

$$u = q_0^2.$$

If all patients with phenylketonuria were detected by mass screening and treated by hyperphenyle alanin dietary cure, and if the patients survived to have offspring like normal individuals, the gene frequency of phenylketonuria in the next generation, q_1, will be:

$$q_1 = q_0\ (1 + q_0)$$

and the gene frequency in the tth generation, q_t, will be:

$$q_t = q_0\ (1 + tq_0).$$

Let n be number of generations for the frequency to double. When the frequency of phenylketonuria in the newborn is between 1: 400,000 and 1: 80,000 persons, n is 80 to 120 generations, namely about 3,000 years. Therefore, the expected effects on autosomal recessive diseases after completely relaxed selection are very small. This pattern can also be generalized for many

TABLE VII.11. SELECTION COEFFICIENTS FOR GENETIC DISEASES (ESTIMATES)

Autosomal dominant inheritance		*Autosomal recessive inheritance*		*X-linked inheritance*	
Disease	*Selection coefficient*	*Disease*	*Selection coefficient* [a]	*Disease*	*Selection coefficient* [a]
Huntington's chorea[b]	0.81	Albinism	0.50	Duchenne muscular dystrophy	0.96
Achondroplasia[c]	0.80	Ichthyosis congenita	1.00	Haemophilia (A+B)	0.62-0.75
		Total color blindness	0.50	Lesch Nyhan	1.00
		Amyotonia congenita	1.00		
		Phenylketonuria	1.00		
		Microcephaly			
		Caucasian	1.00		
		Japanese	0.98		
		Microphthalmos	1.00		
		Cerebellar ataxia	0.37		
		Cystic fibrosis (non-Caucasians)	1.00		

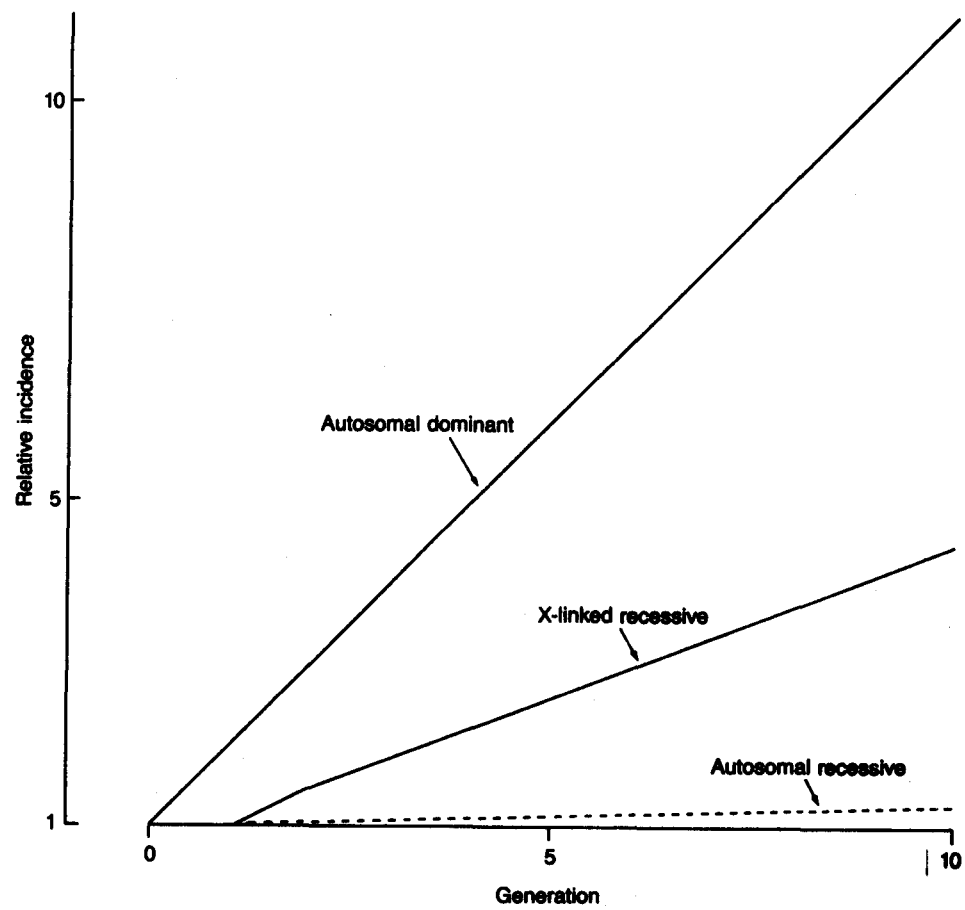
Sources:
[a] After Morton (1982).
[b] After Reed and Neel (1959).
[c] After Popham (1953).

TABLE VII.12. RISING PATTERN OF AUTOSOMAL DOMINANT, AUTOSOMAL RECESSIVE, X-LINKED RECESSIVE AND MULTIFACTORIAL DISORDERS, PREVIOUSLY LETHAL, AFTER COMPLETE RELAXATION OF SELECTION

Generation after relaxation	*Autosomal dominant*	*Autosomal recessive*			*X-linked recessive*	*Multifactorial disorder (heritability 0.56)*	
		Case 1	*Case 2*	*Case 3*		*Frequency (percentage)*	*Increment (percentage)*
0	1	1.000	1.000	1.000	1.000	1.000	-
1	2	1.02	1.006	1.002	1.000	1.073	0.073
2	3	1.04	1.012	1.004	1.500	1.133	0.060
3	4	1.06	1.019	1.006	1.750	1.187	0.054
4	5	1.08	1.025	1.008	2.125	1.235	0.048
5	6	1.10	1.031	1.010	2.438	1.283	0.048
6	7	1.12	1.038	1.012	2.781	1.330	0.047
7	8	1.14	1.044	1.014	3.109	. .	. .
8	9	1.16	1.051	1.016	3.445	. .	. .
9	10	1.18	1.057	1.018	3.777	. .	. .
10	11	1.20	1.063	1.020	4.111	. .	. .

Source: Modified from Matsunaga (1982).
NOTES: *Case 1:* Frequency of disease is assumed to be 1 per 10,000 persons.
Case 2: Frequency of disease is assumed to be 1 per 100,000 persons.
Case 3: Frequency of disease is assumed to be 1 per 1,000,000 persons.

Figure VII.2. Rising trends in autosomal dominant, autosomal recessive and X-linked recessive diseases, previously lethal, after complete relaxed selection



other autosomal recessive diseases. Table VII.12 and figure VII.2 show the results. For recessive diseases the increase is very small.

The rising trend in X-linked recessive diseases

Consider X-linked recessive diseases. The following results are obtained from Matsunaga.[30] Let y_0, s and x_0 be the frequency of male patients, selection coefficient for males, and the frequency of female carriers, respectively. Then, the following formula can be given:

$$y_0 s = u + 2v$$

where u and v are mutation rates per locus per generation for males and females, respectively. If by

successful treatment the condition could be completely cured in all the patients even if the trait was previously lethal ($s=1$), and fertility becomes 1, the frequencies for the male patients and female carriers in the tth generation, y_t and x_t will be:

$$y_t = v + x_{t-1}/2$$

$$x_t = u + v = x_{t-1}/2 + y_{t-1}.$$

From the following relationship: $x_{t-1} = u + y_{t-1} + y_{t-2}$,

$$y_t = (1 + r_t s)y_0$$

$$\text{where } r_t = (1 + r_{t-1} + r_{t-2})/2.$$

Table VII.12 and figure VII.2 show the results. The frequency of patients increased 1.5-fold by the second generation, 2.1-fold by the fourth generation and 4.1-fold by the tenth generation. Therefore, the rising trends in X-linked recessive diseases are intermediate between those of autosomal dominant diseases and autosomal recessive diseases.

The rising trend in multifactorial disorders

The previous sections dealt with cases of the single locus according to the mode of inheritance. However, in this section, multifactorial disorders (such as cleft lip, congenital heart disease and diabetes mellitus) will be considered. Theoretical predictions for the frequency of multifactorial disorders following relaxed selection are considered by Matsunaga[30] and Davie and others.[31] The latter authors have applied Matsunaga's formula to more general formulae. Their conclusions are as follows: after relaxed selection in multifactorial disorders, an increase in frequency per generation may be expected of, at most, a few per cent of the frequency in the initial generation. The greatest increase will be in the first generation following the introduction of the new treatment. Table VII.12 shows the results for Matsunaga.[32] The rising trend in multifactorial disorders depends on the heritability.[33] When the heritability is 0.56, the frequency of multifactorial disorders increases 1.3-fold by the sixth generation.

E. Discussion and conclusion

Treatment that increases the survival and hence the fertility of affected individuals leads to increased frequencies of genetic disorders. In this chapter, the rising trends in genetic disorders have been discussed by mode of inheritance. The frequency of autosomal dominant diseases increased linearly from generation to generation. Then, following relaxed selection, expected effects on autosomal dominant diseases are very great. On the other hand, expected effects on autosomal recessive diseases are very small. The frequency of X-linked recessive diseases increased to 1.5-fold in the second generation and 4.1-fold in the tenth generation. The expected effects on X-linked recessive diseases are therefore intermediate between those for autosomal dominant diseases and those for autosomal recessive diseases. As for multifactorial disorders, an increase in frequency per generation of, at most, a few per cent of the frequency in the initial generation may be expected. The greatest increase will be in the first generation following the introduction of the new treatment. Therefore, the rising frequency of the multifactorial disorders is intermediate between that for X-linked recessive diseases and that for autosomal recessive diseases.

It can be concluded that the genetic and biological consequences of mortality reduction to low levels are greater or lesser deteriorations in human gene pools. However, in actual populations, detrimental effects from mortality reduction (reduced selection) have generally been balanced by the beneficial effects of fertility and nuptiality changes. Beneficial effects are expected from the lowering of paternal and maternal ages at reproduction in the cases of genetic diseases and chromosome aberrations, respectively. Similarly, a beneficial effect is expected from the decline of consanguinity in the case of autosomal recessive diseases.

At the conclusion of this chapter, I would like to cite several opinions of human geneticists and population geneticists. Crow[34] mentioned that "the genetic consequences of the successful treatment of diseases caused by rare recessive genes are slight. The situation is quite different with a rare dominant gene. . . . The difference in the immediate consequences of successful treatment of dominant and recessive diseases is lessened if there is genetic counselling[35] or if the person knows the mode of inheritance of his diseases. If the disease is caused by a recessive gene, the incidence is slight, especially if the gene is rare and consanguineous marriages continue to decrease in frequency." Vogel and Motulsky[36] also mentioned that "genetic defect might be slightly more or less frequent than at present but will be under effective control by counselling and antenatal diagnosis. Living cases with autosomal chromosome aberrations may become rarities. Diseases caused by polygenic factors[37] are likely to increase because of medical and surgical treatments and other cultural factors leading to relaxation of selection." According to Fraser,[38] following the medical treatment (leading to increased fertility) of autosomal dominant, autosomal recessive and X-linked recessive diseases, frequencies of deleterious genes might be increased, but will be under effective control by counselling leading to reproductive restraint, lowering of parental age at reproduction, artificial insemination by donor[39] and so on. However, the deleterious frequencies of new mutant genes can be increased by environmental factors due to radiation and chemical agents.

Notes

[1] J. G. Wilson, *Environment and Birth Defects* (New York, Academic Press, 1973).

[2] E. Matsunaga, "Parental age, live-birth order and pregnancy-free intervals in Down's syndrome in Japan", *Mongolism*, G. E. W. Wolstenholme and R. Porter, eds. (Boston, Little, Brown and Co., 1967), pp. 6-17.

[3] L. S. Penrose, "Review of W. M. Court Brown and others: abnormalties of the sex chromosome complement in man", *Annals of Human Genetics, London*, vol. 28 (1964), pp. 199-200.

[4] E. Matsunaga, "Parental age, live-birth order and pregnancy-free intervals . . .".

[5] R. G. Record and A. Smith, "Incidence and sex distribution of mongoloid defectives", *British Journal of Preventive and Social Medicine*, vol. 9 (1955), pp. 10-15.

[6] C. O. Carter, "A life-table for mongols with the cause of death".

[7] J. Fabia and M. Drolette, "Life tables up to age 10 for mongols with and without congenital heart disease", *Journal of Mental Deficiency Research*, vol. 14 (1970), pp. 235-242.

[8] K. Tsuda and others, "Mortality and survival in Down syndrome", *Shonika Shinryo*, vol. 42 (1978), pp. 993-998 (in Japanese); M. Masaki and others, "Mortality and survival for Down syndrome in Japan", *American Journal of Human Genetics*, vol. 33 (1981), pp. 629-639.

[9] Masaki and others, *loc. cit.*, pp. 629-639.

[10] F. Vogel, "Spontaneous mutations in man", *Chemical Mutagenesis in Mammals and Man*, F. Vogel and G. Rohrborn, eds. (New York-Berlin-Heidelberg, Springer-Verlag, 1970), pp. 16-68.

[11] Use of the terms "autosomal" or "X-linked" (sex-linked) is obvious, indicating that the gene in question is located either on one of the autosomes (without specifying which one) or on the X-chromosome.

[12] E. Matsunaga, "Effect of changing paternal age patterns on chromosomal aberrations and mutations", *Social Biology*, vol. 20 (1973), pp. 82-88.

[13] A marriage between blood relations.

[14] The coefficient *F* that expressed the likelihood that two alleles at a locus would be identical by descent. Alleles are defined as alternative forms of a gene that can be present at any particular locus.

[15] Y. Imaizumi and others, "Inbreeding in Japan: Results of a nation-wide study", *Japanese Journal of Human Genetics*, vol. 20 (1975), pp. 91-107.

[16] J. Sutter and L. Tabah, "L'évolution des isolats de deux départements français: Loir-cher, Finistère", *Population*, vol. 10 (1955), pp. 645-674.

[17] A. Moroni, "Historical demography, human ecology and consanguinity", *General Conference, London, 1969* (London, International Union for the Scientific Study of Population, 1969).

[18] A. Valls, "Consanguineous marriages in a Spanish population", *Acta genética*, vol. 17 (1967), pp. 112-119.

[19] W. J. Schull and J. V. Neel, *The Effects of Inbreeding on Japanese Children* (New York, Harper and Row, 1965); M. Yamaguchi and others, "Effects of inbreeding on mortality in Fukuoka population", *American Journal of Human Genetics*, vol. 22 (1970), pp. 145-159; K. Tanaka, "Genetic studies in inbreeding in some Japanese populations, XI. Effects of inbreeding on mortality in Shizuoka", *Japanese Journal of Human Genetics*, vol. 17 (1973), pp. 319-331.

[20] Yamaguchi and others, *loc. cit.*

[21] The genetic constitution of an individual.

[22] Mating without regard to genotype or phenotype.

[23] Detrimental to the genetic quality of a species.

[24] J. F. Crow, "The quality of people: human evolutionary changes", *BioScience*, vol. 16 (1966), pp. 863-867; J. F. Crow, "Some effects of relaxed selection and mutation", *Human Genetics: Proceedings of the Fourth International Congress of Human Genetics*, J. de Grouchy and others, eds. (Amsterdam, Excerpta Medica, 1972), pp. 155-166.

[25] L. L. Cavalli-Sforza and W. F. Bodmer, "Cultural evolution and its effect on natural selection", *The Genetics of Human Populations* (San Francisco, W. H. Freeman and Company, 1971), pp. 774-779.

[26] Measure of ability to survive and reproduce.

[27] V. A. McKusick, *Mendelian Inheritance in Man* (Baltimore, Johns Hopkins University Press, 6th edition, 1983).

[28] National Academy of Science – National Research Council, BEIR (Biological effects of ionizing radiation) report: *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation* (Washington, D.C., Government Printing Office, 1972).

[29] A disorder influenced by the cumulative effects of both genes and environmental factors.

[30] E. Matsunaga, "Possible genetic consequences of relaxed selection against common disorders with complex inheritance", *Human Genetics*, vol. 31 (1976), pp. 53-57.

[31] A. M. Davie and others, "On effects of relaxed selection in familial disorders", *Annals of Human Genetics, London*, vol. 41 (1978), pp. 481-489.

[32] E. Matsunaga, "Possible genetic consequences of relaxed selection . . .".

[33] The degree of genetic determination.

[34] J. F. Crow, "The quality of people . . .".

[35] A service for married or engaged couples to help them understand and solve problems related to the risk of having genetically abnormal progeny.

[36] F. Vogel and A. G. Motulsky, "Biologic future of mankind", *Human Genetics: Problems and Approaches* (Berlin, Springer-Verlag, 1979), p. 549.

[37] By "Diseases caused by polygenic factors" are meant multifactorial disorders.

[38] G. R. Fraser, "Long-term genetic consequences of advances in treatment and prevention of hereditary disease", *Service and Education in Medical Genetics*, I. H. Porter and E. B. Hook, eds. (New York, Academic Press, 1979), pp. 21-28.

[39] Where the father is affected or a carrier.

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Part Two

CONSEQUENCES RELATED TO THE LIFE CYCLE

VIII. EFFECTS OF MORTALITY LEVELS ON KINSHIP

*Noreen Goldman**

The effects of demographic transitions on the household and family have been analysed by demographers, sociologists and historians. In particular, the processes of urbanization and modernization that often accompany or follow a society's change from a high-fertility/high-mortality population to a low-fertility/low-mortality one have been shown to influence size of households, household composition, and the economic and behavioural relationships among members of a household and among kin within the family.

The focus of this paper is specifically a demographic one. Changes in fertility and mortality indirectly affect intra-family relations, but they directly determine the numbers of kin who are available at any given time to be part of a family, both in terms of the numbers of kin who are born under specified régimes of fertility and mortality and the numbers who remain alive at successive ages. Demographers have examined the effects of declining mortality on the probabilities of survival of various family members (especially on the survivorship of parents, children and spouses.)[1] Less attention has been given to an assessment of the ways in which fertility and mortality interact to determine average numbers of kin at different stages of the life cycle.

A decade ago, Goodman, Keyfitz and Pullum demonstrated that, in a closed population, fixed age-specific fertility and mortality rates determine average numbers of kin, numbers which can be calculated from closed-form expressions.[2] In this chapter we use the expressions developed by Goodman and others[2] for the average numbers of descendants and collateral kin ever born and still alive for women of various ages to investigate the relationship between fertility and mortality schedules and the frequency of various kinship relationships. Although our main interest concerns the effects of declining mortality on kinship structure, we cannot ignore the often dominating effects of fertility. For example, we show that the numbers of sisters and aunts ever born are almost completely determined by the level of fertility. On the other hand, the proportions of various kin who are alive at different ages are mostly determined by the mortality schedule. The extent to which recent declines in mortality and fertility affect numbers of kin is explored with data from the Republic of Korea for the periods 1955-1959 and 1975-1979, an interval over which life expectancy rose by about ten years and total fertility fell by almost half. Model schedules[3] are used to assess potential variations in kinship structure over the range of fertility and mortality observed in human populations.

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METHODS

Although the techniques developed by Goodman and others[2] can be used to estimate numbers of kin for any specified sequence of fertility and mortality rates, we assume that all demographic rates are fixed. Hence, we are in essence looking at the kinship structure that results from a fixed régime of fertility and mortality—i.e., a stable population. We also assume, as do Goodman and others, that fertility and mortality are independent of one another—e.g., that more fertile women experience the same mortality risks as do less fertile women—and that the fertility schedule (and mortality schedule) for a given age is applicable to all women of that age in the population.[4]

As frequently happens in the realm of stable population analysis, we ignore males. Since the life tables and fertility schedules described below refer only to the female population, all kin refer to those within the female lines of descent. Thus, for example, aunts refer only to maternal aunts (a mother's sisters) and (first) cousins to daughters of maternal aunts. To obtain approximate total numbers of kin one could multiply the numbers presented in this chapter by the appropriate factors: daughters and sisters by two to obtain children and siblings; granddaughters, nieces and aunts by four to obtain grandchildren, nieces and nephews, and aunts and uncles; and cousins by eight. Clearly, more exact results could be obtained by considering male mortality schedules and sex ratios at birth.

Some of the expressions presented in Goodman and others[2] are very straightforward—e.g., numbers of daughters and granddaughters, proportions of living mothers—and have been known for a long time. On the other hand, the expressions for numbers of sisters, nieces, aunts and cousins are less obvious and are derived for the first time in Goodman and others. Below, we derive the expression for the average or expected number of sisters ever born to a woman aged a, chosen at random from the stable population.

The probability that a female survives from birth to age x is denoted by $\ell(x)$ and the probability of a woman having a female child between ages x and $x+dx$ is denoted by $m(x)dx$. In this stable population, the intrinsic rate of increase equals r, where r is the solution of Lotka's characteristic equation $[\int e^{-rx}\ell(x)m(x)dx=1]$. Let us temporarily impose the condition that this woman was born when her mother was aged x, $\alpha < x < \beta$, where α and β are the first and last ages of childbearing. Then, she can expect to have $[\int_\alpha^x m(y)dy]$ older sisters and $[\int_0^\beta \frac{\ell(x+y)}{\ell(x)} m(x+y)dy]$ younger sisters. Note that in order for her to have younger sisters, her mother must survive beyond age x; thus the conditional survival probability $\ell(x+y)/\ell(x)$ enters only the expres-

sion for younger sisters. The density of ages of motherhood in a stable population is denoted by $e^{-rx}\ell(x)m(x)$ (the age distribution of all women in a stable population times the fertility function), so that the probability that this woman was in fact born when her mother was between ages x and $x+dx$ equals $e^{-rx}\ell(x)m(x)dx$. Hence, if we remove the condition that the woman was born when her mother was aged x, the expected number of older sisters ever born and the expected number of younger sisters ever born, for a woman aged a, equal

$$\int_\alpha^\beta \left[\int_a^x m(y)dy\right] e^{-rx}\ell(x)m(x)dx \qquad (1)$$

and

$$\int_\alpha^x \left[\int_0^a \frac{\ell(x+y)}{\ell(x)} m(x+y)dy\right] e^{-rx}\ell(x)m(x)dx \qquad (2)$$

respectively. The total number of sisters ever born is simply the sum of (1) and (2).

The formula for the number of older sisters still alive by age a of the woman requires a survival factor $\ell(a+x-y)$ in the inner integral of (1); likewise, the formula for younger sisters still alive requires the factor $\ell(a-y)$ in the inner integral of (2).

Formulas for the numbers of nieces, aunts and cousins ever born and still alive can be obtained in a similar manner—i.e., by separately considering the number of kin through younger sisters and the number through older sisters, and by imposing the condition that the woman aged a was born when her mother was aged x. These formulas will not be derived here but can be found in Goodman and others.[2]

Numbers of kin ever born and still alive

Kin ever born

According to equations (1) and (2) and similar formulas in Goodman and others,[2] a fertility schedule and life table together specify the average kinship structure in the population. Bear in mind that the numbers presented here are not actual numbers of kin in the Republic of Korea, but rather the numbers which would exist, if the fertility and mortality schedules of a given period were to remain unchanged for a long period of time.

Table VIII.1 shows the demographic changes which occurred in the Republic of Korea over the approximately 20-year interval between 1955-1959 and 1975-1979: life expectancy increased by 10.5 years while total fertility dropped by almost 50 per cent from 5.8 to 3.0 children per woman. The rapid fall in marital fertility and rise in age at marriage which together produced this substantial decline in fertility after 1960 have been well documented.[5] The overall effect on the intrinsic rate of increase has been dramatic: a decline from almost 3 per cent to just over 1 per cent.

Table VIII.2 shows the implied "eventual" numbers of kin for the Republic of Korea during these two periods. Note that when we refer to numbers of kin we generally need to specify an age of woman because numbers of kin ever born increase throughout the life cycle of a woman, up to a certain age. For example, if α and β equal 15 and 45 respectively, then the number of sisters for a given woman increases up to age 30 $(\beta-\alpha)$, by which time the mother has to have reached the end of her reproductive period. Similarly, all of a woman's aunts will have been born by the time she is 15 $(\beta-2\alpha)$, all of her nieces before she is 75 $(2\beta-\alpha)$ and all of her (first) cousins before she is age 60 $[2(\beta-\alpha)]$. Note that the term "eventual" as used here is simply a cumulative count of all kin born into specific roles without regard to the survival of the reference woman. Knowledge of a woman's survival status is important only for determining numbers of daughters and granddaughters. For example, the average number of daughters born to a 50-year-old woman equals the gross reproduction rate (GRR), since we know that this woman has survived the entire reproductive period. On the other hand, the average number of daughters eventually born to a female infant or child equals the net reproduction rate (NRR). It is this latter figure that appears in table VIII.2.

By and large, the changes in eventual numbers of kin from the late 1950s to the late 1970s reflect the decline in Korean fertility more than the rise in life expectancy. The decline in numbers of daughters embodies the drop in the net reproduction rate, a decrease of 41 per cent, whereas the decrease in numbers of granddaughters reflects the drop in the net reproduction rate squared, a

TABLE VIII.1. DEMOGRAPHIC PARAMETERS FOR FEMALES: REPUBLIC OF KOREA, 1955-1959 AND 1975-1979

	1955-1959	*1975-1979*
Life expectancy (e_0)	58.9	69.4
Net reproduction rate (NRR)	2.34	1.38
Gross reproduction rate (GRR)	2.80	1.48
Total fertility rate (TFR)	5.76	3.05
Intrinsic rate of increase (r)	0.029	0.012

Source: Mortality and fertility data for 1955-1959 are from A. J. Coale, L. J. Cho, and N. Goldman, "Estimation of recent trends in fertility and mortality in the Republic of Korea", report No. 1, National Research Council, Committee on Population and Demography, National Academy of Sciences (Washington, D.C., 1980). Death rates and fertility information for 1975-1979 are from the *Demographic Yearbook*. (Reported death rates have been smoothed by use of the Brass logit system.)

TABLE VIII.2. EXPECTED EVENTUAL NUMBERS OF FEMALE KIN EVER BORN, ACCORDING TO FERTILITY AND MORTALITY SCHEDULES: REPUBLIC OF KOREA, 1955-1959 AND 1975-1979

Female descended kin[a]	*1955-1959*	*1975-1979*
Daughters	2.34	1.38
Granddaughters	5.46	1.91
Sisters	2.73	1.47
Nieces	6.37	2.04
Aunts	2.73	1.47
Cousins	6.37	2.04
GRR	2.80	1.48
GRR^2	7.82	2.19
NRR	2.34	1.38
NRR^2	5.46	1.91
NRR·GRR	6.53	2.05

[a] Numbers of kin through female line of descent. To obtain approximate total numbers of kin ever born, the following multipliers should be used: number of children ≈ 2 x number of daughters; number of grandchildren ≈ 4 x number of (female descended) granddaughters; number of siblings ≈ 2 x number of sisters; number of nieces and nephews ≈ 4 x number of (female descended) nieces; number of aunts and uncles ≈ 4 x number of (female descended) aunts; number of cousins ≈ 8 x number of (female descended) cousins.

decrease of 65 per cent. Note in table VIII.2 that the eventual numbers of sisters ever born is almost identical to the gross reproduction rate in each period. This finding appears to be paradoxical for two reasons: we would expect the average number of sisters to be GRR-1, so as to yield GRR children in the family including the woman herself; and, the number of sisters ever born appears to be almost completely independent of the level of mortality.

The fact that, in the absence of mortality, the average number of sisters eventually born equals GRR, rather than GRR − 1, is a result of "sampling bias": we are more likely to sample women with many sisters than women with no or few sisters. The proof of this result, which depends upon the assumption that all women in the population experience the fertility schedule $m(x)$, can be found elsewhere.[6]

It is important to bear in mind that the average number of sisters (as well as of aunts, nieces and cousins) depends strongly on the assumed variation of completed family size. An illustration from China demonstrates the importance of variance. For example, if all Chinese families adhered strictly to the "one-child family" rule, children in the current generation would have no siblings, and hence no nieces or nephews. If the policy were to continue, children in the following generation would have no aunts, uncles or cousins as well. On the other hand, if the Chinese population adhered to the population policy on *average*, with half of couples having no children and the other half having two children, each child in the current generation would have one sibling. The assumption inherent in the Goodman and others model—that all women experience the same birth rate at age x—yields a variance of family size equal to the mean family size in the absence of mortality.

The fact that mortality has little influence on numbers of sisters ever born is the result of our considering sisters of a living woman. Her very presence (or existence) tells us that her mother survived to at least the beginning of the reproductive period; in all probability, her mother survived through much of the reproductive period since, at moderate and high levels of life expectancy, death rates at reproductive ages are low. Note that for the period 1955-1959 when e_0 equaled 59 years, the eventual number of sisters is 2.73, a figure equal to 98 per cent of the GRR. Calculations on model schedules indicate that even when life expectancy is as low as 30 years, a woman eventually has about 95 per cent of the number of sisters she would have in a high life expectancy population, i.e., 0.95 × GRR. However, as described later, she actually has many fewer surviving sisters when death rates are high.

An obvious finding from table VIII.2 is that the eventual number of aunts ever born (through the female line of descent) equals the eventual number of sisters since these aunts are simply a mother's sisters. Hence, the eventual number of aunts (through the female line of descent) is almost equal to the GRR regardless of the level of mortality, and the total number of aunts and uncles is approximately 4 × GRR. From 1955-1959 to 1975-1979 the number of sisters and aunts (as implied by the ongoing fertility and mortality rates) dropped by 46 per cent, from 2.73 to 1.47, a drop almost equal to the proportionate decline in total fertility. Undoubtedly, such a large drop in average number of siblings implies a much larger proportion of Korean children who will eventually have no or only one sister or brother. However, as noted above, an accurate estimate of the distribution of eventual numbers of siblings, or of numbers of kin, requires information on the variation of age-specific fertility (and mortality) across the population, information which is not easily obtainable.

One can also show that, in the absence of mortality, the average number of nieces and cousins eventually born through the female line of descent equals GRR^2. However, with allowance for mortality, the numbers of nieces and cousins can fall far short of this value. For the Republic of Korean in 1955-1959, the average eventual number of nieces of 6.37 is 81 per cent of the maximum possible given the level of fertility; in 1975-1979 the eventual number of nieces of 2.04 is 93 per cent of GRR^2. Calculations for a low life expectancy population (e_0=30) indicate that fewer than half of the "potential" number of nieces and cousins are born and, of course, even fewer survive to subsequent ages. As we would expect, mortality has a much greater effect on numbers of nieces and cousins ever born, as compared with numbers of sisters and aunts, because the higher mortality risks of infancy and childhood come into play: e.g., for a woman to have GRR^2 nieces, not only must her mother survive to age β, but all of the woman's sisters must survive from *birth* to the end of the reproductive period.

Nevertheless, the implied numbers of kin for the Republic of Korea indicate that at moderate-to-high levels of life expectancy, fertility is the more important determinant of numbers of nieces and cousins ever born. From the late 1950s to the late 1970s, these numbers fell by over two thirds, an order of magnitude approximately equal to the change in the product of the GRR and the NRR over the interval. These changes in demographic rates in the Republic of Korea over the 20-year period imply a drop in the average number of nieces and nephews from 25 to 8 and in total (first) cousins from 51 to 16. The corresponding changes in numbers of siblings and in numbers of aunts and uncles, from about 5.5 and 11, respectively, to about 3 and 6, are also substantial.

Kin still alive

Table VIII.3 shows the mean number of living kin by successive ages of a woman, according to birth and death rates in the Republic of Korea during 1955-1959 and 1975-1979. For those kin who are generally as old or older than the woman herself—i.e., sisters, cousins and aunts—the change from 1955-1959 to 1975-1979 in numbers of living kin is notably smaller than the change in numbers of kin ever born. That is, the rise in life expectancy partly offsets the dramatic decline in fertility in terms of numbers of surviving kin. For example, the ratio of numbers of aunts ever born for the late 1970s to those for the late 1950s is almost 2 to 1, whereas the corresponding ratio for living aunts is 1.5 to 1 by age 20. Nevertheless, the "kin-reducing" effect of the fertility decline remains significant. In terms of surviving kin, a 30-year-old woman has about 23 per cent fewer daughters, 36 per cent fewer sisters, 58 per cent fewer nieces, 27 per cent fewer aunts and 62 per cent fewer cousins as a result of the demographic changes in Korea. Below we use model schedules to obtain a clearer view of the separate effects of fertility and of mortality on numbers of kin ever born and still alive.

TABLE VIII.3. EXPECTED NUMBERS OF VARIOUS FEMALE KIN ALIVE BY SUCCESSIVE AGES OF WOMEN, ACCORDING TO FERTILITY AND MORTALITY SCHEDULES: REPUBLIC OF KOREA, 1955-1959 AND 1975-1979

Female descended kin		*Ages of women (years)*							
		0	*10*	*20*	*30*	*40*	*50*	*60*	*70*
Daughters	1955-1959	-	-	0.1	1.3	2.3	2.5	2.3	2.2
	1975-1979	-	-	0.0	1.0	1.4	1.4	1.4	1.3
Granddaughters	1955-1959	-	-	-	-	0.1	0.9	3.0	4.8
	1975-1979	-	-	-	-	0.0	0.4	1.4	1.9
Sisters	1955-1959	1.1	2.0	2.3	2.2	2.1	1.8	1.5	1.0
	1975-1979	0.7	1.3	1.4	1.4	1.3	1.2	1.0	0.7
Nieces	1955-1959	0.0	0.2	1.0	2.6	4.3	5.1	5.1	4.8
	1975-1979	0.0	0.0	0.4	1.1	1.7	1.9	1.8	1.8
Aunts	1955-1959	2.2	2.1	1.8	1.5	1.0	0.6	0.2	0.0
	1975-1979	1.4	1.3	1.2	1.1	0.8	0.5	0.1	0.0
Cousins	1955-1959	2.4	3.9	4.8	5.0	4.8	4.2	3.4	2.4
	1975-1979	0.9	1.6	1.8	1.9	1.8	1.6	1.4	1.0

RELATIVE INFLUENCES OF FERTILITY AND MORTALITY

Figure VIII.1 illustrates the average numbers of sisters, aunts, nieces, and cousins ever born by successive ages of women, for two levels of fertility (GRR=1 and GRR=3) and three levels of mortality (e_0=30, 50, 70). These values have been calculated from model life tables[7] and model fertility schedules[8] in order to span a realistic range for numbers of kin and to investigate the relative influences of fertility and mortality. These figures highlight our previous finding that mortality may be an important factor in determining the numbers of nieces and cousins ever born, but that the numbers of sisters and aunts ever born are almost entirely independent of the mortality level.

The graphs also point out the differing ages at which a woman acquires her various kin. Virtually all of a woman's aunts are born before her; about half of a woman's sisters are born before her, and almost all are born by the time she is 15; about half of a woman's cousins are born before her and almost all are born by the time she is 20 or 25; and about half of a woman's nieces are born by the time she is 30 and almost all are born by the time she is 50.

An analysis of numbers of kin who are living at various stages of a woman's life is more difficult because of the complex interaction between fertility and mortality: i.e., actual numbers living are a function of both numbers ever born and numbers who die. Figure VIII.2 illustrates this interaction for the average number of living sisters by successive ages of a woman, for two levels of fertility and three levels of mortality. Note the contrast between this graph and the corresponding one in figure VIII.1. Whereas the level of mortality has barely any effect on sisters ever born, the effect on surviving sisters is substantial, at both a high and a low level of fertility. By age 50 a woman from the high fertility, low life expectancy population (GRR=3, e_0=30) has the same number of living sisters as does a 50-year-old woman from the low fertility (GRR=1), high life expectancy (e_0=70) population.

Table VIII.4 presents numbers of living kin for a fixed fertility schedule and three levels of life expectancy: e_0=30, 50 and 70 years. The level of fertility (GRR=3) is roughly equal to that in developing countries in which there is little fertility control. The contrast between the low and the high life expectancy populations are substantial: the average 40-year-old woman in a population with e_0=70 has 50 per cent more children, almost three times as many siblings, four times as many nieces and more than five times as many aunts and cousins alive than does a 40-year-old woman in a society with e_0=30. At the older ages the differentials are even more striking. For example, a 60-year-old woman in the high life expectancy population has almost five times as many surviving nieces and siblings and nine times as many surviving cousins as does the 60-year-old in a low life expectancy society.

The odds of a woman in the high-mortality population knowing older kin—e.g., aunts and grandmothers—are quite low. Although almost three aunts would have been born in this woman's family (since GRR=3), only 1.3 on average are alive by the time she herself is born; virtually no aunts are alive for those women who survive to age 50. The fact that increased life expectancy has a dramatic effect on the survival of older kin has been frequently demonstrated. For example, Martin and Culter recently examined the dramatic increases in parents' and grandparents' survival rates over the past 40 years in Japan, and the implications of the changes for families' living arrangements.[9] Similarly, Preston assessed the effect of cause-specific mortality reductions on the survivorship of parents, grandparents and spouses in the United States.[10] Clearly, as death rates fall, children spend a much higher proportion of their years together with parents, grandparents and aunts and uncles. This finding will be re-examined in the next section.

In addition, the data in table VIII.4 indicate that women in low mortality populations have many more surviving nieces and cousins than do women in high mortality areas. Although our earlier analysis indicated that a woman could have as many as nine (GRR^2) nieces and nine cousins in the absence of mortality, when life expectancy is as low as 30 years, on average no more than two nieces and two cousins are alive at a given point in the woman's lifetime. Similarly, on average less than half (1.4) of "potential" siblings are alive at any point.

An obvious consequence of these findings is the reduced likelihood of parents having a surviving heir when faced with high-mortality conditions. In certain societies in which son preference is strong and survival of a male heir is deemed necessary, it has been suggested that a desire for a minimum number of

Figure VIII.1. Expected numbers of sisters, aunts, nieces and cousins ever born, by age of woman

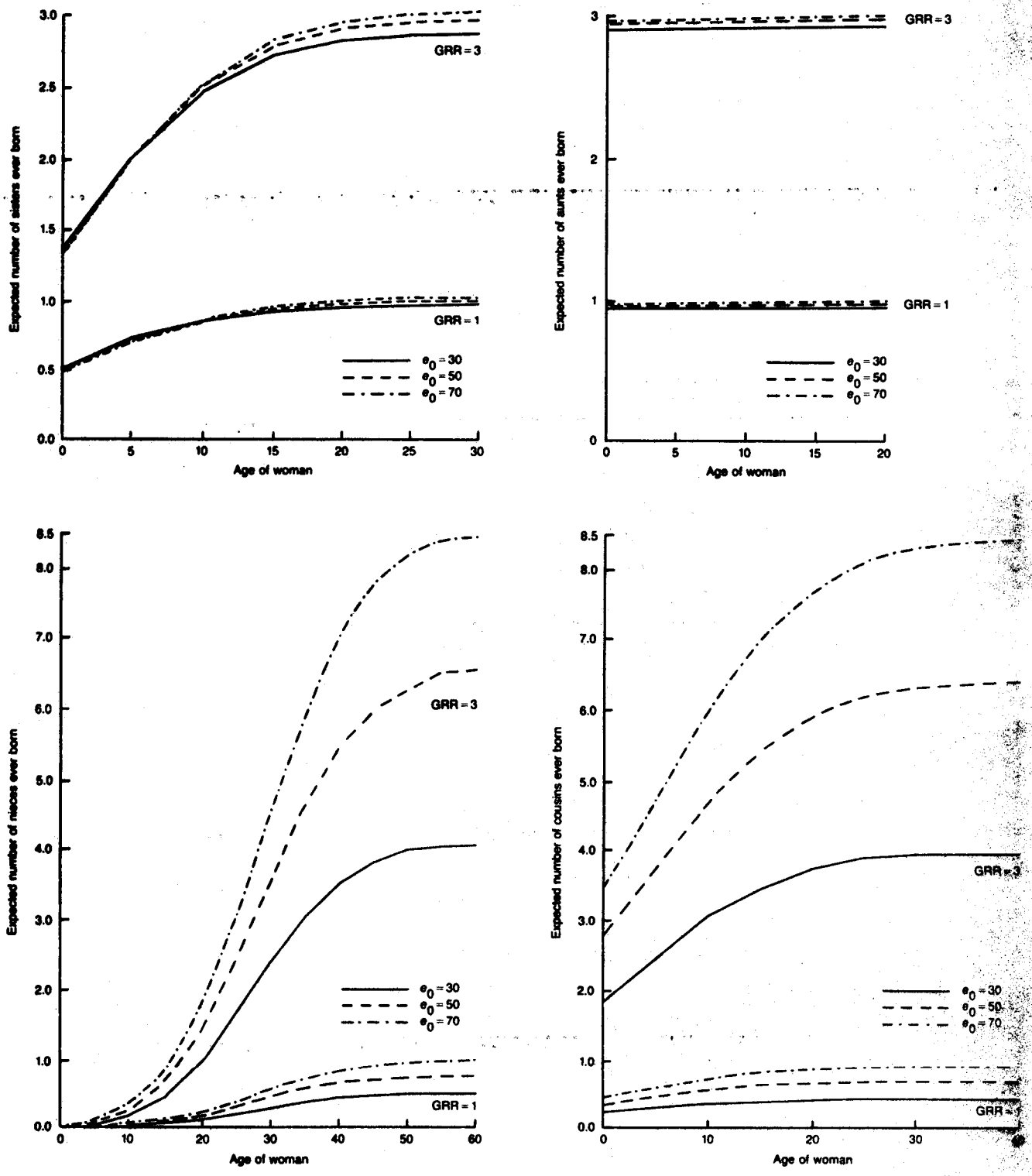
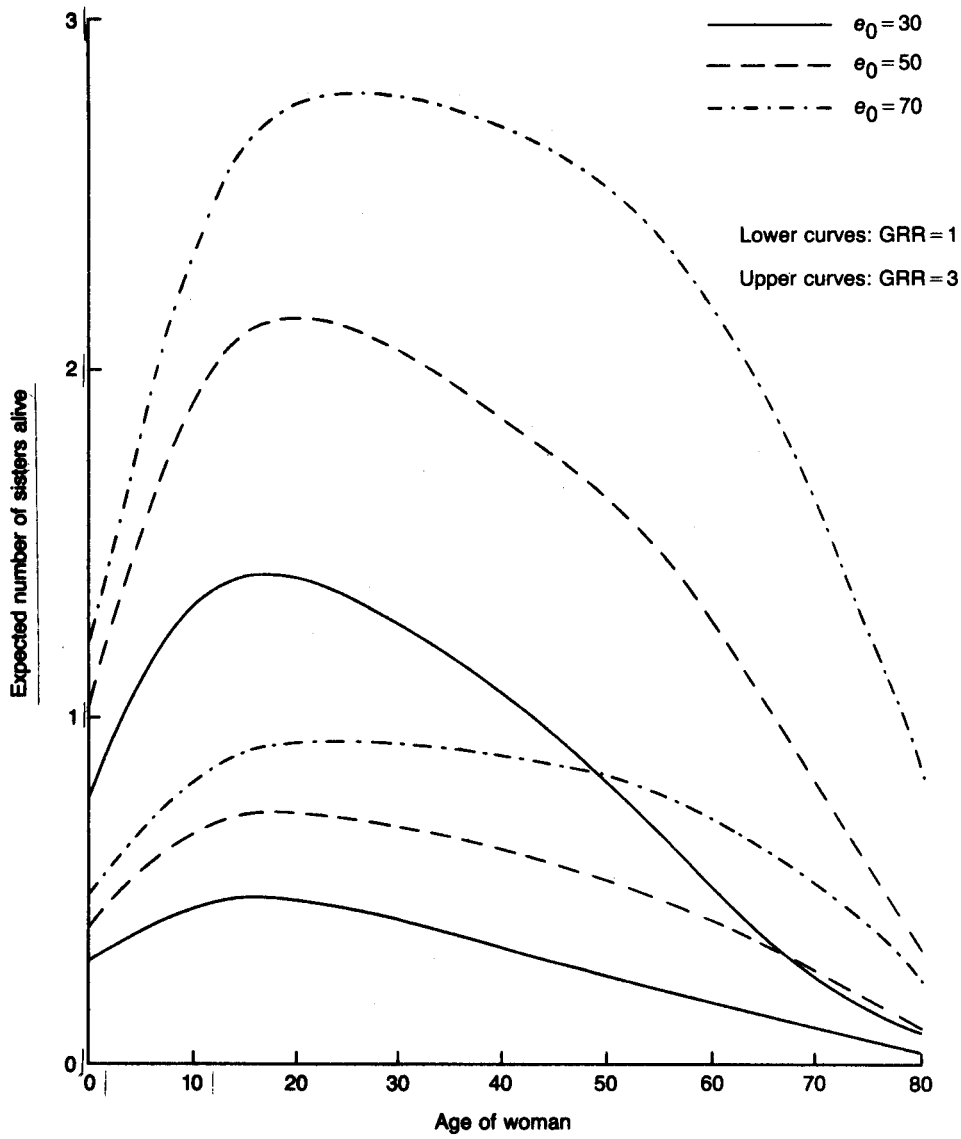


Figure VIII.2. Expected number of sisters alive, by age of woman



surviving sons helps to maintain high levels of fertility in areas that experience high death rates.[11] The data in table VIII.5, abstracted from Krishnamoorthy,[12] indicate that a 10-year increase in life expectancy at moderate or high levels of life expectancy (as in the Republic of Korea) allows for a drop in the GRR of about 0.7 child, for couples who want to maintain a 90 per cent chance of having at least one son survive to age 50 of the father. At low levels of e_0, a 10-year increase in life expectancy allows for a drop of roughly two children per woman. The data clearly suggest that if son or child survival is an important determinant of fertility behaviour, a reduction in death rates would permit a substantial reduction in fertility.

Proportions of surviving kin

Another way to analyse the effects of changing mortality on numbers of kin is to examine proportions of surviving kin. Although a change in the level or shape of fertility has some effect on these proportions, the effect is a relatively modest one in comparison with the effects of changing life expectancy.[13] The fact that these proportions are so heavily determined by the mortality schedule has proven very useful to demographers who estimate life table probabilities from proportions of women with surviving mothers and proportions of children ever born who are still alive.[14]

The effects of a 10-year increase in life expectancy in the Republic of Korea can be seen in table VIII.6. The proportion of women with surviving mothers has risen by an order of magnitude "consistent" with the change in e_0: i.e., for ages below 40, the odds of a woman aged x having a living mother in the earlier period equal those in the later period for a woman aged $x + 10$. According to demographic rates in 1955-1959, about half of 40-year-old women would have a living mother, whereas according to fertility and mortality rates in 1975-1979, about half of 50-year-old women would have a living

TABLE VIII.4. EXPECTED NUMBERS OF VARIOUS FEMALE KIN ALIVE BY SUCCESSIVE AGES OF WOMEN, FOR FIXED FERTILITY SCHEDULE AND THREE LEVELS OF MORTALITY [a]

Female descended kin		*Ages of women*							
		0	*10*	*20*	*30*	*40*	*50*	*60*	*70*
Daughters	$e_0 = 30$	-	-	0.1	1.3	1.7	1.5	1.3	1.1
	$e_0 = 50$	-	-	0.2	1.6	2.3	2.3	2.1	2.0
	$e_0 = 70$	-	-	0.2	1.9	2.8	2.8	2.8	2.7
Granddaughters	$e_0 = 30$	-	-	-	-	0.1	0.7	1.7	2.1
	$e_0 = 50$	-	-	-	-	0.1	1.5	3.6	4.7
	$e_0 = 70$	-	-	-	-	0.2	2.2	5.6	7.5
Sisters	$e_0 = 30$	0.8	1.3	1.4	1.2	1.0	0.8	0.5	0.3
	$e_0 = 50$	1.1	1.9	2.2	2.0	1.9	1.6	1.3	0.8
	$e_0 = 70$	1.3	2.4	2.8	2.8	2.7	2.5	2.2	1.6
Nieces	$e_0 = 30$	0.0	0.1	0.5	1.3	1.8	1.9	1.6	1.3
	$e_0 = 50$	0.0	0.2	1.1	2.8	4.2	4.6	4.4	3.9
	$e_0 = 70$	0.0	0.3	1.6	4.3	6.7	7.7	7.7	7.4
Aunts	$e_0 = 30$	1.3	1.1	0.8	0.6	0.3	0.1	0.0	0.0
	$e_0 = 50$	2.1	1.9	1.7	1.4	0.9	0.5	0.2	0.0
	$e_0 = 70$	2.8	2.7	2.6	2.3	1.8	1.1	0.4	0.1
Cousins	$e_0 = 30$	1.1	1.6	1.8	1.7	1.4	1.1	0.7	0.4
	$e_0 = 50$	2.2	3.0	4.4	4.4	4.1	3.5	2.7	1.8
	$e_0 = 70$	3.3	5.7	7.2	7.7	7.5	7.0	6.0	4.5

[a] Fertility is based on a model schedule with a mean age of childbearing of 29 years and a GRR of 3: (A. J. Coale and J. Trussell, "Model fertility schedules: variations in the age structure of childbearing in human populations", *Population Index*, vol. 40 (1974), pp. 185-258). Life tables are taken from the "West" series. e_0 = 30, 50 and 70 (A. J. Coale and P. Demeny, *Regional Model Life Tables and Stable Populations* (Princeton, New Jersey, Princeton University Press, 1966)).

TABLE VIII.5. GROSS REPRODUCTION RATE (GRR) NECESSARY TO ACHIEVE 90 PER CENT PROBABILITY OF AT LEAST ONE SON SURVIVING TO THE TIME WHEN FATHERS ARE AGED 40, 50, 60 AND 70, FOR DIFFERENT LEVELS OF LIFE EXPECTANCY [a]

Age of father	e_0						
	18	*25*	*35*	*45*	*54*	*64*	*74*
40	4.4	3.2	2.3	1.8	1.3	1.0	0.6
50	5.2	3.6	2.5	1.8	1.3	0.9	0.6
60	7.0	4.6	3.0	2.1	1.5	1.0	0.6
70	9.8	6.1	3.8	2.5	1.8	1.2	0.7

Source: Adapted from table 1 *in* S. Krishnamoorthy, "Mortality level, desire for surviving son and rate of population increase", *Demography*, vol. 33 (1979), pp. 565-571.

[a] Life tables are taken from Coale and Demeny, *op. cit.*, "West" levels Nos. 1, 4, 8, 12, 16, 20, and 24.

mother. In a very low life expectancy population (e_0=30), the proportion of women with surviving mothers drops to one-half by age 30.[15]

With some rough approximations, probabilities of at least one sister or aunt surviving to various ages of the reference woman can be estimated from table VIII.6. According to the data in tables VIII.2 and VIII.6, the probability that the "average" Korean woman aged 30 has at least one surviving maternal aunt equals 0.88 for 1955-1959 and 0.85 for 1975-1979; the corresponding probabilities for any aunt (maternal or paternal) are 0.99 and 0.98 respectively.[16] Similarly, the odds of a 30-year-old woman having at least one surviving sister equals 0.99 for 1955-1959 and 0.98 for 1975-1979. Declines in death rates which increase the survival odds for each kin counteract the decreases in fertility which reduce the total numbers of kin. Taken together, these demographic changes do not lead to a notable difference in the probabilities of having at least one surviving sister, niece, aunt or cousin, for many ages of the reference women. They do, of course, alter the survival prospects of each kin who is born.

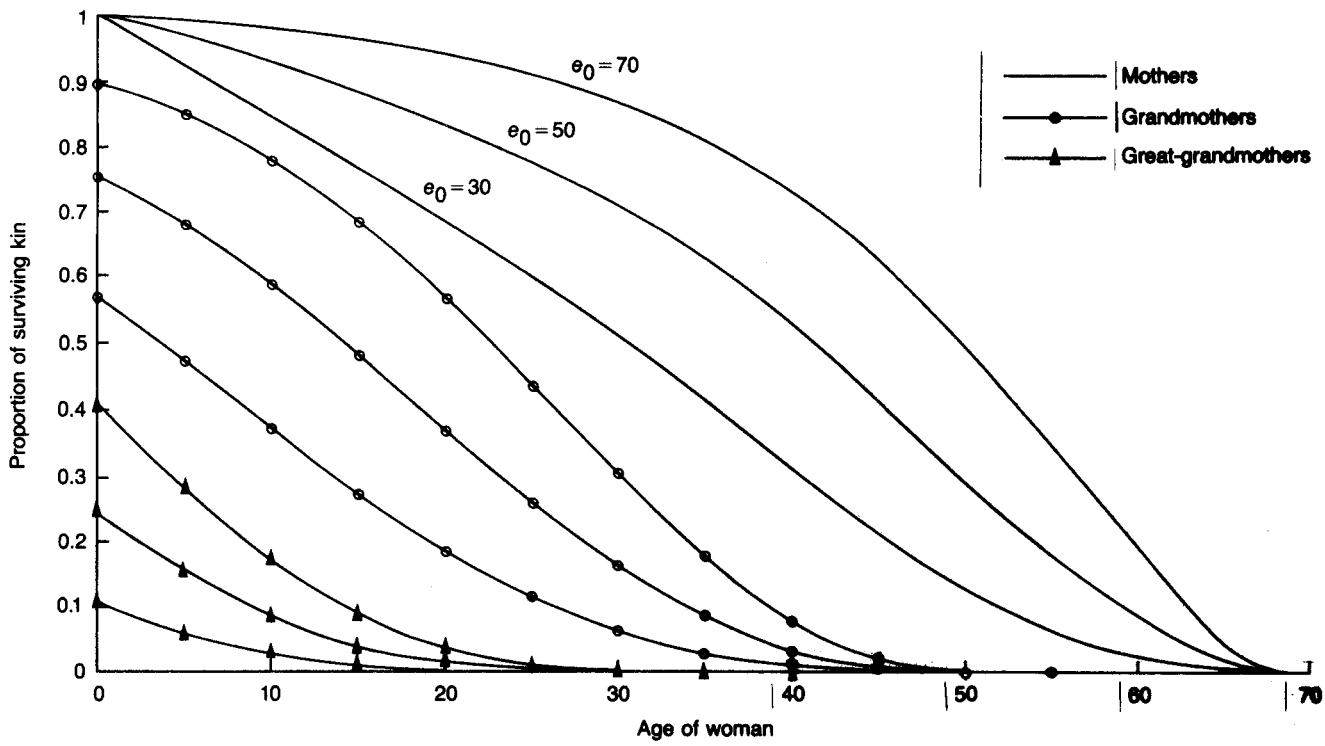
On the other hand, the probability of having at least one surviving ancestor—e.g. parent or grandparent—increases considerably over the twenty-year interval in Korea. For example, the chance that a 30-year-old woman has at least one surviving grandmother equals $1-(1-.13)^2$ or 0.24 for 1955-1959 and $1-(1-.25)^2$ or 0.44 for 1975-1979, an increase of over 80 per cent. Declines in mortality have the greatest effect on the survival of mothers, aunts and grandmothers and the smallest effect on the survival of nieces. This is because at moderate to high levels of life expectancy, increases in e_0 are produced by reductions in death rates at older ages. Hence, from the point of view of the reference woman's lifetime, these changes will have their biggest effect on kin older than the woman herself.

Figure VIII.3 illustrates this latter point by depicting the probability of a woman having a surviving mother, grandmother and great-grandmother under three régimes of life expectancy: e_0=30, 50 and 70 years.[15] The differences are striking. For example, a 35-year-old woman has twice the chance (over 80 per cent) of having a surviving mother when life expectancy is 70 years as compared with a life expectancy of 30 years. When e_0 is 70 years a 25-year-old woman has almost a 50 per cent chance that her maternal grandmother is alive (and a 70 per cent chance that at least one grandmother is alive) whereas a 25-year-old in the high mortality population has only about a 10 per cent

TABLE VIII.6. PROPORTIONS OF VARIOUS FEMALE KIN ALIVE BY SUCCESSIVE AGES OF WOMEN, ACCORDING TO FERTILITY AND MORTALITY SCHEDULES: REPUBLIC OF KOREA, 1955-1959 AND 1975-1979

Female descended kin		*Ages of women*						
		0	*10*	*20*	*30*	*40*	*50*	*60*
Mother	1955-1959	1.0	0.94	0.86	0.73	0.54	0.29	0.08
	1975-1979	1.0	0.97	0.94	0.86	0.72	0.48	0.14
Grandmother	1955-1959	0.74	0.56	0.33	0.13	0.02	0.00	0.00
	1975-1979	0.88	0.75	0.53	0.25	0.03	0.00	0.00
Daughters	1955-1959	-	-	0.93	0.92	0.91	0.88	0.84
	1975-1979	-	-	0.97	0.97	0.96	0.94	0.93
Granddaughters	1955-1959	-	-	-	-	0.91	0.91	0.90
	1975-1979	-	-	-	-	0.96	0.96	0.96
Sisters	1955-1959	0.90	0.89	0.86	0.82	0.76	0.67	0.53
	1975-1979	0.96	0.95	0.94	0.92	0.88	0.82	0.71
Nieces	1955-1959	0.91	0.91	0.90	0.90	0.88	0.85	0.81
	1975-1979	0.97	0.96	0.96	0.96	0.95	0.93	0.91
Aunts	1955-1959	0.82	0.76	0.67	0.54	0.38	0.20	0.08
	1975-1979	0.92	0.89	0.83	0.73	0.55	0.31	0.10
Cousins	1955-1959	0.89	0.88	0.85	0.81	0.75	0.66	0.53
	1975-1979	0.96	0.95	0.94	0.91	0.88	0.81	0.69

Figure VIII.3. Proportions of surviving mothers, grandmothers and great-grandmothers, for three levels of life expectancy, by age of woman



chance. In this latter population, almost 40 per cent of grandmothers and 90 per cent of great grandmothers would have died before the reference woman was ever born.

The curves in figure VIII.3 are strikingly reminiscent of life table functions. Indeed, it can easily be shown that the probability that a woman aged a has a living mother approximately equals $\ell(a+\kappa)/\ell(\kappa)$, where κ is the mean age of childbearing (in the associated stable population) and $\ell(x)$ is the probability of surviving from birth to age x.[17] Similarly, the probability that a woman aged a has a surviving grandmother and great grandmother equals $\ell(a+2\kappa)/\ell(\kappa)$ and $\ell(a+3\kappa)/\ell(\kappa)$, respectively. Hence, the differences between each set of curves in figure VIII.3 capture the differences in life table rates for a given age span, conditional on survivorship to about age 25. It is just these types of relationships which have led to the use of kinship survival data for the estimation of life tables.

Note from table VIII.6 that the proportions of surviving cousins and of surviving sisters are almost identical to one another, as they should be, since sisters and first cousins are born at about the same time. However, the probability of a mother being alive at any

specified age of a woman is considerably greater than the corresponding value for an aunt. This apparent paradox is due to the fact that we know that the mother survived to at least the earliest age of reproduction, whereas an aunt may have died in infancy or childhood.

Conclusions

The above illustrations have demonstrated the influence of changes in death rates and in birth rates on the numbers of various kin. Not surprisingly, large reductions in fertility result in large decreases in the numbers of daughters, sisters, nieces, aunts and cousins who are ever born. Reductions in death rates both increase the numbers of kin ever born (particularly of nieces and of cousins) and raise the chances that each of these types of kin will be alive at a specified age of the reference person. The combination of a 50 per cent reduction in fertility and a 10-year increase in life expectancy, as in the Republic of Korea from the late 1950s to the late 1970s, shows the dominating effects of fertility: i.e., there is a substantial reduction in the numbers of living descendants and collateral kin throughout the life cycle of the reference woman.

On the other hand, from the reference woman's point of view, changes in fertility and mortality obviously have no effect on the number of parents, grandparents and great-grandparents who have ever been born. Declines in mortality, however, can greatly increase the survivorship of these kin. Hence, the net effect of a demographic transition is a reduction in the proportion of the family consisting of collateral kin—e.g., sisters and cousins—and an increase in the proportion composed of parents, grandparents and even great-grandparents. Via a set of simulation experiments, Ryder demonstrates that the transition from a high-fertility/high-mortality society to a low-fertility/low-mortality one is accompanied by an increase in the average person-years which each child spends together in the household with each parent and a slight decrease in the average time each child spends with a sibling.[18]

Although a number of demographers have evaluated the changes in household size and structure which result from decreases in fertility and mortality rates,[19] few have examined the emerging changes in the numbers and types of kin in the family. The potential social, psychological and economic implications of changing kinship structure are innumerable. For example, will the reduction in the number of sisters, aunts and cousins strengthen emotional and financial ties between parent and child, or between grandparent and child, and thereby strengthen parental influence over children? Or will non-relatives assume some of the social and economic responsibilities formerly assumed by family members? Caldwell and others[20] have argued that a reduction in fertility is in part a consequence of changes in the direction of intergenerational wealth flows—i.e., from one of child to parent to one of parent to child. But surely, the large changes in numbers and types of kin which result from a decline in fertility will in turn have their impact on the nature of the transfers of wealth.

Notes

[1] For example, L. G. Martin and S. Culter, "Mortality decline and Japanese family structure", *Population and Development Review*, vol. 9 (1983), pp. 633-649; S. H. Preston, "Demographic and social consequences of various causes of death in the United States", *Social Biology*, vol. 21 (1974), pp. 144-162; N. Goldman and G. Lord, "Sex differences in life cycle measures of widowhood", *Demography*, vol. 20 (1983), pp. 177-195.

[2] L. A. Goodman, N. Keyfitz and T. W. Pullum, "Family formation and the frequency of various kinship relationships", *Theoretical Population Biology*, vol. 5 (1974), pp. 1-27.

[3] A. J. Coale and P. Demeny, *Regional Model Life Tables and Stable Populations* (Princeton, New Jersey, Princeton University Press, 1966); A. J. Coale and J. Trussell, "Model fertility schedules: Variations in the age structure of childbearing in human populations", *Population Index*, vol. 40 (1974), pp. 185-258.

[4] The formulas presented here and in Goodman and others, *loc. cit.*, are based on the assumption that the birth rate for women age x is $m(x)$, regardless of whether the woman has had a birth at age y, $y \neq x$. This is equivalent to assuming a non-homogeneous Poisson process of births and, in the absence of mortality, yields a variance of family size equal to the mean family size. For a discussion of alternative possibilities for $m(x)$, see L. A. Goodman, N. Keyfitz, and T. W. Pullum, "Family formation and the frequency of various kinship relationships", addendum, *Theoretical Population Biology*, vol. 8 (1975), pp. 376-381.

[5] See, for example A. J. Coale, L. J. Cho, and N. Goldman, "Estimation of recent trends in fertility and mortality in the Republic of Korea", report No. 1, National Research Council, Committee on Population and Demography, National Academy of Sciences (Washington, D.C., 1980).

[6] See, for example, N. Keyfitz, *Applied Mathematical Demography* (New York, John Wiley and Sons, 1977); N. Goldman, "The demography of kin", unpublished doctoral dissertation, Harvard University, 1977.

[7] Coale and Demeny, *op. cit.*

[8] Coale and Trussell, *loc. cit.*

[9] Martin and Culter, *loc. cit.*

[10] Preston, *loc. cit.*

[11] See, for example, D. Heer and D. Smith, "Mortality level, desired family size and population increase", *Demography*, vol. 5 (1968), pp. 104-121.

[12] S. Krishnamoorthy, "Mortality level, desire for surviving son and rate of population increase", *Demography*, vol. 33 (1979), pp. 565-571.

[13] For example, a two-year reduction in the mean age of childbearing (from 28 to 26 years) increases the proportion of surviving sisters, nieces, aunts and cousins by 0.2, 0.5, 9.8, and 3.2 per cent, respectively; similarly, an increase of one in the GRR (from 2 to 3 girls) increases these proportions by 0.6, 0.1, 5.2, and 1.3 per cent respectively. These calculations are based on model fertility schedules (Coale and Trussell, *loc. cit.*, and model life tables (Coale and Demeny, *op. cit.*). In the first example, GRR=2 and e_0=50; in the second example, mean age of childbearing =28 and e_0=50.

[14] See, for example, A. J. Lotka, "Orphanhood in relation to demographic factors: A study in population analysis", *Metron*, vol. 9 (1931), pp. 37-109; W. Brass and K. Hill, "Estimating adult mortality from orphanhood", *International Population Conference, Liège, 1973* (Liège, International Union for the Scientific Study of Population, 1973), vol. 3, pp. 111-120; W. Brass and A. J. Coale, "Methods of analysis and estimation", in *The Demography of Tropical Africa*, W. Brass and others, eds. (Princeton, New Jersey, Princeton University Press, 1968), pp. 88-142.

[15] Calculations based on a model fertility schedule with a mean age of childbearing =28 and GRR=2.

[16] These values are approximations which use the non-integral numbers of kin given in table 2 and are based on the omnipresent assumption that survival of one kin is independent of the other.

[17] Keyfitz, *op. cit.*

[18] N. B. Ryder, "Reproductive behavior and the family life cycle", in *The Population Debate: Dimensions and Perspectives*, papers of the World Population Conference, Bucharest, 1974, vol. II (United Nations publication, Sales No. E/F/S.75.XIII.5), pp. 278-288.

[19] For example, T. Burch, "The size and structure of families: A comparative analysis of census data", *American Sociological Review*, vol. 32 (1967), pp. 347-363; see also Goldman, *op. cit.*

[20] John C. Caldwell, "Toward a restatement of demographic transition theory", *Population and Development Review*, vol. 2 (1976), pp. 321-366.

IX. EFFECTS OF MORTALITY DECLINES ON MARRIAGE PATTERNS IN DEVELOPING COUNTRIES

Samuel H. Preston and Michael A. Strong**

The relative prevalence of the married state in a population has many social and demographic implications. In many developing countries, the family is the fundamental social unit that organizes the production, distribution, and exchange of goods and services. The core relationship in family systems nearly everywhere is that between the husband and wife, who are responsible for adding other family members through births. Societies are organized in such a way that important privileges and responsibilities attach to the role of husband and wife, particularly in the area of sexual relations and child-raising.

The prevalence of the married state is thus an indicator of the degree to which individuals are both able and willing to perform a central social role and to enjoy the fruits thereof. Two concepts of prevalence are relevant here: prevalence in a population at a moment in time; and prevalence over the course of life of an individual. Quantitative measures of these two concepts can be quite different, because marriage prevalence varies greatly with age and because the age distribution of persons in the population can be very different from the age distribution of years lived in a life cycle. In fact, developing countries today present a situation of extreme disparity between the two age distributions. Because of a recent history of rapid population growth, the age distribution of a population is nearly always much younger than the age distribution of years to be lived in the life cycle of a person in that population.

What has created such rapid population growth and the large disparity between populations and life cycles is a history of very rapid mortality decline in most developing countries during the 20th century and especially since the Second World War. Life expectancy, at least for developing countries as a whole, has risen from an estimated 42.4 years in 1950-1955 to 57.0 years in 1980-1985.[1] It would be surprising if such a large change in the volume of life both in populations and in life cycles had not left an imprint on marriage behaviour. Yet we find very few attempts to examine the connection between mortality and marriage, and none that are comparative in scope.[2]

The purpose of this paper is to provide an initial assessment of the role of mortality levels and change in both population and life cycle marriage prevalence in developing countries. Rather than painting a fine-grained picture for one or two countries, we have chosen to draw a somewhat cruder picture for a large number of countries. In particular, we will content ourselves with examining census and survey data on marital status, rather than data on the flows of population into and out of the various marital categories. These latter data are available in reasonable detail and completeness for only a few developing countries in any event.

Formal demographic analysis of the relation between mortality change and nuptiality is quite complex, because the relation depends upon the age- and sex-specific nature of the mortality change, as well as on the current characteristics of the population. Furthermore, the effects vary through time and are often quite different in populations and in life cycles. These relations have never been sketched out, however, and they are essential, perhaps more than any empirical demonstration, to an understanding of the processes. Therefore, we will devote much of the paper to presenting some basic formal considerations of mortality/nuptiality linkages. We use explicitly throughout a two-sex model, unlike several other attempts to deal with the issues. Our interest is in males as much as in females. The absence of a systematic set of studies of male marriage patterns is one of the most glaring deficiencies in demographic literature.

A. THE FORMAL DEMOGRAPHY OF RELATIONS BETWEEN NUPTIALITY AND MORTALITY

We will assume that we are dealing with a monogamous society. Therefore, the number of married males at a moment in time will equal the number of married females. Let us define the following terms:

$M(a)$	=	number of males aged a;
$m(a)$	=	proportion of males aged a who are currently married;
$M^*(a)$	=	number of married males at age a;
$F(a)$	=	number of females aged a;
$f(a)$	=	proportion of females aged a who are currently married;
$F^*(a)$	=	number of married females at age a;
M,F	=	total number of males and females;
M^*, F^*	=	total number of married males and females, respectively;
$P_M(a), P_F(a)$	=	probability of surviving from birth to age a in the period life table for males and females respectively;
$r_M(a), r_F(a)$	=	growth rates at age a for males and females respectively.

Each of these functions prevails at a particular moment t, so that we could write $F(a,t)$, $M^*(t)$ etc. We have dropped the t identification for convenience.

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The number of married males at age a is

$$M^*(a) = M(a)\, m(a)$$

and the total number of married males is

$$M^* = \int_0^\infty M(a)\, m(a)\, da.$$

By a recent theorem (Preston and Coale, 1982) we know that, in a closed population,

$$M(a) = M(o) e^{-\int_0^a r_M\ (x)\, dx} P_M(a).$$

Therefore,

$$M^* = \int_0^\infty M(o) e^{-\int_0^a r_M\ (x)\, dx} P_M\ (a)\, m(a) da.$$

The proportion of males married in the population is

$$\frac{M^*}{M} = \frac{\int_0^\infty e^{-\int_0^a r_M\ (x)\, dx} P_M\ (a)\, m(a)\, da}{\int_0^\infty e^{-\int_0^a r_M\ (x)\, dx} P_M\ (a)\, da}. \quad (1)$$

In the life cycle of an individual subject for all of his life to the mortality schedule of the period, $P_M(a)$, and to the nuptiality schedule of the period, $m(a)$, he will live

$$LM^* = \int_0^\infty P_M\ (a)\ m\ (a)\ da$$

years in the married state and a total of

$$LM = \int_0^\infty P_M(a)\ da$$

years altogether, so that he spends the proportion

$$\frac{LM^*}{LM} = \frac{\int_0^\infty P_M\ (a)\ m(a)\ da}{\int_0^\infty P_M\ (a)\ da} \quad (2)$$

years of his life married. There are, of course, exactly equivalent expressions for females. For example, the proportion of the female life cycle spent in the married state is

$$\frac{LF^*}{LF} = \frac{\int_0^\infty P_F\ (a)\, f(a) da}{\int_0^\infty P_F\ (a) da}.$$

We can see immediately that the expression for the prevalence of marriage in the population, equation (1), is very similar to the expression for the prevalence of marriage in the life cycle, equation (2). The only difference is that the population expression includes, for example in the male case, the term $r_M(x)$, the age-specific growth rate for males. If $r_M(x) = 0$ at all ages (as in a stationary population), then the two expressions would be identical: individual marital life cycles would simply be expected to recapitulate the population age structure of married persons (see Preston, 1982,[3] for a discussion of this point).

We are constrained by the fact that the number of married males must equal the number of married females:

$$M^* = \int_0^\infty M(o) e^{-\int_0^a r_M\ (x) dx} P_M\ (a) m(a) da$$

$$= \int_0^\infty F(o) e^{-\int_0^a r_F\ (x) dx} P_F\ (a) f(a) da = F^* \quad (3)$$

B. Change in Mortality Uniform by Age and Sex

We now have a framework for examining the impact of changes in mortality on nuptiality. We first consider only the effects that operate through age-sex distributions. The population is presumed to try to maintain the same marital proportions by age ($m(a)$ and $f(a)$) after the change in mortality, under the assumption that these schedules reflect some sort of "preferences" for marriage under the existing marriage market constraints. Our emphasis is on studying how changes in mortality alter those constraints and, in turn, force an alteration in $m(a)$ and $f(a)$. Let us consider first the simplest case, in which the change in mortality is uniform by age and sex.

In particular, let us assume that the age-specific death rate at all ages and for both sexes declines by amount K. Then the new survival functions (designated with a prime) become

$$PM'(a) = P_M\ (a) e^{Ka}$$

$$PF'(a) = P_F\ (a) e^{Ka}.$$

What happens to the age-specific growth rate function? With K fewer deaths per person per year, the age-specific growth rate rises by K per year (just as the growth rate for all ages combined rises by the amount of decline in the crude death rate, K). The rate of growth of the annual number of births rises by K as well because of the greater survivorship of reproductive aged persons. One year after the decline in mortality, the number of persons arriving at any age x is greater by the factor e^K; the second year it is greater by e^{2K}; the third year by e^{3K}; and so on. Relative to the number arriving at that age a year earlier, it is always greater by e^K, so that the growth rate is permanently higher at every age by K.

Therefore, at the time of the change in mortality (and at any time thereafter as long as $r_M(a)$ or $r_F(a)$ are understood to be the functions that would have prevailed in the absence of a mortality change),

$$r'_M\ (a) = r_M\ (a) + K$$

$$r'_F\ (a) = r_F\ (a) + K.$$

What effect does this change in mortality have upon the proportion married among the male and female populations? Inserting the expressions for $P'_M(a)$, and $r'(a)$ into equation (1), we find that

$$\frac{M^{*\prime}}{M'} = \frac{\int_0^\infty e^{-\int_0^a r_M(x)\,dx} e^{-Ka} P_M(a) e^{Ka} m(a) da}{\int_0^\infty e^{-\int_0^a r_M(x)\,dx} e^{-Ka} P_M(a) e^{Ka} da} = \frac{M^*}{M}.$$

The terms in e^{Ka} and e^{-Ka} cancel and no change whatsoever occurs in M^*/M. Likewise, these terms cancel to leave F^*/F unaffected. Male and female births grow faster at rate K so that T years after the change,

$$M'(o) = M(o)e^{KT}$$
$$F'(o) = F(o)e^{KT}.$$

The terms in e^{KT} cancel out of the monogamy constraint (3) so that no disparity occurs between the number of married males and married females.

In other words, when there is a mortality decline of equal amount for all ages and sexes, nothing need change in the marriage market. The market simply grows larger, while age-sex ratios are unaffected. There is no necessary behavioural response to the changes, since supply and demand conditions in the marriage market are unaffected. Note that this result pertains in any population, and not just in the highly restrictive class of stable populations.

Results are quite different, however, in the life cycle of marriage. Although age-specific marriage proportions remain the same, a mortality decline results in a higher fraction of life being lived at older ages. Thus, these ages receive higher weight in the marriage life cycle. To demonstrate this explicitly, let us insert the new mortality function in equation (2), which expresses the proportion of life spent in the married state:

$$\frac{LM^*}{LM} = \frac{\int_0^\infty P_M(a)e^{Ka}m(a)da}{\int_0^\infty P_M(a)e^{Ka}da}. \qquad (4)$$

Since K can take on a value of zero, as in the pre-decline population, we can differentiate (4) with respect to K about a K=0 in order to develop an expression for the effect of mortality change on the proportion of years spent married:[3]

$$d\left[\frac{LM^*}{LM}\right] = \frac{LM^*}{LM}(A_{MM} - A_{ML})$$

or

$$d\,ln\left[\frac{LM^*}{LM}\right] = (A_{MM} - A_{ML})dK. \qquad (5)$$

where A_{MM} = mean age of married males in the stationary population corresponding to $P_M(a)$ and $m(a)$;

A_{ML} = mean age of all males in the stationary population corresponding to $P_M(a)$.

So the proportion of life spent in the married state will rise when an age-sex-neutral mortality decline occurs. The increase will equal (for small declines) the size of decline in death rates times the average number of years by which the age of a married male in the stationary population exceeds the age of a randomly-chosen male. For example, if married males are 25 years older than average in the stationary population and death rates decline by 2/1000, then the proportion of life spent married will rise by

$$d\,ln\left[\frac{LM^*}{LM}\right] = 25(.002) = .05$$

or by 5 per cent.

The proportion of life spent unmarried will correspondingly decline by

$$d\,ln\left[\frac{LUM^*}{LUM}\right] = (A_{MUM} - A_{ML})\,dk \qquad (6)$$

where LUM^* is the number of years of life spent in the unmarried state for males and A_{MUM} is the mean age of unmarried males in the stationary population. There are, of course, exactly equivalent expressions to (5) and (6) for females.

In order to give flesh to these formulas, table IX.1 presents values of the amount by which the mean age of married persons exceeds that of all persons in various stationary populations ($A_{MM} - A_{ML}$). These hypothetical populations are constructed by combining proportions married by age in different empirical populations with model age distributions drawn from model life tables.[4]

For males, the age difference is usually on the order of 11-15 years and shows relatively little variation with mortality level or region. This means that the first order effect of a decline in death rates by .002 or 2 per 1,000 is to increase the proportion of the male life cycle spent married by .022 to .030. We refer to proportions only; the number of *years* spent married obviously increases even faster.

For females, the changes are substantially less. The age differences between married females and all females is usually in the range of 5-9 years, only about half the difference observed for men. This reflects the fact that women universally marry at a younger average age than men, and the related fact that there are very large proportions of unmarried females—usually widows—at older ages in developing countries. One clear consequence is that mortality decline has less advantageous first-order life cycle effects for females than for males, if time spent unmarried is considered disadvantageous.

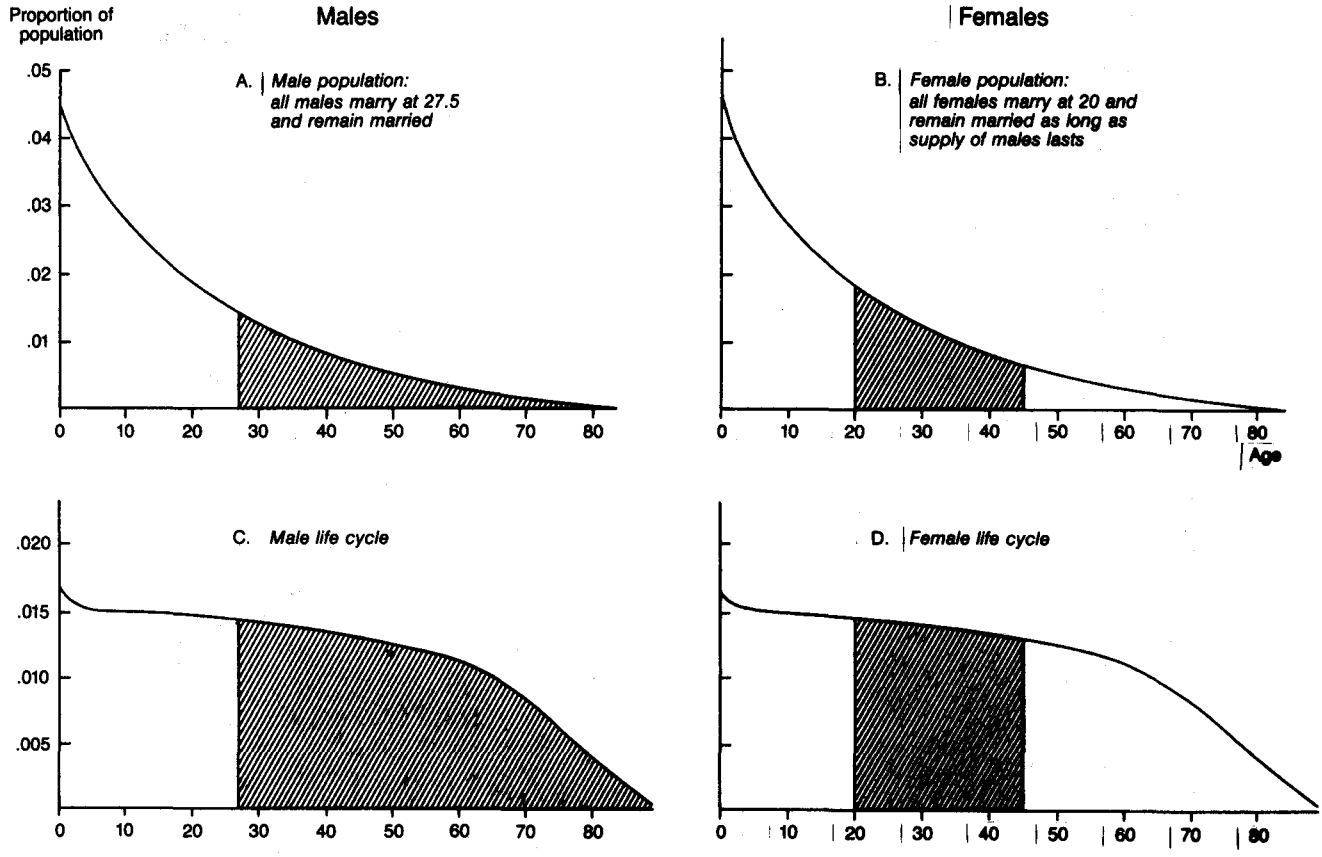
One fascinating implication made clearer by these results is the inappropriateness of a marriage system with very large age differences between spouses for maximizing the volume of marriage in the female life cycle. As noted above, in a stationary, zero-growth population, marriage behaviour in the life cycle simply recapitulates that in the population at a moment in time. But rapid population growth drives an enormous wedge between the two, so that the monogamy constraint that operates at the population level can produce large disparities in life cycle performance. The situation in most developing countries is illustrated with hypothetical stable population data in figure IX.1. The population has life expectancy of 60 (for both sexes), a sex ratio at birth of 1.00 and is growing at a rate of .035 per year (a Coale-Demeny (1966) female "West" population age structure is used for this purpose). This

TABLE IX.1. COMPARISON OF MEAN AGES OF ALL PERSONS AND MARRIED PERSONS, BETWEEN DIFFERENT MORTALITY PATTERNS AND VARIOUS NATIONAL NUPTIALITY PATTERNS

Country or area	"West" model life tables					
	Level 9		Level 13		Level 17	
	Males 37.3	Females 40.0	Males 47.1	Females 50.0	Males 56.5	Females 60.0
	Panel 1: Mean age of married persons, assuming national nuptiality pattern and model mortality pattern					
Kenya, 1979	45.2	40.2	46.8	41.4	48.1	42.5
Mauritius, 1972	45.5	40.0	46.9	40.9	48.0	41.7
Reunion, 1967	44.9	40.8	46.4	41.7	47.6	42.5
Bangladesh, 1976	44.3	36.0	45.8	36.9	47.1	37.7
India, 1971	42.5	37.0	44.1	38.1	45.3	38.9
Nepal, 1976	41.5	37.2	43.0	38.3	44.3	39.3
Pakistan, 1975	44.3	39.6	45.8	40.8	47.0	41.8
Philippines, 1978	45.3	42.7	46.8	43.8	48.0	44.7
Republic of Korea, 1975	46.0	40.9	47.4	41.8	48.5	42.5
Singapore, 1970	45.8	41.1	47.2	42.0	48.3	42.7
Sri Lanka, 1975	46.7	42.4	48.2	43.4	49.3	44.3
Thailand, 1975	43.9	41.0	45.3	42.1	46.5	43.1
Egypt, 1976	45.8	39.5	47.2	40.5	48.4	41.3
Libyan Arab Jamahiriya, 1973	44.7	38.7	46.3	39.7	47.5	40.6
Morocco, 1971	44.9	38.1	46.5	39.1	47.8	39.9
Tunisia, 1975	46.1	40.8	47.6	41.8	48.8	42.6
Bahamas, 1970	45.0	38.8	46.6	39.8	47.8	40.7
Costa Rica, 1973	45.0	42.0	46.6	43.2	47.8	44.3
Cuba, 1970	44.5	41.6	46.1	42.9	47.4	44.0
Dominican Republic, 1975	45.8	40.7	47.5	41.9	48.8	43.0
Haiti, 1971	48.0	43.5	49.6	44.8	50.9	45.9
Mexico, 1976	44.0	41.0	45.6	42.1	46.8	43.1
Panama, 1970	45.2	41.5	46.9	42.8	48.2	43.8
Argentina, 1970	45.3	42.2	46.8	43.4	48.0	44.4
Chile, 1970	44.8	41.6	46.3	42.7	47.5	43.6
Colombia, 1977	45.6	40.9	47.2	42.0	48.5	42.9
Guyana, 1970	44.3	40.7	45.9	41.9	47.1	42.8
Peru, 1977	45.2	42.1	46.7	43.3	47.9	44.3
	Panel 2: Difference between mean ages of married persons (panel 1) and mean ages of all persons in the underlying stationary population given as:					
	30.4	*31.6*	*32.7*	*34.0*	*34.6*	*35.9*
Kenya, 1979	14.8	8.5	14.1	7.5	13.4	6.5
Mauritius, 1972	15.0	8.3	14.1	6.9	13.3	5.7
Reunion, 1967	14.5	9.1	13.7	7.8	13.0	6.6
Bangladesh, 1976	13.8	4.4	13.1	2.9	12.4	1.7
India, 1971	12.1	5.4	11.3	4.1	10.7	3.0
Nepal, 1976	11.1	5.6	10.3	4.4	9.6	3.3
Pakistan, 1975	13.9	8.0	13.1	6.8	12.3	5.9
Philippines, 1978	14.9	11.1	14.0	9.9	13.3	8.8
Republic of Korea, 1975	15.6	9.2	14.6	7.8	13.8	6.6
Singapore, 1970	15.4	9.5	14.4	8.0	13.6	6.8
Sri Lanka, 1975	16.3	10.7	15.4	9.4	14.7	8.3
Thailand, 1975	13.4	9.4	12.6	8.2	11.9	7.1
Egypt, 1976	15.3	7.9	14.5	6.5	13.8	5.4
Libyan Arab Jamahiriya, 1973	14.3	7.0	13.5	5.8	12.9	4.7
Morocco, 1971	14.5	6.5	13.8	5.1	13.1	4.0
Tunisia, 1975	15.7	9.1	14.9	7.8	14.2	6.6
Bahamas, 1970	14.6	7.2	13.8	5.9	13.2	4.8
Costa Rica, 1973	14.6	10.3	13.9	9.3	13.2	8.3
Cuba, 1970	14.1	9.9	13.4	9.0	12.8	8.1
Dominican Republic, 1975	15.3	9.0	14.7	8.0	14.1	7.0
Haiti, 1971	17.5	11.9	16.9	10.9	16.3	9.9
Mexico, 1976	13.6	9.3	12.8	8.2	12.2	7.1
Panama, 1970	14.8	9.8	14.2	8.8	13.6	7.9
Argentina, 1970	14.9	10.6	14.1	9.4	13.4	8.4
Chile, 1970	14.3	10.0	13.5	8.8	12.8	7.7
Colombia, 1977	15.2	9.3	14.5	8.1	13.8	7.0
Guyana, 1970	13.9	9.1	13.1	7.9	12.5	6.9
Peru, 1977	14.7	10.5	13.9	9.3	13.2	8.3

Source: National censuses of population.

Figure IX.1. Marriage in a hypothetical population with life expectancy at birth of 60 years, growing at 3.5 per cent annually and having a sex ratio at birth of unity



Shaded area: married population

is a rapid growth rate but is well within the range of human experience. All males above age 27.5 are assumed to be currently married in the population. All women first marry at 20 and stay married up to the age where they exhaust the supply of married males. In the hypothetical population, this upper age limit for females being married is age 44.5. This age leaves a small fraction of the adult female *population* unmarried, but a very large fraction of the female *life cycle* unmarried. In our example, 52 per cent of expected years beyond age 20 are to be spent unmarried, even though all women marry at 20. In contrast, males (who have in this example the same mortality conditions) spend only 18 per cent of their lives beyond age 20 as unmarried persons. Thus, by postponing marriage to age 27.5, males nearly double the amount of time beyond age 20 that they spend married. This same option is clearly open to females. Each year that first-marriage is delayed means roughly 1.6 additional years that women can expect to be married.

The logic here is not unlike that of interest on investment; by delaying consumption, there is more to consume. In this case the equivalent to interest is population growth. By delaying marriage *to the same age group* of males, a cohort of women would have a larger cohort of males to attach themselves to, hence would have more years of male marriage to share amongst themselves. These ironic results are a consequence of the enormous wedge that mortality decline drives between population age-sex distributions and cohort age-sex distributions. Note that these results pertain to marriage systems, and not to individuals within a particular system who may be quite reasonable in believing that the earlier they marry, the more years they can expect to spend married.

C. Decline in mortality uniform by sex but greater at younger ages

If the only non-neutral decline in mortality occurs below age 15, then there need be no immediate response in the marriage market, since the number of adults of marriageable age is unaffected by the decline. In the intermediate term, say 15 to 25 years after the mortality decline, an age distributional bulge will appear in the early marriageable ages. With equally large declines in age-specific mortality for males and females, their proportionate growth will be the same, age by age. Since female proportions married at ages 15-29 are higher than male proportions married in virtually every country, this mortality decline would, *ceteris paribus*, lead to a greater increase in the number of married females than of married males. Such a relative increase is of course impossible in the presence of a monogamy constraint, and either the female proportions married will have to decline at some ages or the male proportions married will have to rise. If the male response is not fully compensating, the result will be a mortality-

induced "marriage squeeze" on women. Just such a phenomenon has been suggested as a major reason for declining female marriage in Hong Kong by Salaff[5] and in Sri Lanka by Fernando.[6]

Table IX.2 shows clearly that the changing availabilities were not confined to these countries. In order to make vivid the forces that have been at work, we choose for illustrative purposes a relatively large age gap of 10 years between spouses. Table IX.2 shows that an enormous increase of 18.5 per cent took place between 1950 and 1975 in the ratio of women aged 15-19 to men aged 25-29 in developing countries as a whole. This major and widespread alteration of conditions of marriage availability seems to have escaped attention altogether. Surely it must be at least partially responsible for declining female marriage propensities in many countries, declines that are normally attributed to socio-economic modernization. The change in availability conditions was greatest by far in East Asia, where mortality declines were also far and away the largest.[1] Subsequently, we will try to suggest how marriage behaviour accommodated itself to this change.

The mortality decline concentrated at the young ages is not felt merely in the short and intermediate term, disappearing as the "bulge" ages. Instead, the decline induces a permanent rejuvenation of the population. In order to see this, assume that we are dealing with an initially stable population ($r(a) = r$ for all a) in the above formulas; a population with constant fertility and mortality and an age distribution implied by those conditions. Now impose a decline in infant mortality in the amount K for both sexes (mortality is assumed for analytic convenience to decline at the moment of birth: $a = 0$). The new survival function is

$$p'(a) = K\,p(a)\ a>0.$$

When this expression is inserted into equation (3), the terms in K cancel out so M^* still equals F^*. However, the growth rate, r, has also risen by an equal amount for the two sexes. Nothing guarantees that the equation will continue to hold after the rise in r unless we insert an adjustment term into the equation. Let us assume that the female marriage schedule, $f(a)$, adjusts to a change in availability conditions by scaling itself upwards or downwards by a scalar, λ. Then we have from (3), after cancelling the K's,

$$\int_0^\infty M(o)e^{-ra}p_M(a)da = \lambda\int_0^\infty F(o)e^{-ra}p_F(a)f(a)\,da.$$

Using implicit differentation on this expression, we find that

$$\frac{d\lambda}{dr} = AS_{MF} - AS_{MM} \qquad (7)$$

the difference between mean ages of married females and males in the stable populations corresponding to r and to the $p(a)$, $m(a)$ and $f(a)$ schedules. Equation (7) says that females will have a lower marriage propensity at each age when mortality drops in infancy ($AS_{MF} - AS_{MM}$ is negative) as long as married females are, on average, younger than married males in the stable population. The reason for this result is that the drop in youthful mortality makes the population younger; if married women are younger than married men, then the rise in the number of married women would exceed the rise in the number of married men when r rises, forcing an adjustment. This nascent excess supply of married women thus forces λ to fall. Table IX.3 presents the value of the mean age of married males and females in different populations. It is clear that the mean age of married men exceeds that of married women in every population. The differences are usually in the range of 6-10 years in Africa and South Asia, and 3-6 years elsewhere. Thus, a decline in youthful mortality would generally lead to a decline in proportions married by age for females, or a rise for males, in the amount of around six times the induced change in the growth rate.

What is the life cycle response to a decline in infant mortality? It is clear from inserting these new expressions into equation (2) that the K terms cancel out in

TABLE IX.2. CHANGES IN SEX RATIOS OF EARLY MARRIAGEABLE AGES IN DEVELOPING REGIONS, 1950-1975

Region/Year	Females aged 15-19 F	Males aged 25-29 M	Ratio, F/M	1975 F/M ratio / 1950 F/M ratio
Less developed countries				
1950	81 680	67 511	1.210	1.185
1975	15 573	108 568	1.434	
Africa				
1950	11 156	7 146	1.371	1.067
1975	20 758	14 203	1.472	
Latin America				
1950	8 128	6 401	1.270	1.127
1975	16 902	11 815	1.431	
East Asia (except Japan)				
1950	26 201	24 533	1.068	1.345
1975	52 554	36 580	1.437	
South Asia				
1950	36 059	28 326	1.273	1.120
1975	65 287	45 801	1.425	

Source: Demographic Indicators of Countries: Estimates and Projections As Assessed in 1980, Population Study No. 82 (United Nations publication, Sales No. E.82.XIII.5).

TABLE IX.3. MEAN AGE OF MARRIED MALES AND FEMALES IN DIFFERENT POPULATIONS

Region/ Country/Area	Year	Mean age of married: Males	Mean age of married: Females	Difference M − F
Africa				
Kenya	1979	42.2	34.8	7.4
Liberia	1974	43.8	33.9	9.9
Mauritius	1972	43.9	37.4	6.5
Reunion	1967	42.4	38.6	3.9
Egypt	1976	44.0	36.8	7.2
Libyan Arab Jamahiriya	1973	43.8	35.7	8.1
Morocco	1971	44.7	35.2	9.5
Tunisia	1975	45.8	37.9	7.9
Asia				
Bangladesh	1976	42.7	31.7	11.0
India	1971	40.4	34.2	6.2
Nepal	1976	39.0	33.6	5.4
Pakistan	1975	43.4	35.8	7.7
Philippines	1978	43.2	39.7	3.5
Republic of Korea	1975	43.0	38.7	4.3
Singapore	1970	43.8	38.5	5.3
Sri Lanka	1975	45.8	39.1	6.7
Thailand	1975	41.2	37.5	3.8
Caribbean				
Bahamas	1970	41.4	38.0	3.4
Costa Rica	1973	42.2	37.5	4.7
Cuba	1970	43.5	38.6	4.9
Dominican Republic	1975	42.6	35.4	7.2
El Salvador	1971	36.3	33.2	3.1
Haiti	1971	45.1	39.1	6.0
South America				
Honduras	1974	35.9	32.3	3.5
Mexico	1976	41.7	37.0	4.6
Nicaragua	1971	36.0	32.7	3.3
Panama	1976	39.5	37.3	2.2
Argentina	1970	45.5	41.9	3.7
Chile	1970	43.3	39.4	3.9
Colombia	1977	42.5	36.4	6.0
Guyana	1970	42.6	37.5	5.1
Peru	1977	43.5	38.7	4.8

Source: Demographic Indicators of Countries: Estimates and Projections As Assessed in 1980, Population Study No. 82 (United Nations publication, Sales No. E.82.XIII.5).

the numerator and denominator, leaving the prevalence of marriage in the life cycle unaltered. However, if as is likely the monogamy constraint in the population produces a change in $m(a)$ or $f(a)$, then the life prevalence will change accordingly. We have just seen that in both the short run and long run, the greater youthfulness of married women relative to married men means that either female marital proportions by age will decline or that male marital proportions will rise. Just as in the case of a neutral mortality decline, *the implications of declining mortality for the prevalence of marriage over the life cycle are far more advantageous for men than for women.*

A more precise quantitative picture of the amount of behavioural adjustment required in the long run is possible. In stable populations a decline in infant mortality produces a rise in growth rates equal (to a close approximation) to:[7]

$$\Delta r = \frac{-\Delta IM\Sigma}{A_B}$$

where A_B is the mean age of women at childbirth. If IMR drops by .100 and A_B is 28, the increment in the growth rate is .100/28 = .0036. If A_{MM} exceeds A_{MF} by 6 years, then the required change in female proportions married age-by-age would be

$$\begin{aligned} d\lambda &= dr(-6) \\ &= .0036(-6) = -.022. \end{aligned}$$

Female proportions married would have to decline by 2.2 per cent. This does not appear to be a large amount, but it should be remembered that we artificially restricted the mortality decline to infancy. We can expand the range to all ages below 15 by noting that, since $m(a)$ and $f(a) = 0$ below age 15, equation (3) can be rewritten as

$$P_M(15)\int_{15}^{x} M(o)e^{-ra}{}_{15}P_M(a)m(a)da$$

$$= P_F(15)\int_{15}^{x} F(o)e^{-ra}{}_{15}P_F(a)f(a)da \qquad (8)$$

where

$P_M(15), P_F(15)$ = male and female probabilities of survival to age 15;

$15P_M(a), 15P_F(a)$ = male and female probabilities of survival from age 15 to a, a>15.

If we now impose a decline in mortality below age 15 that is equal for both sexes,

$$P'_M\ (15) = K P_M\ (15)$$

$$P'_F\ (15) = K P_F\ (15)$$

the K's continue to cancel out of equation (8) but now

$$r = \frac{1n\,K}{28}\ .$$

When mortality improves from an $e_0=40$ to an $e_0=65$, K (the factor by which $p(15)$ is multiplied) is about 1.350,[4] so that

$$\Delta r = 1n\,1.350/28 = .011$$

$$d\lambda = \Delta r(-6) = -.066.$$

Female marriage proportions would have to decline by a non-trivial 6.6 per cent, male proportions rise by a similar amount, or some combination of the two changes would have to occur.

D. Decline in mortality uniform by sex but greater at older ages

If the only change in mortality occurs above age 50, then it is safe to assume that the mortality decline will have no effect on births or on age-specific growth rates below age 50. Thus, we can focus on the older population itself without worrying about the totality of ages as in the earlier sections. We will simplify the analysis here by dealing only with first marriages, which enables us to concentrate on the issue of widowhood, probably the most important connection between old-age mortality change and nuptiality. For convenience, we assume that the number of first marriages, and the proportions ever-marrying in a population will be unaffected by mortality declines above age 50. The concern, therefore, is with the survivorship of marriages. To simplify, we will assume that all males are age 25 at first marriage and all females are age 20. Assuming for illustrative purposes that husbands' and wives' mortality risks are equal to those of males and females in the population and are independent of one another, we know that the proportion of marriages that survive to duration x is

$$g(x) = {}_xP^F_{20} \cdot {}_xP^M_{25}\ ,$$

the product of the probabilities that a woman will survive x years beyond 20 and that a man will survive x years beyond 25. Suppose we now impose a mortality change in amount K at all ages above 50. Marriage survivorship is unaffected through the first 25 years. Beyond that,

$$g'(x) = g(x)e^{(x-50)k}\quad 50 < x < 55$$

and

$$g'(x) = g(x)e^{(x-50)k}\ e^{(x-55)k}\ x > 55.$$

We need not concern ourselves with availability constraints in the population because each added woman in a surviving first marriage is obviously accompanied by an added man. So we can proceed directly to the life cycle results. These are rather surprising. Table IX.4 shows the proportionate effects of the mortality decline on the number of married males and females, the number of males and females, and the proportions married by age. It assumes that the mortality decline has been in place for 20 years, so that (up to age 70) the numbers of persons have fully accommodated to the decline.

The table shows clearly that after a certain age, the number of first-married persons rises by a larger proportion than does the number of persons. The reason is, of course, that the survival of first-married persons is a product of joint survivorship risks, rather than of survival for one sex alone. What is perhaps surprising about the table is that the schedule of increases in the proportion married for males is displaced upwards by 10 years rather than by the 5 years that separates the ages of spouses.

Why should the age displacement in increments to proportions married be double the age displacement between spouses? The reason is that the proportions married for a particular sex don't begin to rise until their spouses pass the age where mortality has declined.

Table IX.4. Increases in the number of first-married persons by age and sex; number of persons and proportion first-married caused by age-specific death rate decline of amount K at all ages above 50

(Males are assumed to be age 25 at first marriage, females age 20)

	Exact ages				
	50	55	60	65	70
	Proportionate increases of numbers				
Females					
Number of first-married women	e^{5K}	e^{15K}	e^{25K}	e^{35K}	e^{45K}
Number of women	-	e^{5K}	e^{10K}	e^{15K}	e^{20K}
Proportion of women in first marriages	e^{5K}	e^{10K}	e^{15K}	e^{20K}	e^{25K}
Males					
Number of first-married men	-	e^{5K}	e^{15K}	e^{25K}	e^{35K}
Number of men	-	e^{5K}	e^{10K}	e^{15K}	e^{20K}
Proportion of men in first marriages	-	-	e^{5K}	e^{10K}	e^{20K}

This passage occurs, in our example, at age 45 for females and age 55 for males. This double magnification of age differences between spouses in regard to marital proportions would appear to be a relatively important phenomenon. It is obviously not limited to our example but pertains to any instance of fixed age differences between brides and grooms. It would not pertain to a mortality decline that is neutral at all ages, because then all spouses, regardless of age, would be eligible for the mortality reduction.

The results in table IX.4 pertain only to first marriages and overstate the net advantage for women that results from the mortality decline. The reason is that female remarriages become more difficult as a result of the mortality decline. Since the reduction in mortality produces the same number of additional males in first marriages as additional females, and since there are in all populations fewer unmarried males than unmarried females above age 50, the removal of equal numbers of males and females from the remarriage pool by virtue of greater survivorship of first marriages increases the ratio of unmarried females to unmarried males over age 50. It is reasonable to presume that this increased ratio makes it harder for females and easier for males to remarry. This negative effect on remarriage for females would not totally offset the effect of increased marital survivorship on the $f(a)$ function unless all those whose marriages were "saved" would have instantaneously remarried upon widowhood. (This assumption is made implicitly in section B above).

Table IX.5 summarizes the effects of the three different kinds of mortality declines that we have considered on the life cycle prevalence of marriage. Being married is in most societies a preferred state for adults, so that an increase in the prevalence of marriage that results from improved opportunities for marriage is viewed here as a desirable outcome. All of the forms of mortality decline are expected to increase the proportion of life spent married. First, mortality declines skew the life cycle away from younger ages, where marriage prevalence is low. Secondly, mortality declines that are concentrated at older ages reduce the incidence of widowhood. Third, even declines that are concentrated at the very early ages are an advantage for males because, by changing the age structure of the population, they increase the relative availability of females, who marry at a younger average age.

This latter factor obviously works to the disadvantage of females, whose age-specific proportions married are likely to fall because of availability factors when a mortality decline occurs that is concentrated at young ages. Also, a mortality decline spread evenly over all ages is less advantageous for females than for males because the increasing life cycle skew towards older

TABLE IX.5. SUMMARY OF APPROXIMATE EFFECTS OF VARIOUS KINDS OF MORTALITY DECLINE ON PREVALENCE OF MARRIAGE IN POPULATIONS AND IN LIFE CYCLES

Kind of mortality decline	*Population response*	*Life-cycle response*
Decline in mortality of equal amount (K) at all ages	No change in proportions married by age	Proportionate increase in proportion of life spent married in amount of $K \times (A_M - A_p)$, or approximately $K \times 7$ for females $K \times 13$ for males
Decline in infant mortality by amount K	Proportions married by age decline for females or rise for males. If a proportionate adjustment is made by females alone, the proportionate decline in the steady state is $\frac{K}{A_B}(AS_{MM} - AS_{MF})$	Same as population response; results in decline in proportion of life spent married for females, a rise for males, or both
Decline in mortality by amount K at all ages above 50	Proportions currently in first marriage rise at older ages by, very approximately: $e^{K(a-50-G)}$ $a>50-G$ for females $e^{K(a-50+G)}$ $a>50+G$ for males	Same as population response; results in rise in proportion of life spent married for both sexes, larger for females

Symbols A_M: Mean age of married persons of a particular sex in the stationary population corresponding to current mortality conditions and proportions married by age

A_p: Mean age of the sex-specific stationary population corresponding to current mortality conditions

AS_{MM}, AS_{MF}: Mean ages of married males and females, respectively, in the stable population corresponding to current conditions of mortality and fertility and current proportions married

A_B: Mean age at childbearing in stable population

ages is superimposed upon a younger married female than married male population. Only the mortality decline concentrated at high ages is clearly more beneficial to female marital life cycles than to male. If one is alive, the probability of being in a surviving first marriage is a function of the age of one's spouse rather than of one's own age; women's spouses are older than men's on average, and have therefore been the recipient of more cumulative benefit from a mortality decline. The sex differential in effects can be large; we demonstrated that the male and female age-curves of rising proportions in surviving first marriages are displaced from one another by double the amount of displacement in ages at first marriage.

E. Mortality declines concentrated among one sex

A neutral mortality decline pertaining to only one sex does two things; it increases for that sex the fraction of life spent in the post-childhood ages where marital prevalence is highest and it creates a relative oversupply of that sex, which will tend to reduce proportions married age-by-age. These two effects obviously work in opposite directions. The oversupply effect operates even if the one-sex mortality decline produces more births of the opposite sex; added births will just serve to offset the added births among the sex enjoying the mortality decline (as male births are only about five per cent more than female births), with nothing left to offset that sexes' greater survivorship after birth.

Which of these effects will dominate? To answer this question, let us suppose that the mortality decline pertains to females and occasions no change in male or female births (results are not, as indicated above, substantially changed if the birth sequence is altered). Then the $r_F(a)$ and $F(o)$ functions in equation (3) are unaltered.[8] Let us also suppose that the number of married males stays fixed. Then we can write (3), after a neutral mortality change, as

$$F^* = \int_0^\infty F(o)\, e^{-\int_0^a r_F(x)dx} \lambda\, P_F(a) e^{Ka} f(a) da = M^*. \quad (9)$$

Now we implicitly differentiate (9) with respect to the mortality decline parameter, K, and find that

$$\frac{d\lambda}{d_K} = -A_{MF}$$

or the mean age of married females in the population. When $A_{MF} = 40$, a decline of .002 in all death rates would lead to a decline of

$$d\lambda = -40\,(.002) = -.08$$

or 8 per cent, in all age-specific marital proportions. This is a very large decline and swamps the effect operating in the opposite direction, whose magnitude from equation (5) is

$$dln\left[\frac{LF^*}{LF}\right] = [A_{FM} - A_{FL}]\, K$$

the *difference* between the mean ages of married females and all females in the stationary population.

So the effect of a neutral decline in mortality for one sex alone is to reduce the prevalence of marriage in the life cycle for that sex. In the above example, what we have basically done is to divide up the same number of married males amongst more women; it is not surprising that the proportion of women married in both the population and life cycle declines. It is possible, even likely, that men's marriage behaviour could adjust so that part of the added female years of life are absorbed by marriage; but the required adjustment is extremely large if the entire decline is to be absorbed in this fashion. In all cases, the sex enjoying the mortality decline will spend a smaller fraction of its life married; the total number of years spent married may rise if the opposite sex takes advantage of improved availability conditions by increasing its proportions married. We see here again that the marital life cycle for a particular sex is more favourably affected by the mortality decline for the opposite sex than for its own.

F. Recent changes in the prevalence of marriage in developing countries

Above, we explored the sensitivity of marriage behaviour to changes in mortality, using population mathematics that recognize the "monogamy constraint". Data were introduced on variables that were identified as important determinants of marriage sensitivity to mortality change. In this section, we leave behind the certitudes of mathematical identities and attempt to interpret data on recent changes in marriage structure in developing countries. We expect that mortality decline will change availability conditions adversely for females because

(*a*) They marry at younger ages than males and the mean age of currently married women is substantially less than that of currently married males in all countries for which data are available;

(*b*) Mortality decline typically makes a population younger in both the short run and the long run.

Therefore, we expect that, where marriage is decreasing in prevalence, decreases will be smaller for males; where it is increasing, increases will be larger for males. We do not attempt to deal with other socio-economic causes of marriage change (for a review, see Smith[9]). Furthermore, we are not able on a country-by-country basis to parcel out how much change in availability conditions is attributable to mortality change, to fertility change or to migration. This decomposition is extremely tedious and data required for satisfactory results are missing in most developing countries. Fertility change should not be an important source of disturbance in most places because our latest observations are usually in the early 1970s and pertain to the population over age 15, so that fertility decline would have had to begin before the mid 1950s to have an effect; such declines are rare (although fluctuations related to wars and other disturbances are more common).

Schoen has developed an index of relative availability conditions that uses vital statistics on marriage (hence is mainly applicable to developed countries) and compares actual populations to model populations at one point in time.[10] Here we use several simple indexes designed for use with census or survey data. We examine only countries with two observations because we are interested in change. Designate the first observation as 1 and the second as 2 and define

$_5m_x^1, {}_5f_x^1$ = proportions currently married at ages x to $x + 5$ at time 1 for males and females, respectively;

$_5M_x^1, {}_5F_x^1$ = number of males and females, respectively, at ages x to $x + 5$ at time 1;

M^1, F^1 = total number of males and females married at time 1;

EM^2, EF^2 = expected number of males and females married at time 2;

$$= \sum_{x=15}^{\infty} {}_5M_x^2 \cdot {}_5m_x^1 ,$$

$$\sum_{x=15}^{\infty} {}_5F_x^2 \cdot {}_5f_x^1 .$$

Our index of male marriage change will be

$$\frac{M^2 - EM^2}{EM^2} .$$

It is interpretable as the proportionate amount by which the number of married males at time 2 exceeds the expected number, when the expected number is derived by applying the age-specific proportions married at time 1 to the numbers of males by age at time 2.

Likewise, the index of female marriage change, analogously interpreted, is

$$\frac{F^2 - EF^2}{EF^2} .$$

Our index of change in availability conditions is

$$\frac{EM^2 - EF^2}{EF^2} .$$

It is interpretable as the proportion by which the number of married males would exceed the number of married females at time 2 if both sexes retained the same marriage proportions by age as they had at time 1. It is thus a measure of the degree to which growth in marriageable-age males exceeds that of marriageable-age females.

We applied these indexes to a wide variety of countries, using data from the 1950, 1960 and 1970 rounds of censuses as well as from The World Fertility Survey. We also applied a version of the indexes that focused on the younger end of the marriageable age-range, where the decline in relative male availability is expected to be greatest. In this version of the index, the female age-range terminates at age 40. The male age-range terminates at an age below which the number of married males equalled the number of married females below age 40 at time 1. The point of introducing this flexibility is to study male marriage in the male age-range that is roughly equivalent in marital connotations to the female age-range below 40; it also ensures that $M^1 = F^1$. Results using this alternate index were more clear-cut and straightforward and we will focus on it hereafter. Note that we have included among the "married" those who are reported as separated or living in a consensual union. Since we are comparing two data sources, a more inclusive definition gives results that are more robust to changes in classification systems.

Results of applying the indexes are shown in table IX.6. The results are generally consistent with expectations. In 22 of the 34 countries examined, the availability of males declines during the period under investigation. This tendency is consistent with faster growth induced by mortality decline for the female population of marriageable age, which is younger than the male. In some countries where male availability does not decline (e.g. Argentina and Uruguay), the reason is probably that effects of declining fertility more than offset the effects of mortality decline. In the Republic of Korea, war losses are clearly playing a role, and in other countries (as in the Syrian Arab Republic) migration is probably a factor. Nevertheless, the bulk of the change is in the direction of reduced male availability.

TABLE IX.6. CHANGES IN THE PREVALENCE OF MALE AND FEMALE MARRIAGE IN DEVELOPING COUNTRIES DURING RECENT DECADES AND CHANGES IN RELATIVE MALE AVAILABILITY PER FEMALE

Region/Country	*Upper bound of age range*		*Proportionate increase in male marriage*	*Proportionate increase in female marriage*	*Difference between male and female increase*	*Proportionate increase in male availability per female*
	M	*F*				
Latin America						
Argentina (1960-1970)	45.11	40.	.034	−.009	.043	.025
Brazil (1950-1970)	46.87	40.	.060	.029	.031	.010
Chile (1952-1970)	46.85	40.	.124	.068	.056	−.007
Colombia (1951-1976)	49.93	40.	.162	.075	.087	−.078
Costa Rica (1950-1973)	46.86	40.	.082	.056	.026	−.003
Cuba (1953-1970)	47.32	40.	.189	.131	.058	−.013
Dominican Republic (1960-1975)	52.99	40.	.171	.126	.045	−.094
Ecuador (1950-1974)	47.29	40.	.058	.079	−.021	.012
El Salvador (1950-1971)	49.46	40.	.119	.091	.028	.013
Guatemala (1950-1973)	48.00	40.	.052	.014	.038	−.009
Guyana (1960-1970)	47.50	40.	.014	−.053	.067	−.060
Haiti (1950-1971)	50.33	40.	.000	.000	.000	.015
Honduras (1961-1974)	50.06	40.	.141	.182	−.041	−.027
Mexico (1960-1976)	47.60	40.	.036	.036	.000	.037
Nicaragua (1950-1971)	50.21	40.	.132	.132	.000	.013
Panama (1950-1970)	49.17	40.	.162	.139	.023	−.036
Paraguay (1950-1972)	47.90	40.	.072	.138	−.066	.118
Peru (1961-1977)	47.03	40.	.055	.023	.032	−.015
Puerto Rico (1950-1970)	49.51	40.	.083	−.058	.141	−.049
Uruguay (1963-1975)	45.04	40.	.087	.058	.029	.002
Venezuela (1950-1971)	47.92	40.	.145	.029	.116	−.081

TABLE IX.6 *(continued)*

Region/Country	Upper bound of age range M	Upper bound of age range F	Proportionate increase in male marriage	Proportionate increase in female marriage	Difference between male and female increase	Proportionate increase in male availability per female
Africa						
Libyan Arab Jamahiriya (1954-1973)	51.73	40.	.174	.061	.113	−.048
Asia						
Bangladesh (1961-1974)	50.68	40.	−.033	−.038	.005	−.020
India (1961-1971)	47.40	40.	−.021	−.022	.001	−.010
Jordan (1961-1976)	54.35	40.	−.033	−.061	.028	−.036
Nepal (1961-1976)	49.56	40.	−.028	−.016	.012	−.018
Pakistan (1961-1973)	47.45	40.	−.095	−.099	.004	−.014
Philippines (1960-1978)	45.13	40.	−.078	−.114	.036	.013
Republic of Korea (1955-1975)	47.64	40.	−.152	−.163	.011	−.090
Singapore (1957-1970)	44.18	40.	−.098	−.228	.130	−.174
Sri Lanka (1963-1971)	48.50	40.	.007	−.040	.047	−.069
Syrian Arab Republic (1960-1970)	52.06	40.	.015	−.027	.042	.003
Thailand (1960-1975)	44.33	40.	.048	.018	.030	−.045
Turkey (1955-1975)	45.52	40.	−.058	−.088	.030	−.006

Source: National censuses of population and World Fertility Survey.

How have marriage systems reacted to this change? Obviously it is not possible to isolate the effects of mortality change or even of availability changes. But it is clear that results are in the direction that would be expected if availability changes were in some important sense driving marriage systems. In 28 out of 34 countries, the prevalence of marriage for females in the ages below 40 deteriorated relative to males in their equivalent age-range. In only three of 34 countries did the relative female prevalence of marriage increase.

Is the size of the change in availability related to the size of the sex differential in marriage change? Figure IX.2 suggests that there is indeed a connection between the change in availability and the sex differential in marriage change. Countries where the relative availability of males deteriorated the most had, on an average, the largest increases in male marriage propensity relative to female. The possibility that an important mortality-induced "marriage squeeze" is operating on a broad range of countries is clearly supported by this relationship. In nine countries, the reduction in male availability exceeded 4 per cent (their average reduction was 7.8 per cent), and in all nine countries female marriage declined relative to male, with the average decline being 8.6 percentage points. These are very large changes in marriage and suggest a non-trivial role for availability conditions in explaining marriage change in a sizable number of countries.

The changes in male availability can be accommodated by an increased male marriage prevalence a reduced female marriage prevalence or some combination of the two. Our results suggest that reactions have been very different in Latin America than they have been in Asia. In each of the 20 Latin American countries, the prevalence of male marriage rose between the observations. In Asia and Africa, on the other hand, male marriage rose in only four of 13 countries. Here the change in availability conditions was principally accommodated by a sharp reduction in female marriage, which exceeded the male reduction (the female change index fell short of the male) in all of the 13 countries. The sharp rise in male marriage in Latin America in the past several decades has received almost no comment from demographers; the sharp fall in female nuptiality in Asia is more widely known. But it is clear that both phenomena are to some extent products of, or are at least conditioned by, a rather pervasive marriage squeeze in developing countries that was induced by mortality reduction.

NOTES

[1] *Demographic Indicators of Countries: Estimates and Projections as Assessed in 1980,* Population Study No. 82 (United Nations publication, Sales No. E.82.XIII.5), p. 62.

[2] Harold Hansluwka, "Mortality and the life cycle of the family: some implications of recent research", *World Health Statistics Report,* vol. 29 (1976), pp. 220-227.

[3] S. H. Preston, "Relations between individual life cycles and population characteristics", *American Sociological Review,* vol. 47 (1982), pp. 253-264.

[4] A. J. Coale and P. Demeny, *Regional Model Life Tables and Stable Populations* (Princeton, New Jersey, Princeton University Press, 1966).

[5] Janet Salaff, "The status of unmarried Hong Kong women and the social factors contributing to delayed marriage", *Population Studies,* vol. 30, No. 3 (1976), pp. 391-412.

[6] Dallas Fernando, "Changing nuptiality patterns in Sri Lanka, 1901-71", *Population Studies,* vol. 26, No. 3 (1975), pp. 445-454.

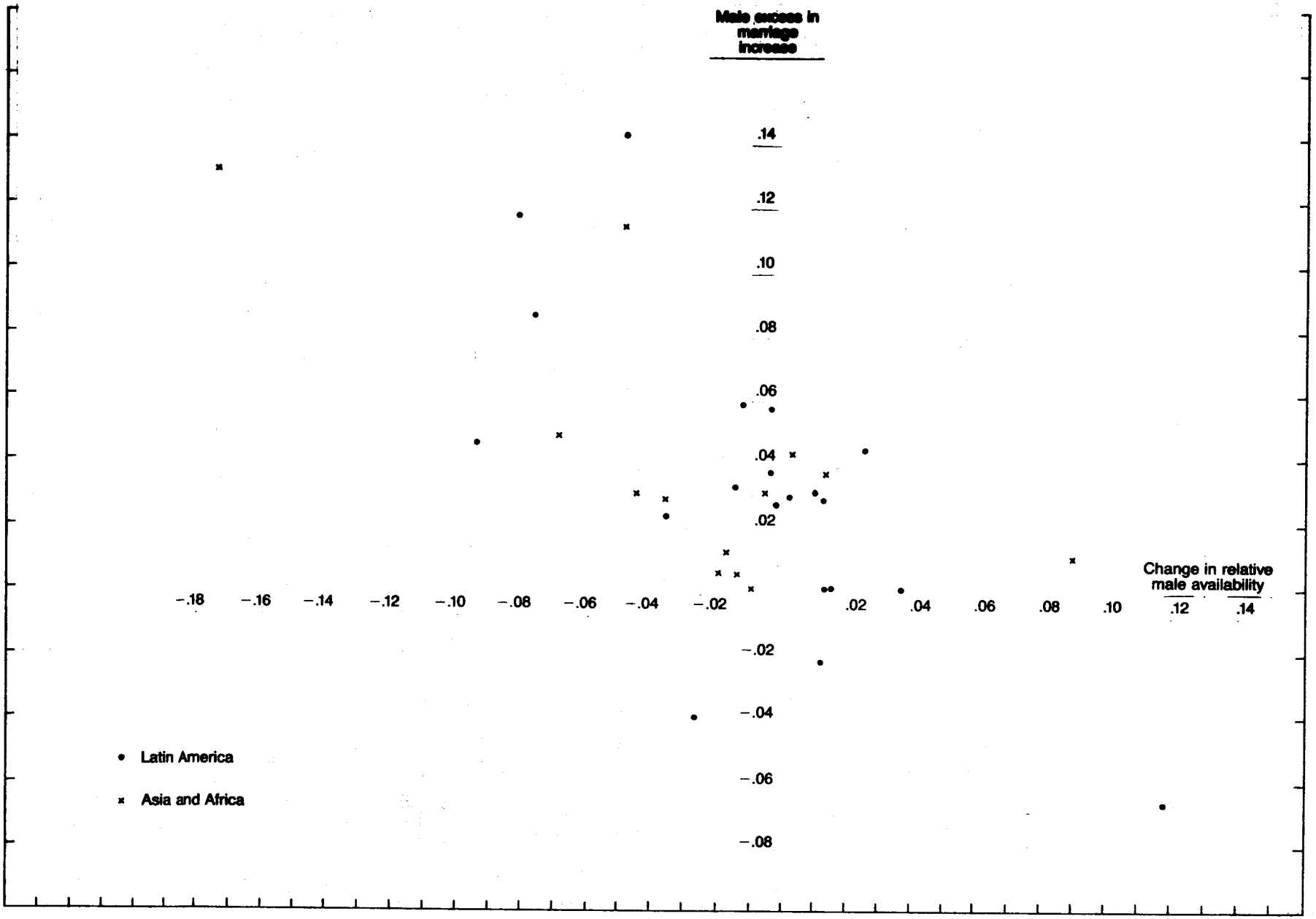
[7] S. H. Preston, "Effects of mortality change on stable population parameters", *Demography,* vol. 11, No. 1 (1974), pp. 119-130.

[8] $^4r_F(a)$ increases in the short run, but eventually the age distribution accommodates to the mortality change and incremental growth disappears. $r_F(a)$ is affected by the growth of births a years earlier and by *changes* in mortality over the past a years. See Shiro Horiuchi, "How do age-specific growth rates reflect the impacts of the past history upon the current age structure?", paper presented at the annual meeting of the Population Association of America, Minneapolis, May 1984. Eventually no mortality change will have occurred in the lifetime of persons currently alive, and $r_F(a)$ will be the same as it would have been without the mortality decline.

[9] Peter Smith, "Asian marriage patterns in transition", *Journal of Family History,* vol. 5 (1980), pp. 58-96.

[10] Robert Schoen, "Measuring the tightness of a marriage squeeze", *Demography,* vol. 20, No. 1 (February 1983), pp. 61-78.

Figure IX.2. Scatter-plot of changes in male availability and changes in male marriage prevalence relative to female



X. THE RESIDENTIAL LIFE CYCLE: MORTALITY AND MORBIDITY EFFECTS ON LIVING ARRANGEMENTS

*Christabel M. Young**

The increased probability of surviving to the older ages coupled with the decline in fertility that has been occurring in many countries has contributed to an increased proportion of the elderly in many countries of the world. As those trends continue, projections of the world population profile point to a future further increase in the elderly component, with particularly large increases expected in the developed countries when the post-war "baby-boom" cohort reaches age 65 years, and in the developing countries when the cohorts born before the onset of the decline in fertility reach the older ages. The growing awareness of the increasing proportion of aged persons in the population has brought with it concern about the future needs of those people and, particularly, about who will be responsible for their care and living arrangements.[1]

While the proportion surviving to age 65 years was considerably higher in the more developed countries in comparison with the less developed countries in the earlier years of this century, the improvement in survival in some of the developing countries has occurred at a very rapid rate, and some are now approaching the levels in the more developed nations. Overall, there has been a gradual convergence, so that around 75 per cent of males and 85 per cent of females are now surviving to age 65 years, compared with levels of 40-50 per cent of males and 50-60 per cent of females in the more developed regions near the beginning of the century.[2] An important characteristic of this change in mortality experience has been the greater improvement in survival among females than among males, and accordingly their higher level of survival to the older ages.

The main focus of this chapter is an analysis of changes in living arrangements during the residential life cycle with particular respect to elderly parents. The level and pattern of mortality during their lifetime determines the probability that they will survive to the time when the children marry and/or leave home. Living arrangements are then affected by decisions about whether grown children remain in the parents' household or adopt separate living arrangements. The combination of changes in survival and changes in attitudes towards living separately is then illustrated by the observed patterns of living arrangements in selected countries.

A. Morbidity, mortality and the life cycle

Timing and incidence of disability among the elderly

The onset of severe chronic disability of the aged has implications for the living arrangements of the very old. Rowland has documented three stages of disability: locality-bound, house-bound and bed-bound.[3] It would seem that elderly persons who are locality-bound or house-bound, can continue with their existing living arrangements, either in an extended family household, or in an independent household with visits from relatives and some form of domiciliary care. However, the care of those whose disability has rendered them bed-bound may be outside the scope of family or community services, and in both developed and developing societies, this would require some form of institutional care. Accordingly, the age of onset of severe disability would determine the point at which such a change in living arrangements might be necessary.

Some indication of the extent of disability among the aged is available from surveys conducted in Britain in 1968 and in Australia in 1981.[4] The information from each country suggests that up to about one quarter of those aged 65-74 years, about 40 per cent of those aged 75-84 years, and over one half of those aged 85 years or more are handicapped. Among those with a handicap in Australia 41 per cent of the 65-74 year age group and 66 per cent of those aged 75 years and over are classified as having a severe handicap, in which personal help or supervision is necessary. Corresponding data for Britain show that 38 per cent of the handicapped 65-74 year age group and 44 per cent of the handicapped 75 years and over age group have an appreciable, severe or very severe handicap.

Overall, the Australian data indicate that up to 8 per cent of the 65-74 year age group and 20-30 per cent of those aged 75 years or more have one or more chronic limiting conditions. The Australian data also show a sharp increase in the institutionalization of the handicapped elderly with age, from only 6-7 per cent of handicapped persons aged 65-69 years, to 12-17 per cent of those aged 75-79 years, and to 33-52 per cent of the handicapped aged 85 years or more.

Although there is a lack of precise information about the relationship between the level of mortality and the age pattern of morbidity among the elderly, some authors suggest that the postponement of death that has occurred has also been accompanied by a postponement of the average age of onset of severe chronic disability.[5] This implies that elderly people remain active and able to cope alone until a more advanced age in a low mortality community than in one where the overall level of mortality is high.

Contribution of mortality to changes in family life cycle experience

For a given birth cohort various patterns of family life cycle experience are possible, depending on the level of mortality and the effect of other demographic factors

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during the cohort's lifetime. Uhlenberg has discussed these various life cycle patterns in relation to female cohorts in the United States.[6] By amending his method to include changes in other demographic factors, that is, changes in the proportions married, the proportions of married women who remain childless, the duration of the childbearing period, and the ages at which adult children marry or leave home, estimates of life cycle patterns in Australia have been obtained. As shown in table X.1, there have been large decreases in the proportion of the initial cohort who die before marriage, decreases in the proportions of spinsters and childless women and in the proportion of families where one or both of the parents die before the last child leaves home. Overall, only 18 per cent of the females born in 1860 could expect to experience the normal life cycle of marriage, children, and survival of husband and wife until the last child has left home; 76 per cent of the 1940 female birth cohort could expect to experience this normal life cycle. A component analysis of these changes shows that the decline in mortality accounts for 55 per cent of the increase, from 18 to 76 per cent.

TABLE X.1. PROPORTION OF FEMALES WHO EXPERIENCE EACH FAMILY LIFE CYCLE PATTERN, AND A COMPONENT ANALYSIS OF THE CONTRIBUTION OF THE CHANGE IN MORTALITY: AUSTRALIA, 1860-1940

(Percentage)

	Females with the given life cycle experience, among cohorts with birth year		*Contributions to the difference between 1860 and 1940 from:*	
	1860	*1940*	*Mortality*	*Other factors*
1. Dies before the median age at marriage	26.5	5.0	− 96.0	− 4.0
2a. Spinster, dies between marriage age and the age when the last child would leave home	4.1	0.2	− 56.7	− 43.3
2b. Spinster, survives to the age when the last child would leave home	5.5	3.7	+159.7[a]	−259.7
3a. Childless, dies between marriage age and the age when the last child would leave home	3.3	0.3	− 62.7	− 37.3
3b. Childless, survives to the age when the last child would leave home	5.4	5.9	+606.7[a]	−506.7
4a. Mother dies before last child leaves home and father survives	9.6	2.4	− 80.9	− 19.1
4b. Mother and father both die before the last child leaves home	9.4	0.2	− 56.4	− 43.6
5. Father dies before the last child leaves home and mother survives	17.9	6.5	− 19.6	− 80.4
6. Both parents survive until the last child leaves home	18.3	75.8	+ 55.3	+ 44.7
TOTAL	100.0	100.0		

Source: Derived from C. M. Young, "Mortality and the family life cycle in Australia", in *Health and the Family Life Cycle* (Federal Institute for Population Research, Wiesbaden, in collaboration with the World Health Organization, Geneva, 1982), pp. 431-480.

[a] Mortality acts in the opposite direction to the other factors.

Another approach to the analysis of the influence of mortality on the family life cycle is with regard to the number of years of joint survival of a parent and child after the child reaches marriageable age. These values, according to Australian experience, are shown in table X.2. Mothers born in 1860 and daughters born in 1890 have an expected 13.5 years of joint survival after the daughter leaves home, with the corresponding value for fathers and daughters of 9.9 years. These values increase to 32.5 and 22.7 years, respectively, for parents born in 1940 and daughters born in 1960.

TABLE X.2. AVERAGE NUMBER OF YEARS OF JOINT SURVIVAL OF A PARENT AND CHILD AFTER THE CHILD HAS LEFT HOME ACCORDING TO COHORT MORTALITY EXPERIENCE: AUSTRALIA, 1860-1940 PARENTAL BIRTH COHORTS

Parent's birth year	*Mother-daughter*	*Father-daughter*	*Mother-son*	*Father-son*
1860	13.5	9.9	10.6	7.4
1880	15.6	10.7	13.1	8.5
1900	22.0	14.4	18.6	11.6
1920	26.7	18.1	23.3	15.1
1940	32.5	22.7	28.8	19.5

Source: C. M. Young, in *Health and the Family Life Cycle.*

Timing and duration of the widowhood stage

One important effect of a decline in mortality is the increase in the duration of joint survival of the husband and wife, and the consequent postponement of the onset of widowhood. The combination of this and the change in the age of a parent when the last child marries (due to changes in the average ages at marriage and the timing of childbearing) thus determines the duration of the post-marriage stage (that is, the interval between when the last child marries and when the first parent dies). This duration also indicates the potential interval during which the parents might be living as a solitary couple if all married children leave home at, or before, marriage.

The increase in the duration of the post-marriage stage in selected countries is indicated in the second column of table X.3. In particular, it is evident that, on average, among the early cohorts this stage of the family life cycle did not exist, because the first parent had died before the last child had married. Accordingly, on average, there was no opportunity for an elderly couple to live as a solitary couple. Recent experience in the more developed countries suggests that the duration of this stage is now in the region of 12 years.

Apart from delaying the commencement of widowhood, the decline in mortality has favoured females, and, as a consequence, increasing proportions of wives now survive their husbands. Examples of this are given in table X.3. From a value of around 50-60 per cent for the earliest years, the proportions of wives surviving their husbands has now increased to around 70 per cent. An associated trend is a steep decline in the average duration of widowerhood among males, but only a slight decrease in the average duration of widowhood among females, as also indicated in table X.3.

The relevance of these trends to the living arrangements of elderly parents is that an increasing proportion of elderly men will remain married until their death and so will have a spouse (usually younger than they are) as a companion and carer. However, although widowhood for elderly females will be postponed, a higher proportion of these will experience this stage of the life cycle, and their widowhood will continue to be of a relatively long duration.

General characteristics of the levels and trends in widowhood in the population of a given country are a

TABLE X.3. AVERAGE DURATION OF THE FAMILY LIFE CYCLE STAGES SPENT IN THE POST-CHILD-MARRIAGE STAGE[a] AND THE WIDOWHOOD STAGE: SELECTED COUNTRIES

Country and year	Average duration of: Post-child-marriage stage	Widowhood stage: Males (years)	Widowhood stage: Females	Wives surviving their husbands (percentage)
Australia				
1881-90	−12	18	20	59
1920-22	− 2	15	18	64
1960-62	9	12	18	70
Australia—cohort				
1860	-	19	21	61
1900	1	16	19	69
1940	16	11	17	77
Austria				
1870	..	17	19	57
1900	..	18	20	60
1930	..	15	19	69
1950	..	13	18	73
1970	..	12	18	75
England and Wales—cohort				
1841	..	18	20	58
1871	..	17	20	62
1901	..	15	18	68
1931	..	12	17	69
France—cohort				
1875	..	18	23	65
1900	..	18	21	67
1920	..	14	18	70
1950	..	12	18	72
Hungary				
1937	− 1	16	18	..
1949	5	14	19	..
1960	10	13	18	..
1970	13	11	18	..
1979	14	11	18	..
Italy				
1901	− 7	17	20	..
1931	− 4	14	19	..
1961	2	11	19	..
United States—cohort				
1880-89	1	16	19	..
1890-99	6	15	19	69
1900-09	9	13	18	70
1910-19	11	13	18	71
1920-29	12	13	18	72

Source: G. Feichtinger, "Report on family life cycle patterns in Europe", mimeographed paper, no date; G. Feichtinger and H. Hansluwka, "The impact of mortality on the life cycle of the family in Austria", mimeographed paper, 40 pp., no date; Paul C. Glick and Robert J. Parke, "New approaches in studying the life cycle of the family", *Demography*, vol. 2 (1965), pp. 187-220; P. Jozan, "Mortality and the life cycle of the family in Hungary", in *Health and the Family Life Cycle* (Federal Institute of Population Research, Wiesbaden, in collaboration with the World Health Organization, Geneva, 1982), pp. 261-284; Fiorenzo Rossi, "A simulation model for the study of the life cycle of the family", *Genus*, vol. XXXI, Nos. 1-4 (1975), pp. 35-94; C.M. Young, in *Health and the Family Life Cycle*, pp. 431-480.

[a] The duration between the time when the last child marries until the death of one of the elderly parents. A negative number indicates a parent died before the last child married.

higher proportion widowed among females than males in each age group, and an increase in the proportion of widowed males and females in each higher age group. Over successive calendar years, with declining mortality, there is a much greater decline in the proportions widowed among males than among females, and the declines in the proportions widowed are steeper at the younger ages than at the older ages.[7]

Accordingly, one would expect, in a given age group, a higher proportion of females than males to be living alone (because a higher proportion of females are widowed). In addition, if patterns of living arrangements of the elderly remained unchanged from a period of high mortality to one of low mortality, then, over successive years, one would expect a marked decline in the proportion of males living alone in each age group, but only a gradual decrease in the proportion of females living alone, and only at the younger ages.

Furthermore, if the level of mortality were the only determinant of residential arrangements among the elderly, then it would be expected that countries with similar histories and current levels of mortality and nuptiality, and hence a similar age-sex-marital status distribution, would also have similar proportions of the elderly living alone.

In section C of this chapter empirical data are examined to determine to what extent residential arrangements follow the patterns suggested by the level and trend in the age-sex-marital distribution of the elderly population.

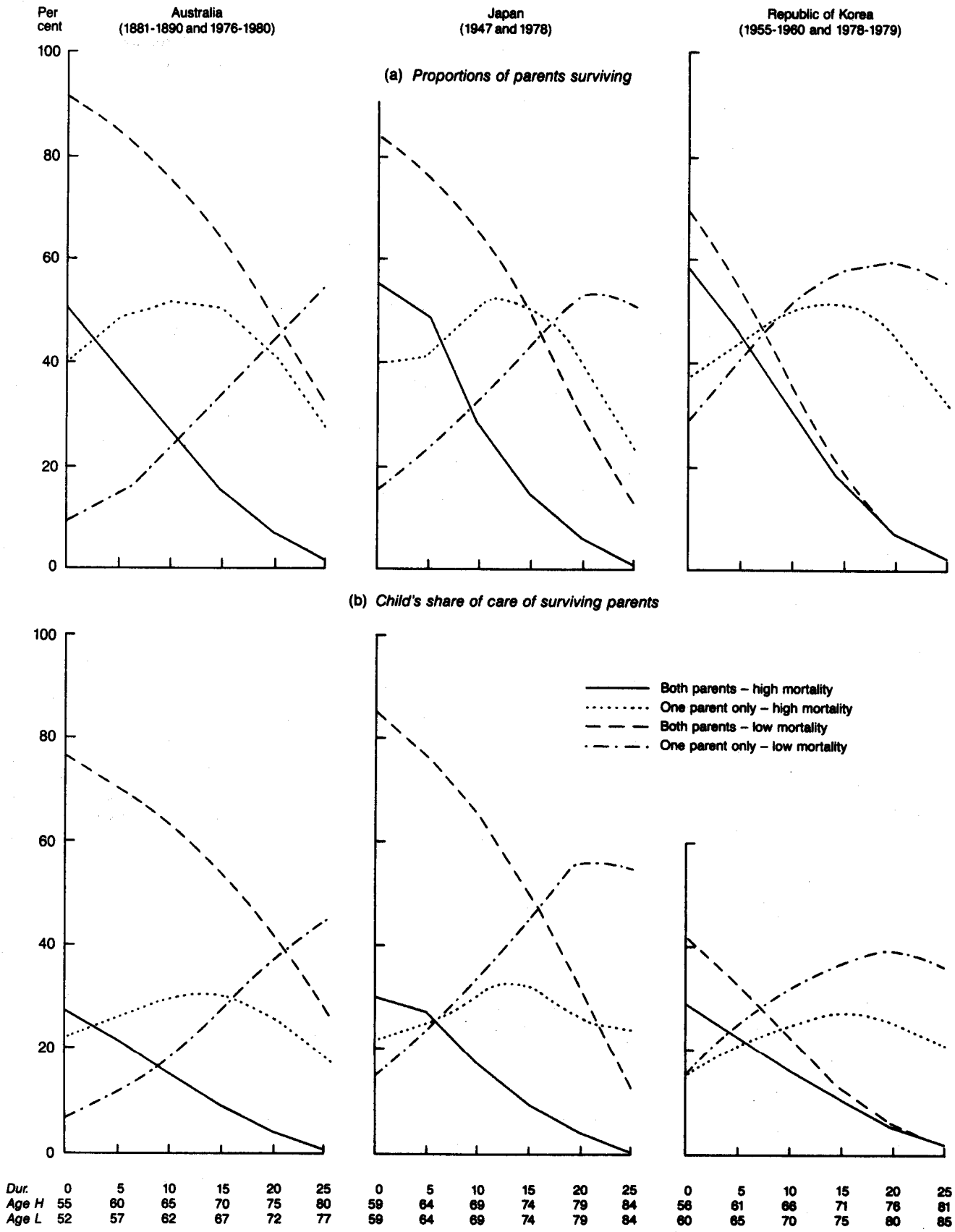
Share of elderly couples or widowed parents among sons or daughters

From information about the proportion of fathers and mothers surviving to various ages since childbearing, their average number of children ever born, and the mean age at childbearing, it is possible to estimate the proportion of families in which one or both parents have survived, and the share of these among the surviving grown-up children. In estimating this latter quantity, only male or only female children have been used in the denominator on the assumption that in most Western societies the care of elderly parents is mainly the responsibility of daughters, while in many of the Eastern societies such care is almost exclusively provided by sons. Also, by considering only the children of one sex, it is appropriate to ignore the care provided to parents-in-law; that is, the assumption is that one married couple can share the care of only one set of elderly or widowed parents. Calculations have been made with respect to Australia, the Republic of Korea and Japan, each at two different time periods,[8] and these results are presented in figure X.1.

In a given country the main differences in experience between conditions of higher mortality and low mortality is that in the earlier high mortality period there is a much lower incidence of both parents surviving from the time of the child's marriage. In addition, in the high mortality situation the peak in the presence of widowed parents occurs at a much earlier duration of the child's marriage, and generally reaches a lower maximum value in comparison with the low-mortality situation.

In the early durations of marriage a greater proportion of married children have widowed parents present in the high-mortality situation compared to the more recent time. However, the reverse occurs at a later

Figure X.1. Proportion of one or both parents surviving beyond a child's marriage and the child's share of the care of elderly parents in Australia, Japan and the Republic of Korea in an early high-mortality period and a recent low-mortality period



duration of the child's marriage, when the corresponding curves in figure X.1 cross over. As would be expected, the higher fertility during the earlier period of high mortality reduces the share of the care of an elderly parent among the children. Accordingly, when a child's share of a widowed parent is considered, the crossing over of the two curves in figure X.1 occurs at an earlier duration of the child's marriage. Thus it is found that an Australian daughter's share of the care of a widowed parent is greater in 1981 than in 1881-1890 after a marriage duration of 15 years; in Japan a son's share of the care of a widowed parent is greater in 1978 than in 1947 after a marriage duration of six years; while in the Republic of Korea, a son's share is greater in 1978-1979 than in 1955-1960 from the beginning of his marriage. The reason for the Korean pattern is that, because of the increase in the average age at marriage, the mother's age at the time of a son's marriage is greater at the more recent date than in the earlier period.

If there were no change from the high-mortality period to the low-mortality period in the proportion of elderly married couples who share a household with a married child, then there would be an increase in the proportion of shared two-couple households among married children. If, on the other hand, there was no change from the high-mortality to the low-mortality period in the proportion of married children who share a household with elderly married parents, then there would be an increase in the proportion of elderly married couples living without others in a two-person household.

Similarly, if there were no change from the high- to the low-mortality period in the proportion of widowed parents who share a household with a married child, then at the early durations of the child's marriage there would be a lower proportion of shared households, but at the later durations there would be a very much greater proportion. Alternatively, if the proportion of married children who share a household with a widowed parent were to remain unchanged, then there would be an increase in the proportion of very elderly widowed parents living alone in a one-person household, and possibly some increase in the proportion living in institutions who are unable to cope alone.

B. Living arrangements

In the more developed countries, excluding Japan, there is often an acceptance that the elderly prefer to live apart from their married children, and also that they prefer to live in private households rather than in institutions.[9] Moreover, services exist to varying degrees in different countries to enable the well elderly to maintain independent households, in the form of pensions, special housing, home-help, a meals service to households, and other community services. In addition there is an increasing expectancy that there should be government support for such services.[10] Institutional care is seen as appropriate for only a minority, and despite the increasing incidence of separate living arrangements, there is evidence of a continuing flow of help from married children to their elderly parents.[11]

Many of the discussions of the situation of the elderly in the developing countries, and Japan, stress the respect for the elderly, and the expectation that economic support, housing and care will continue to be provided by the married children. Although some acceptance of changing attitudes is apparent in some studies, in others the assumption is that the tradition of filial duty to the elderly parents is so firmly established that it will remain despite modernization.[12]

In general the behaviour of children as they approach marriageable age is often related to these different attitudes. Thus one finds a graduation in customs from societies in which at least one of the married children remains in the parents' household until the parents die, to one in which a married child remains with the parents for a short number of years before setting up a separate household, to one in which the child leaves home at marriage, and to the more recent trend in Western societies in which adult children leave the parents' home for other reasons and before they marry. At a later stage of their marriage, married children may be joined by elderly parents or a widowed parent, again depending on the customs of the society. Therefore it is the extent to which married children leave the parents' household and the extent to which an elderly couple or widowed parent later joins the married child's household that determines the ultimate pattern of living arrangements.

If one assumes a greater vulnerability of widowed parents in comparison with elderly married parents in the same age group, and if other factors are constant, then it is likely that a higher proportion of widowed parents than elderly married parents will be sharing a household with a married child. Accordingly the presence of widowed rather than married parents is of particular importance with regard to the potential sharing of households, and so the incidence of one-person households as an indicator of the extent to which widowed parents live alone is of special relevance in the study of the residential life cycle.

Proportion of one-person households

Because of the lack of extensive comparable data on the living arrangements of the elderly in different countries over time, this first part of the analysis is directed towards the discussion of household data that are more widely available, namely, the proportion of one-person households. Although obviously approximate, this measure provides some indication of the extent to which the elderly population live alone, since in many countries of Europe, North America and Australia it is found that around 40-50 per cent of one-person households are occupied by a person aged 65 years or more.[13] Figures for Britain show the secular trend in the relative incidence and greater share of one-person households among those over retirement age (65 years for males and 60 years for females) in comparison with those under retirement age:[14]

	Below retirement	*Above retirement*
1961	4	7
1966	5	10
1971	6	12
1976	6	15
1981	7	15

Trends in the proportion of one-person households to all households over time in various countries or areas are documented in table X.4. Substantial increases are evident in most European countries, North America and

TABLE X.4. HOUSEHOLDS CONTAINING ONLY ONE PERSON: SELECTED COUNTRIES OR AREAS
(Percentage)

Year	One-person households
NORTH AMERICA AND CARIBBEAN	
Canada	
1951	7.4
1956	7.9
1961	9.3
1966	11.4
1971	13.4
1976	16.8
Costa Rica	
1950	4.8
1963	5.9
1973	4.7
1976	4.3
Mexico	
1950	11.5
1970	7.8
1976-1977	4.2
Trinidad and Tobago	
1946	16.9
1960	16.5
1970	14.6
United States	
1790	3.7
1900	5.1
1950	10.9
1960	13.1
1965	15.0
1970	17.0
1975	19.6
1981	23.0
SOUTH AMERICA	
Chile	
1960	5.0
1970	5.5
ASIA	
Bangladesh	
1960	4.2
1973	3.0
1975	2.5
Hong Kong	
1961	15.1
1965	13.9
1971	14.7
1976	15.1
India	
1961	7.1
Japan	
1920	5.7
1930	5.5
1950	5.4
1955	3.5
1960	5.2
1965	8.1
1970	10.8
1975	13.5
1980	15.8
ASIA *(continued)*	
Republic of Korea	
1930	2.6
1960	2.3
1966	2.8
1970	3.7
1974	5.4
1975	4.2
Philippines	
1948	2.3
1957	1.6
1970	2.3
1978	2.9
Singapore	
1947	5.0
1957	7.2
1966	8.2
1970	13.1
Sri Lanka	
1953	5.0
1963	3.9
1973	4.5
Thailand	
1960	2.5
1970	3.2
1975	2.0
EUROPE	
Austria	
1951	17.5
1961	19.7
1971	24.6
Belgium	
1930	11.0
1947	15.9
1961	16.8
1970	18.8
Finland	
1950	18.5
1960	21.5
1970	23.9
France	
1946	18.6
1962	19.6
1968	20.3
Federal Republic of Germany	
1950	18.5
1957	17.8
1961	20.4
1970	25.1
Hungary	
1960	14.5
1970	17.5
EUROPE *(continued)*	
Ireland	
1946	10.4
1961	12.6
1970	14.8
Italy	
1961	10.6
1971	12.9
Luxembourg	
1900	6.5
1910	7.0
1930	5.8
1935	6.7
1947	8.8
1960	11.5
1966	13.0
1970	15.7
Netherlands	
1960	11.9
1971	17.1
Sweden	
1945	25.2
1950	20.7
1960	20.6
1970	25.3
Switzerland	
1920	8.5
1930	8.5
1960	14.2
1970	19.6
United Kingdom (England and Wales)	
1911	5.3
1921	6.0
1931	6.7
1951	10.7
1961	11.9
1966	15.2
1971	18.1
1976	21
1981	22
1986[a]	25
1991[a]	26
2001[a]	26
Yugoslavia	
1948	12.1
1961	13.8
1971	12.9
OCEANIA	
Australia	
1947	8.1
1954	9.0
1961	10.3
1971	13.5
1976	15.7
1981	18.0

TABLE X.4 *(continued)*

Source: Australian Bureau of Statistics, Census of the Population of Australia, 1947 to 1981; United Nations, Economic and Social Commission for Asia and the Pacific (ESCAP), *Population of Hong Kong*, Country Monograph Series, No. 1 (E/CN.11/1120), Bangkok, 1974; ESCAP, *Population of the Republic of Korea*, Country Monograph Series, No. 2 (E/CN.11/1241), Bangkok, 1975; ESCAP, *Population of Sri Lanka*, Country Monograph Series, No. 4, Bangkok, 1976, p. 217; European Community, *Economic and Social Features of Member States of the European Community* (Luxembourg, 1982), pp. 38, 39; *Japan, Statistical Yearbook, 1982* (Statistics Bureau, Prime Minister's Office, 1982), p. 42; Mohammad Kabir, *The Demographic Characteristics of Households*, Comparative Studies, Cross National Summaries, No. 6, World Fertility Survey (London, 1980); E. I. Kim, "An overview of the family life cycle in Korea: 1945-1975", in *Health and the Family Life Cycle* (Federal Institute for Population Research, Wiesbaden, in collaboration with the World Health Organization, Geneva, 1982), p. 407; P. C. Kwong, "Patterns of family and household composition and the family life cycle in East Asia, 1950-1970", in *Health and the Family Life Cycle*, p. 336; Organisation for Economic Co-operation and Development, *Child and the Family: Demographic Developments in OECD Countries* (Paris, 1979), pp. 80, 100, 114, 123, 133, 165, 183; *Social Trends*, vol. 7 (1976), and vol. 10 (1980); Statistics Canada, *Canada Yearbook 1980-81* (Ottawa Ministry of Supply and Services, 1981), p. 139; United States Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States 1982-83*, 103rd edition (Washington, D.C., 1982), p. 44; United Nations, *Demographic Yearbook*, 1955, 1962, 1976; *Determinants and Consequences of Population Trends*, vol. I (United Nations publication, Sales No. E.71.XIII.5), pp. 343, 346; *Methods of Projecting Households and Families*, Manual VII (United Nations publication, Sales No. E.73.XIII.2), pp. 12-15.

[a] Projected.

Australia, from around 10 per cent in the earlier years to over 20 per cent in the 1970s. There have also been increases in the proportion of one-person households in Japan and Singapore, from around 5 per cent in 1950 to around 15 per cent in 1970. In contrast, the proportion of one-person households has remained almost constant and at less than 3 per cent in countries such as Bangladesh, the Philippines and Thailand, but has begun to increase slightly in the Republic of Korea to nearly 5 per cent in the 1970s. The proportion of one-person households in Costa Rica has also remained constant from 1950 to 1970, although at a slightly higher level of around 5 per cent.

Rural-urban differences are another dimension in the study of the incidence of solitary living arrangements. For example, in Yugoslavia, particularly, there is a steep increase in the proportion of one-person households from rural towns (9.6 per cent), to large towns (12.8 per cent), to very large towns (17.8 per cent).[15]

However, there does not appear to be much difference in the proportion of one-person households between rural and urban areas in many of the developing countries.[16] In addition, there are relatively small differences in the proportions of households containing three or more generations between the urban and rural areas of those countries, except for the Republic of Korea. There, the differences between urban and rural are quite large, and have also shown appreciable decreases during the past 15 years.[17]

Living arrangements of the elderly

Information about the extent of one-person households among persons aged 65 years or more in various countries is presented in table X.5. Some of the patterns in the proportion of the elderly living alone are in the same direction as would be expected from the levels and trends in widowhood. For example, except for India and Singapore a higher proportion of females than males live alone, consistent with the high proportion of females who are widowed. Overall, the proportion of persons aged 65 years or more who are living alone is in the region of 12-15 per cent for males and 29-44 per cent for females. However, the wide range in the values for females between countries with similar levels of mortality should be noted.

In contrast to the decline in the proportion of the population who are widowed in successive calendar years, there is an increase in the proportion of the elderly who live alone in each more recent year, thus confirming the increasing propensity to live alone. For example, in Britain the proportions living alone have increased from 6 per cent of males and 16 per cent of females aged 65 years or more in 1951 to 14 and 38 per cent, respectively, in 1981, and similar increases have occurred within five-year age groups. Data for Japan also show an increase in the proportion of one-person households among all family households containing persons aged 65 years or more, from 5.6 per cent in 1965 to 10.3 per cent in 1980. However, the values are lower and the increases smaller in comparison with most of the other countries shown in table X.5, as a result of cultural differences.

Initially the proportion of elderly persons living alone increases with each higher age, but a peak is reached for females at around 80-84 years of age, and thereafter the proportions decline. From data for France in table X.6 regarding the proportion of one-person households among the not currently married, it is evident that these trends are the result of the product of an increasing proportion of widowed at each older age and a decreasing tendency to live alone by the not currently married at each older age. While mortality patterns produce the increase in the proportion of widowed persons at each higher age, it is presumably their increasing morbidity at each higher age that causes a lower propensity to live alone at the older ages, but with some contribution also from the decreasing proportion of each more recently born parent cohort living without others. It is also important to note that the proportions of the not currently married who are living alone are very similar for males and females, thus indicating that it is their different marital status distribution and not differences in their propensity to live alone which account for overall male and female differences in living patterns.

The proportion of the not currently married elderly population living alone is in the region of 40-50 per cent in Australia and Canada in 1976, while in Britain the proportion is a relatively high 70 per cent in 1977-1978. Again the proportions are relatively similar for each sex. Corresponding figures for selected countries of Europe in the 1960s indicate very low proportions of the not currently married living without others in Poland and Yugoslavia (around 30 per cent), associated with the greater prevalence of the extended family system in these countries. Data for Japan indicate an even lower

TABLE X.5. PROPORTION OF ELDERLY PERSONS LIVING ALONE: SELECTED COUNTRIES OR AREAS
(Percentage)

Year	*Age (years)*	*Males*	*Females*
Australia			
1976	65-74	11	28
	75+	17	32
1979	65+	14.8	34.2
1981	64-74	13.4	31.9
	75+	19.5	37.5
Austria			
1971	60-64	17.6	
	65-69	23.1	
	70-74	29.2	
	75+	33.6	
Belgium			
1970	65-69	20.3	
	70-74	26.9	
	75-79	32.3	
	80-84	34.8	
	85-89	33.4	
	90-94	31.4	
	95+	24.6	
Britain			
1951	65-74	6.5	15.6
1966	65-74	9.0	23.1
1971	65-74	10.9	27.0
1977-1978	65-74	13	38
1980-1981	65-74	14	38
1951	75+	10.5	23.1
1966	75+	14.7	31.4
1971	75+	17.7	37.5
1977-1978	75+	24	54
1980-1981	75+	25	56
1951	65+	7.7	16.8
1966	65+	10.8	25.4
1971	65+	13.0	30.0
1977-1978	65+	16	44
1980-1981	65+	17	45
1977-1978	85+	35	51
1980-1981	85+	37	54
Canada			
1961	65-69	7.7	13.0
1971	65-69	8.9	20.5
1976	65-69	9.5	24.4
Canada (continued)			
1961	70+	10.4	16.3
1971	70+	12.4	26.2
1976	70+	13.4	31.2
1961	65+	9.4	15.2
1971	65+	11.1	24.3
1976	65+	11.9	28.9
France			
1968	65-69	10.2	26.0
	70-74	12.1	34.4
	75-79	14.8	39.2
	80-84	17.6	39.0
	85-89	19.9	33.6
	90-94	19.9	24.8
India			
West Bengal			
1951	65+	4.6	0.7
West Bengal, rural			
1951	65+	3.5	0.7
Calcutta			
1951	65+	12.9	7.5
Japan			
1965	65+	5.6	
1970	65+	6.7	
1975	65+	8.6	
1980	65+	10.3	
Singapore			
1970	65+	13.8	9.8
United States			
1970	65+	14.1	33.8
1980	65+	14.9	41.0
1976	65-69	11	30
	70-74	14	41
	75-79	17	46
	80-84	20	43
	85+	33	31

Source: Paul C. Glick, "The future marital status and living arrangements of the elderly", *The Gerontologist*, vol. 19, No. 3 (June 1979), p. 306; estimated from Brian R. Harrison, *Living alone in Canada: Demographic and Economic Perspectives. 1951-1976* (Statistics Canada, 1981), pp. 25, 27; Graeme Hugo, "Changes in the demographic structure of Australian families: an analysis of census data", Australian Family Research Conference, 23-25 November 1983 (Australian National University, Canberra); *Japan, Statistical Yearbook 1982* (Statistics Bureau, Prime Minister's Office, 1982), p. 43; Hal L. Kendig and D. T. Rowland, *Family Support of the Australian Aged: A Comparison with the United States*, Working Paper No. 41, Ageing and the Family Project (Australian National University, Canberra, 1983), p. 20; Alain Monnier, "Composition de la population", chap. VI in *La Population de la France* (*Population*, vol. 29, Special issue (June 1974)), p. 141; Organisation for Economic Co-operation and Development, *Child and Family. Demographic Developments in the OECD Countries* (Paris, OECD, 1979), pp. 83, 178, 204; D. T. Rowland, "Living arrangements and the later family life cycle in Australia", *Australian Journal on Ageing*, vol. 1, No. 2 (May 1982), p. 5; Singapore, Department of Statistics, *Report on the Census of Population 1970*, vol. II (Singapore, 1973), p. 225; *Social Trends*, Nos. 10 (1980) and 13 (1983); United States, Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States 1982-83*, 103rd ed. (Washington, D.C., 1982), p. 31; D. C. L. Wroe, "The elderly", *Social Trends*, No. 4 (1973), p. 24.

level of elderly widowed living alone, but also an increase in these proportions from 10 per cent in 1965 to 19 per cent in 1980.

Information about the living arrangements of elderly married persons also adds further understanding of the extent of sharing of households, particularly with respect to married and unmarried children. The first point of interest in table X.7 is the very low proportion of elderly couples in Japan who are living without others, in comparison with the other countries. There are also low proportions of elderly couples living without children in Yugoslavia and Poland in comparison with the other European countries. Also important is that in Britain, Denmark and the United States there is a greater incidence of elderly couples living with unmarried children in comparison with married children,

TABLE X.6. PROPORTIONS OF NOT CURRENTLY MARRIED ELDERLY PERSONS LIVING ALONE

Country	Year	Age group	Marital status	Males	Females
				(percentage)	
Australia	1976	65-74	Not CM[a]	47	52
		75+	Not CM	41	40
		65+	Not CM	45	
Canada	1976	65+	Single	35.2	33.6
		65+	Widowed	41.0	47.7
		65+	Divorced	51.6	59.1
Denmark	1962	65+	Not CM	61	
France	1968	65-69	Not CM	50.4	53.9
		70-74	Not CM	49.2	55.2
		75-79	Not CM	48.1	51.6
		80-84	Not CM	42.0	44.9
		85-89	Not CM	36.3	36.0
		90-94	Not CM	28.1	25.7
India	1951				
West Bengal		65+	Widowed	9.3	8.7
Calcutta		65+	Widowed	14.9	7.7
Japan	1965	65+	Lone parent	10	
	1970	65+	Lone parent	12	
	1975	65+	Lone parent	16	
	1980	65+	Lone parent	19	
Poland	1967	65+	Not CM	30	
United Kingdom	1962	65+	Not CM	43	
	1980-1981	65-74	Not living with spouse	67	75
		75-84		69	73
		85+		57	59
		65+		65	73
		65+		71	
United States[b]	1950	65+	Single	50.4	39.1
	1960	65+	Single	57.4	49.3
	1970	65+	Single	65.4	62.6
	1977	65+	Single	66.2	68.1
Yugoslavia	1969	65+	Not CM	32	

Source: Estimated from Australian Bureau of Statistics, *1976 Census of Population and Housing*, and figures in Hal L. Kendig and D. T. Rowland, *Family Support of the Australian Aged*, Working paper No. 41, Ageing and the Family Project (Australian National University, Canberra); India, Office of the Registrar General, *Census of India 1961*, vol. 1, Monograph No. 9, *Size and Composition of Households* (New Delhi); Brian R. Harrison, *Living alone in Canada : Demographic and Economic Perspectives. 1951-1976* (Statistics Canada, June 1981), p. 21; C.H. Mindel, "Multigenerational family households: recent trends and implications for the future", *The Gerontologist*, vol. 19 (October 1979), p. 460; Alain Monnier, "Composition de la population", chap. VI in *La Population de la France (Population*, vol. 29, Special issue (June 1974), p. 141; E. Shanas, "Family-kin networks and aging in cross-cultural perspective", *Journal of Marriage and the Family*, vol. 35 (August 1973), p. 507; *Social Trends*, vol. 13 (1983), p. 25.

[a] Not CM = not currently married.

[b] Proportion not living with kin.

whereas in Yugoslavia and Japan three times as many elderly couples are living with married children in comparison with unmarried children. The situation in Britain in 1962 is that a high proportion of elderly couples who are living with others are with unmarried children. The situation was similar in eighteenth century Britain.

Again it would seem that cultural differences, in this case the role of married versus unmarried children in the care of the elderly parents, is a more important factor than any differences in mortality in explaining these contrasting living arrangements.

Additional information for Japan shows the trend over time in the composition of households containing elderly persons. From 1965 to 1980, the proportion of one-person elderly households increased from 6 to 10 per cent, and there was also an increase in the proportion of households containing only an elderly married couple, from 8 to 16 per cent. The other major change was a decline in the proportion of households containing a married couple, children, and one elderly parent, from 34 to 26 per cent.[18]

There is also information available for Taiwan province of China, which shows that the proportion of couples who lived with the husband's parents for at least one month after marriage (in relation to surviving parents only) has decreased with each more recent marriage cohort, from 92 per cent among those who had been married for 15 years or more to 78 per cent for those who had been married for less than five years. In addition, among those who had first lived with the husband's parents after marriage, the proportion who had left the household by the third year of marriage had increased from 9 per cent among those who had been married for 15 years or more to 30 per cent among those who had been married for less than five years.[19]

Further information about the living arrangements of the elderly is provided by the data concerning their relationship to the head of the household. General trends with increasing age observed for the countries for which data are available, Austria, Belgium, France and Japan, are an increase in the proportion who are living alone, a decrease in the proportion who are heads of the household among males, but a small decrease or even an

TABLE X.7. LIVING ARRANGEMENTS OF MARRIED PERSONS AGED 65 YEARS OR OVER IN PRIVATE HOUSEHOLDS: SELECTED COUNTRIES

(Percentage)

Household composition	*Britain pre-1800*		*Britain*[a] *1962*	*Denmark 1962*	*Japan*[b] *1965*	*Poland 1967*	*United States 1962*	*Yugoslavia 1969*
	Males	*Females*						
Only with spouse	41	49	68	82	18	50	79	49
Spouse and married children	7	5	5	1	47	22	2	33
Spouse and unmarried children	46	37	23	14	17	19	15	11
Spouse and other relatives	7	9	3	-	18	3	3	5
Spouse and non-relatives			1	3	..	6	1	2
TOTAL	100	100	100	100	100	100	100	100

Source: Estimated from *Japan, Statistical Yearbook 1982* (Statistics Bureau, Prime Minister's Office, 1982), pp. 42, 43; Peter Laslett, "Societal development and aging", chap. 4 in *Handbook of Aging and the Social Sciences,* Robert H. Binstock and Ethel Shanas, eds. (New York, Van Nostrand Reinhold Company, 1976), p. 111; Ethel Shanas, "Family-kin networks and aging in cross-cultural perspective", *Journal of Marriage and the Family,* vol. 35 (August 1973), p. 507.

[a]The proportion of persons aged 65 years or more living only with spouse in Britain in 1977-1978 is 85 per cent. *Social Trends,* No. 10 (1980), p. 99.

[b]The proportion of elderly couples living only with spouse in Japan has been estimated to be 24 per cent in 1970, 30 per cent in 1975 and 35 per cent in 1980.

increase among females, and a decline in the proportion who are the spouse of the head of the household. Other important trends are the increase in the proportion who are the father or the mother of the head of the household, and some slight increase in the proportions who are grandparents or other relatives of the head, but no apparent increase in the proportion where a sibling is the head of the household.[20]

Important differences exist between Japan and the three European countries in that a much higher proportion of elderly Japanese are parents of the head of the household. For example, at ages 75 years and over, 47 per cent of elderly Japanese males and 74 per cent of elderly Japanese females are the parents of the head compared with 16 and 27 per cent of the elderly at the same age in France. In contrast, a higher proportion of elderly men and women in France are living alone or as the head of the household (80 and 52 per cent, respectively, at ages 75 years and over) in comparison with the situation in Japan (where the corresponding proportions are 50 and 10 per cent, respectively). However in both countries a higher proportion of elderly females in comparison with elderly males are living in households headed by one of their children, as a result of the higher proportion widowed among elderly females in comparison with elderly males.

The extent that elderly persons are living in institutions in selected countries is indicated in table X.8. In the countries for which such information is available the proportion for the total population aged over 65 years is less than 10 per cent. There is a slight increase in the proportion of the elderly in institutions over successive calendar years, and a steep increase in the proportion of elderly in institutions beyond ages 75 or 80 years. In Australia over one tenth of males and almost one fifth of females aged 75 years or over are in institutions.

Although there are no precise figures concerning the extent that elderly persons are living in institutions in many of the developing countries or areas, there is some reference to the presence of the sick elderly in hospitals in Indonesia,[21] and the fact that in Thailand "a few old men who lack status from wealth or close kin may re-enter the priesthood and retire to the *wat*", while some of the older women may become nuns.[22] With regard to Singapore, a reference to the existence of public old-age homes suggests that these are mainly for the foreign-born who have no family in Singapore.[23] Figures for Hong Kong suggest that 9 per cent of the aged are living with unrelated persons or in institutions, and Ikels refers to the recent increase in the provision of homes to cater for the elderly in Hong Kong. In the past, an elderly person without a family would have had to enter a Taoist or Buddhist monastery, and today many of the homes for the aged which exist in Hong Kong have also been set up by religious organizations.[24]

C. CONCLUSION

The effect of the decline in mortality during this century has resulted in increasing proportions of males and females surviving to age 65 years, and an increase in the proportion of female cohorts who can expect to experience a normal life cycle (that is, marriage, children and the survival of the husband and wife until the last child marries). Associated with this has been the increase in the duration of the stage between the marriage of the last child and the time at which the first spouse dies, a delay in the onset of widowhood, and a greater proportion of wives surviving their husbands. Consequently the proportion of widowed males within a given age group has declined steeply in successive calendar years, compared with a smaller or no decline for females.

From the child's point of view an increasing proportion of parents now survive until he or she marries, and the peak incidence of a widowed parent being present has been shifted to a much older age of the child. The expected joint survival of a parent and child after the child marries has also increased markedly. In addition, in some countries, the increasing proportion of elderly parents who now survive is shared among a smaller number of married children, due to the associated decline in average family size.

Specific information about the living arrangements of the elderly population shows that in successive calendar years increasing proportions of males and females in North America, Britain, Europe, Australia and Japan are living alone, contrary to the trend in the proportions widowed, and due to the increasing propensity of the elderly "single" population to live alone. In addition, there is evidence of an increasing proportion of elderly married couples living without others.

The greater extent to which the elderly share households with married children in Japan is in contrast to

TABLE X.8. PROPORTION OF THE ELDERLY POPULATION LIVING IN INSTITUTIONS

(Percentage)

Country	*Year*	*Age group*	*Males*	*Females*
Australia	1976[a]	65-74	3.5	3.6
		75+	11.3	17.6
	1979	65+	5.8	8.9
	1981	65-74	2.1	2.4
		75+	8.1	17.2
		65+	4.0	8.2
		65+	6.4	
Austria	1971	60-64	1.0	
		65-69	1.6	
		70-74	2.5	
		75+	6.9	
Canada	1976[b]	65+	6	10
Norway	1970	60-69	1.1	
		70-79	4.3	
		80+	18.2	
Singapore	1957	55-69	2.3	
		70+	4.0	
	1970	65+	3.4	
United States	1960	65+	2.6	3.0
	1970	65+	4.5	5.0
	1970	65-69	1.8	1.6
		85+	12.9	20.8
	1976	65-69	2	2
		70-74	3	3
		75-79	4	6
		80-84	8	12
		85+	14	25

Source: Australian Bureau of Statistics, *Australia's Aged Population 1982,* catalogue No. 4109.0 (Canberra, 1982); Paul C. Glick, "The future marital status and living arrangements of the elderly", *The Gerontologist,* vol. 19, No. 3 (June 1979), p. 306; D. T. Rowland, "Living arrangements and the later family life cycle in Australia", *Australian Journal on Ageing,* vol. 1, No. 2 (May 1982), pp. 5, 6; compiled from *Singapore: Report on the Census of Population 1957* (State of Singapore), pp. 255 and 264; Singapore, Department of Statistics, *Report on the Census of Population in 1970: Singapore,* vol. I (1973), p. 211; Statistics Canada, *Canada's Elderly* (Canada, 1979); United States Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States 1982-83,* 103rd ed. (Washington, D.C., 1983).

[a] New South Wales.

[b] Including collective housing.

the situation in other developed countries which experience similar levels of mortality. There are also differences in residential arrangements between various countries in Europe, North America, Britain and Australia with similar levels of survival. Thus it appears that the influence of mortality with regard to the age-sex-marital distribution of the population and the joint survival of parents and children, that is, characteristics of the population which determine the opportunities for sharing with or living without others, is mediated by social and cultural differences between countries, and by changing attitudes to separate living arrangements in a given country over time.

Morbidity influences residential arrangements in that, because of the increase in severe chronic disability with age, a decreasing proportion of the elderly "single" population is able to cope alone at each older age. Another effect of morbidity is possible, in that if the decline in the level of mortality, which enables more parents to survive to the older ages, also implies a decline in the level of morbidity, then more parents will be in relatively good health when the children reach marriageable age. Such a trend would be further accentuated in countries experiencing a decline in the age of the parents at the marriage of the last child. Consequently the children's departure from the family household may be facilitated by the fact that the parents do not need their physical care at that time, possibly removing some of the constraints which prevent adult children from leaving the parental household either before or after they marry. In addition, attitudes to remaining with the parents after marriage may change when there is an expectation of a long duration of joint survival of parents and child beyond adulthood.

A likely trend in living arrangements is that a decreasing proportion of children will remain in the parents' household when they marry (or as they approach marriageable age), but older grown-up children will increasingly be called upon to provide, or arrange for, the care of an elderly widowed parent, usually a mother, at a later stage of the child's marriage, and this responsibility will be shared among fewer adult children.

Because of the strong emphasis on assisting the elderly to retain independent households in Western societies, it is likely that the proportions of elderly couples and "single" elderly who live without others will increase very much faster than the proportion who live in institutions. Therefore Governments will need to provide suitable housing and supportive community services to assist the elderly to maintain these residential patterns, with sufficient institutional care for the infirm elderly.

NOTES

[1] *World Population Trends and Policies: 1981 Monitoring Report*, vol. I, *Population Trends* (United Nations publication, Sales No. E.82.XIII.2); "Demographic considerations: report of the Secretary-General" (A/CONF.113/4), introductory document prepared for the World Assembly on Aging, Vienna, 26 July – 6 August 1982.

[2] From an examination of the values of l_{65} for a number of countries from the United Nations, *Demographic Yearbook*, various years.

[3] D. T. Rowland, "The vulnerability of the aged in Sydney", *Australian and New Zealand Journal of Science*, vol. 18, No. 2 (July 1982), pp. 229-247.

[4] Australia, Bureau of Statistics, *Australia's Aged Population 1982*, catalogue No. 4109.0 (Canberra); also, D. M. Gibson and D. T. Rowland, "Community versus institutional care", Working Paper No. 20, Ageing and the Family Project, Research School of Social Sciences, Australian National University, Canberra. The definition of handicapped in the Australian study refers to the person's ability in relation to self-care, mobility and communication. The data for Britain are in D. C. L. Wroe, "The elderly", *Social Trends*, No. 4 (1973), pp. 23-33. In the British study an impairment was defined as "lacking all or part of a limb, or having a defective limb, organ or mechanism of the body", while a handicap was defined as the "disadvantage or restriction of activity caused by the loss or reduction of functional ability".

Little information is reported concerning the incidence of disability of the elderly in other countries, although reference to hospital care in Indonesia of sick old people who can no longer be looked after at home is referred to in Jeremy Evans, "The health and well-being of old people in a Javanese city", seminar paper, Department of Demography, Australian National University (Canberra, 1982).

[5] Bernice L. Neugarten, "The future and the young-old", *The Gerontologist*, vol. 15, No. 1, part II (February 1975), pp. 4-9; Fred C. Pampel, *Social Change and the Aged* (Lexington, Massachusetts, Lexington Books, 1981), chap. 11, "A note on changes in health levels in the aged population".

[6] Peter R. Uhlenberg, "A study of cohort life cycles; cohorts of native-born Massachusetts women, 1830-1920", *Population Studies*, vol. 23, No. 3 (November 1969), pp. 407-420.

[7] From an analysis of proportions widowed in each age group beyond 65 years, and the trend in these proportions over successive calendar years, in selected countries.

[8] Assumptions regarding the average age at marriage of males and females, mean age of fertility, and average family size were, for Australia, 27, 24, and 31 years, and 5.0 children in 1881-1890, and 24, 22 and 27 years, and 2.5 children in 1981; for Japan, 26, 23 and 30 years, and 4.6 children in 1947, and 28, 25 and 28 years, and 2.0 children in 1978; and for the Republic of Korea, 25, 21 and 27 years, and 5.1 children in 1955-1960, and 28, 24 and 28 years, and 3.5 children in 1978-1979. Proportions surviving were derived from the relevant life tables for each country.

[9] Orlando B. Di Iulio, *Household Formation 1911-2001*, Research Report No. 10, National Population Inquiry (Canberra, Australian Government Publishing Service, 1981); European Community, *Economic and Social Features of Member States of the European Community* (Luxembourg, 1982); Brian R. Harrison, *Living Alone in Canada: Demographic and Economic Perspectives. 1951-1976* (Ottawa, Statistics Canada, Ministry of Supply and Services, 1981); Frances Kobrin, "The fall in household size and the rise of the primary individual in the United States", *Demography*, vol. 13, No. 1 (1976), pp. 127-138; Simon Kuznets, "Size and age structure of family households: exploratory comparisons", *Population and Development Review*, vol. 4, No. 2 (June 1978), pp. 187-223; Pampel, *op. cit.*, chap. 9.

[10] Frances M. Carp, "Housing and living environments of older people", chapter 10 in *Handbook of Aging and the Social Sciences*, Robert H. Binstock and Ethel Shanas, eds. (New York, Van Nostrand Reinhold Company, 1976); Walter Beattie, Jr., "Aging and the social services", chap. 24 in *Handbook of Aging and the Social Sciences;* Peter G. Coleman, "Social gerontology in the Netherlands. A review of current research", *The Gerontologist*, vol. 15, No. 3 (June 1975), pp. 257-263; Alain Parant, "Les personnes âgées en France et leurs conditions d'habitat", *Population*, vol. 36, No. 3 (May-June 1981), pp. 577-608; *Report of the World Assembly on Aging, Vienna, 26 July to 6 August 1982* (United Nations publication, Sales No. E.82.I.16). Note particularly recommendation 19 regarding housing of the elderly.

[11] E. Shanas, "Social myth as hypothesis: the case of the family relations of old people", *The Gerontologist*, vol. 19, No. 1 (1979), pp. 3-9; Hal L. Kendig and D. T. Rowland, *Family Support of the Australian Aged: A Comparison with the United States*, Working paper No. 41, Ageing and the Family Project, Australian National University, Canberra.

[12] A. Bose, "Aspects of aging in India", *Social Action*, vol. 32, No. 1 (Jan.-Mar., 1982), pp. 1-19; Dae H. Chang, "The Korean family", chap. VII in *The Family in Asia*, Mas Singh Das and Panos D. Bardis, eds. (London, George Allen and Unwin, 1979); R. H. Chaudhury, "The aged in Bangladesh", *Social Action*, vol. 32, No. 1 (Jan.-Mar., 1982), pp. 20-38; Charlotte Ikels, "Old age in Hong Kong", *The Gerontologist*, vol. 15, No. 3 (June 1975), pp. 230-235; Eddie C. Y. Kuo and Aline K. Wong, *The Contemporary Family in Singapore* (Singapore University Press, 1979); E. Palmore, "What the USA can learn from Japan about aging", *The Gerontologist*, vol. 15, No. 1 (February 1975), pp. 64-67; P. R. Sharma, "The aged in Nepal", *Social Action*, vol. 32, No. 1 (Jan.-Mar., 1982), pp. 39-52; Harold E. Smith, "The Thai rural family", chap. II in *The Family in Asia;* H. Yuan Tien, "How China treats its old people", *Asian Profile*, vol. 5, No. 1 (February 1977), pp. 1-7.

[13] European Community, *Economic and Social Features . . .*, pp. 44-45; G. Hugo, "Changes in the demographic structure of Australian families: an analysis of census data", Australian Family Research Conference, 23-25 November 1983, Australian National University, Canberra; Brian Harrison, *Living Alone in Canada . . .*, p. 25; *Social Trends*, No. 1 (1970); United States Department of Commerce, Bureau of the Census, *Statistical Abstract of the United States*, 103rd ed. (Washington, D.C., 1982), p. 44.

[14] *Social Trends*, No. 9 (1979), p. 78, and No. 11 (1981).

[15] Organisation for Economic Co-operation and Development, *Child and the Family: Demographic Developments in OECD Countries* (Paris, 1979), p. 183. For a general discussion of urban and rural differences see T. Burch, "The family in rural and urban setting", chap. VII in *Patterns of Urban and Rural Population Growth* (United Nations publication, Sales No. E. 79.XIII.9).

[16] Mohammad Kabir, *The Demographic Characteristics of Households*, Comparative Studies, Cross National Summaries, No. 6, World Fertility Survey (London, 1980).

[17] E. I. Kim, "An overview of the family life cycle in Korea: 1945-1975", in *Health and the Family Life Cycle* (Federal Institute for Population Research, Wiesbaden, in collaboration with the World Health Organization, Geneva, 1982), p. 407.

[18] Japan, *Statistical Yearbook*, Statistics Bureau (Prime Minister's Office, 1982), p. 43.

[19] R. Freedman, Baron Moots, Te-Hsiung Sun and Mary Beth Weinberger, "Household composition and extended kinship in Taiwan", *Population Studies*, vol. 32, No. 1 (March 1978), p. 78.

[20] Shigemi Kono, "The concept of the family life cycle as a bridge between demography and sociology", *International Population Conference, Mexico*, vol. I (Liège, International Union for the Scientific Study of Population, 1977), pp. 360, 361; OECD, *Child and Family . . .*, pp. 83, 178, 204.

[21] Evans, *op. cit.*

[22] Smith, *op. cit.*

[23] Kuo and Wong, *op. cit.*

[24] Ikels, *loc. cit.*

XI. DIFFERENTIAL MORTALITY DECLINE AND ITS CONSEQUENCES FOR THE STATUS AND ROLES OF WOMEN

*Helen R. Ware**

In very broad terms it would appear that there are three basic stages in the development of sex differentials in mortality. In prehistoric societies and in traditional societies with very high levels of mortality, female mortality may exceed male mortality because of the heavy risks associated with childbearing and the lack of effective measures to reduce those risks. In more complex societies, females generally begin to experience a mortality advantage which results in their having longer life-spans than males (although mortality levels for women may still exceed those for men during the peak childbearing years). Finally, with further reductions in mortality levels and the elimination of maternal mortality as a major cause of death, a stage is reached where females enjoy a mortality advantage in every age group, resulting in a life expectancy at birth for females which exceeds that of males by three years or more. This broad three-stage outline does not necessarily cover societies where there is a marked discrimination against females in the allocation of resources such as food and medical treatment; nor does it cover societies in which males are gravely disadvantaged by the differential impact of warfare or local feuding (say in a society where male captives are killed but females are kept as slaves).

Recently the United Nations Population Division has presented a study of patterns of sex differentials in mortality in less developed countries which centres on 36 life tables from non-European countries.[1] The tables are based upon empirical data collected through vital registration systems or sample surveys, and their construction did not involve the imposition of any assumptions as to sex differentials or age patterns of mortality. Of the 22 countries represented, four have experienced life expectancies at birth that are greater for males than for females during certain periods. These countries are Tunisia (1968-1969); India (1970-1972); Iran (1973-1976) and Sri Lanka (1945-1947 and 1952-1954). Unfortunately the 22 countries are far from providing a geographically or culturally representative sample of the world's countries. The only African country represented is Tunisia; there are 10 Latin American or Caribbean countries; and the countries or areas counted as less developed include Israel, Hong Kong and Singapore in the 1970s.

The data for Sri Lanka, however, are useful in showing a transition from excess female mortality to excess male mortality. In 1945-1947 a new-born Sri Lankan female had a life expectancy at birth (e_0) of 43.1 years, which was 1.7 years shorter than that for a male, and this gap still persisted at age ten. By 1952-1954 the female e_0 had risen to 57.3 years and was only 1.1 less than the male expectation. By 1962-1964 the transition had occurred and the female e_0 was 62.6 years, 0.5 years greater than the male's. Figures for 1970-1972 show females with an e_0 of 66.7 years, which is greater than that for the males by 2.9 years, an advantage that narrows to 2.8 years only at age ten.

Looking at the Sri Lankan data on the sex ratio of mortality by age for the same four time-periods, it is possible to see where females have gained the advantage. Throughout the post-war period male mortality has exceeded that of females during the first year of life. In contrast, female mortality has always exceeded male mortality for young children aged 1 to 4, and until the 1962-1964 period female mortality was greater than that of males at ages 5 to 14. Since 1965, mortality in the latter age group has been virtually the same for both sexes. In the 1940s and 1950s the age-group where females were at the greatest disadvantage was in early adulthood (15-24). During these prime childbearing years male mortality levels were only two thirds those for females, and it was not until the 1970s that the point was reached where young adult male mortality actually exceeded female levels. A similar transition through a somewhat less extreme pattern of contrasts was shown for those aged 25 to 44. Once childbearing is past (ages 45 and above) women have had equality or an advantage since the 1940s. It is in middle age that women have the greatest advantage, with middle-aged women in the 1970s experiencing only two thirds of the male death rate. Overall, the pattern reflects a biological disadvantage to males during the first year of life; continuing discrimination against young girls in early childhood, which has been gradually overcome for the later years of childhood; and a marked disadvantage associated with childbearing, which has also been vanquished. In the 1970s males clearly experienced greater hazards in middle and old age, which have yet to be adequately explained.

Algerian data also give a very good indication of what happens during the transitional period when mortality falls to the point where females are no longer so disadvantaged that they have a lower e_0 than males.[2] In 1969-1970, although e_0 was 53.0 years for females as opposed to 52.2 years for males, excess female mortality was still very pronounced in some age groups. Infant mortality was the same for both sexes but only because the heavy female mortality of the last nine months was counterbalanced by excess male mortality from congenital causes or accidents during childbirth or the first three months. Indeed, during the first year, male mortality from other causes was less than three quarters of that experienced by females. The female disadvantage continued through age 20, during which period

*Human Rights Commission, Canberra, Australia.

excess female mortality was associated with infectious diseases and nutritional causes and reflects the relative neglect of daughters. From age 20 females have higher mortality than males up to age 35, but this is entirely explained by maternal mortality. If deaths from this cause are excluded male mortality exceeds that of females by a ratio of three to two. Once the reproductive years are past there is a clear excess of male mortality, which is why females have a longer life expectancy overall. At these older ages men are dying predominantly from tuberculosis, other respiratory diseases and violence.

Looking at the United Nations' collection of 36 life tables it is clear that the age at which females are most likely to suffer a marked disadvantage is in early childhood (1-4). This is the period when the preference for sons has the greatest impact. Difficult decisions have to be made about the allocation of food or access to expensive medical remedies, and girls are more likely to miss out. Another age group where females are especially exposed to risk is in the later teens and early twenties: at these ages young women are prone to succumb to infections as a consequence of poor nutrition and are also exposed to the risks of childbearing, especially the extra risks associated with the birth of the first child.

Sex differentials in mortality and the value of children

In examining the relation between changes in sex differentials in mortality and variations in the relative value attributed to sons and daughters, it rapidly becomes clear that the change in values almost always precedes the change in relative mortality levels. The causal chain is initiated by a rise in the value of daughters which results in a decline in female infant and child mortality. There is no evidence that mortality among daughters improves because new cures are found for diseases that have an especially adverse impact upon female children (indeed most childhood diseases have a more severe impact upon males when both sexes are given equal nutrition and care). Instead female mortality declines because the degree of discrimination against female children becomes less acute. Once this trend has started it could become self-reinforcing as social changes associated with the greater survival of girls further increase their worth, as, for example, where new employment opportunities become open to females. It is also possible that the position of girls improves either because the value of all children has risen with a consequent reallocation of resources from the older generation towards the younger; or because more resources have become available, making it easier for parents to avoid difficult decisions as to the allocation of resources between their children. In either case girls are likely to benefit more than boys because so much of their mortality is relatively easy to prevent with the allocation of marginally greater resources to their maintenance.

Fisher argued that the sex ratio at birth is genetically determined.[3] His contention was essentially an economic one. The total parental expenditure of time, money and effort incurred by parents in raising children to reproductive age is equal for each sex. Otherwise, those parents genetically inclined to produce the cheaper sex would produce more reproductive value per unit expenditure. This would tend to increase the proportion of the cheaper sex reared in future generations. Hence the sex ratio is subject to natural selection in the sense that it will adjust to the relative expenditure necessary to rear the two sexes to reproductive age.[4] Clearly the cost of raising a child to maturity is related to its mortality risk. However, Fisher's theory, which is inherently untestable in any case, does not allow for the possibility that parents will be so eager to secure children of a particular sex that they will allow children of the unwanted sex to die in order to increase the survival chances of the wanted sex. Also, the costs of rearing a child to reproductive age varies according to the social definition of the appropriate age at which reproduction should commence. Girls can be made cheaper than boys, though not more desirable, by allowing them to marry and commence reproduction at a markedly younger age.

It is now possible to determine the sex of a child before birth by amniocentesis.[5] Where this has been done in developing countries parental willingness to terminate pregnancies involving female fetuses has been in striking contrast to eagerness to carry male fetuses to term, even where genetic defects have been diagnosed. Thus in one Indian hospital, in a sample of 700 sex determinations 95 per cent of women bearing female fetuses chose to have them evacuated, but no pregnancy involving a male was terminated.[6] In the unlikely event of this practice spreading widely in developing countries, uterine mortality of females might come to have dramatic social consequences.

Historically, there is considerable evidence of the linkage of excess female mortality with the undervaluing of girls in what are now the developed countries. Thus, in the United States, Hammel, Johansson and Ginsberg have shown how sex ratios in childhood were skewed with a relative excess of males in agricultural and frontier areas, and the reverse in urban and industrial areas. While this can partially be explained by the sex-specific migration of families according to the mix of their children and by the migration of children themselves, the major factor was mortality patterns arising from differential child care based on the sex-specific economic value of children to the household in agricultural versus urban settings.[7]

The historical evidence from the United Kingdom is even clearer. In nineteenth-century England and Wales females were greatly disadvantaged by very high levels of deaths caused by tuberculosis, and it was young girls aged five to nineteen who were the last to achieve consistently lower death rates than their male counterparts (again belying the common belief that excess female mortality is chiefly associated with the risks of childbearing).[8] Data from Cornwall show plainly that young girls were especially disadvantaged in rural areas where there was virtually no employment available to the daughters of landless agricultural labourers and where the limited amount of protein available was reserved for males.[9] A similar pattern was to be found in Ireland.[10] Girls fared particularly badly in rural areas not because they performed no productive labour but because their hard work brought no wages to the family purse. Therefore the best of everything was saved for husbands and sons, and the daughters who did not find paid employment in the towns tended to die of tuberculosis.

Contemporary data on the relationship between the low value placed upon daughters and excess female mortality in childhood are most abundantly available for

the Indian subcontinent. Simmons and his colleagues have shown that in an Indian community where the mean number of additional sons desired was 2.59 and the mean number of additional daughters desired was 1.41, it was possible to demonstrate that female infants were much more likely to die in families where the wife had expressed a preference for no additional children or especially for no additional female children. Moreover female children are further disadvantaged where an older male child of less than three years is already present in the household.[11]

Overall, the behavioural model used by Simmons and others is much more successful in explaining female rather than male mortality, suggesting that there is a much greater volitional element in the former. "It seems fair to conclude from this evidence that female children are systematically disadvantaged and that the choices are rational and deliberate" in that parents choose to devote their resources to sons rather than to daughters, because they expect to get a greater return on their investment in sons.[12] Rosenzweig and Schultz have similarly shown that households selectively allocate resources to children in response to variations in sex differences in their expected earnings opportunities as adults so that female chances of survival are better in areas where female employment is more widespread.[13] Chen and his colleagues, in Bangladesh,[14] have shown how this differential is put into action through a sex bias in the family allocation of food and health care.

Discrimination against daughters is certainly not confined to the Indian subcontinent. Williamson has reviewed the evidence for parental preference for sons or daughters around the world: in the overwhelming majority of cultures studied there is a strong preference for sons. She found only five cultures with a strong preference for daughters,[15] and two of these societies actually practiced infanticide of boys in preference to girls. There is surprisingly little evidence for outright sex-discriminatory infanticide being practiced around the world.[16] It appears that in general parents will choose to keep their children alive, only discriminating when resources such as food are limited or when it becomes necessary to seek costly medical treatment. Other options may also be found: girl children from poor families may be put up for adoption or sale, or daughters may be left in situations where they are expected to be taken in and cared for by others.[17] In some cultures, indeed, girls may be preferred for adoption since they are regarded as being more malleable and more useful because of their domestic skills.[18] However, almost by definition, reliable demographic statistics are unlikely to be available for societies which practice infanticide, whatever the sexual selection criteria employed.[19]

Sex differentials in mortality: the relation between cause and effect

The accumulated evidence on sex differentials in mortality suggests that the major causal factors are social rather than biological.[20] There are two clear exceptions to this generalization: males are at a biological disadvantage during the first month of life[21] and females are disadvantaged by nature where effective assistance is not available to overcome the biological risks associated with childbirth.[22] For the rest, where females are at a disadvantage it is because they are discriminated against and males receive preference in the allocation of scarce resources such as food and medical attention.[23] When males are disadvantaged it is owing to a greater exposure to the risk of violent death from events ranging from warfare to motor vehicle accidents, or because of their greater indulgence in unhealthy behaviour such as smoking, overeating, taking insufficient exercise, drinking alcohol and leading highly stressed lives. Evidence for male "bad habits" as the major causal factor in excess male mortality comes almost exclusively from Western cultures. Very little is known about the causation of excess male mortality at middle age and beyond in cultures where many of these unhealthy practices are forbidden or rarely practiced. In Chinese cultures it would appear that a major factor in higher male mortality at advanced ages is a much increased likelihood of dying from tuberculosis. There may be an underlying biological advantage in being female which becomes increasingly evident as infectious diseases and other inherently sex-neutral causes of death decline in importance.[24]

With this knowledge it is possible to suggest that where the mortality experience of women has improved relative to that of men, their social position will also have improved. However, it is also possible that a general improvement in living standards may have lowered overall mortality levels to the advantage of females without any change in the treatment of females relative to males. Where there is sufficient food and medical services are readily available at limited cost, parents can provide for the basic needs of both sexes and are not forced to make difficult resource allocations directly affecting the life expectancy of their children. It may still be the case that sons are given the choicest morsels and kept at school longer than daughters, but such preferential treatment has little impact upon sex differentials in mortality. A widespread female disadvantage in mortality is the joint product of poverty to the point where food supplies are seriously constrained and discrimination practiced against females. The fact that early twentieth-century Ireland has become notorious for the high relative mortality of women is a reflection of both the extreme preference given to sons and the deep poverty of rural society.[25]

There are thus two circumstances in which women may be in a poor position to take advantage of their increased longevity relative to men. First, they may still be living in a society where the preference goes to males but where living standards have improved. Secondly, they may be living in a society where the treatment of the sexes has become more equal but where there has been little or no cultural adaptation to the prospect of a growing surplus of older women. The latter situation is common in most developed countries.

Will social customs adapt to changing mortality patterns?

Social customs of the younger generation will only adapt to reduced mortality risks at older ages if young people are aware of the prospect of increased longevity. In the case of the interaction between fertility behaviour and infant mortality levels demographers have long been concerned to ask whether parents know that increased chances of survival mean that a smaller number of births than in the past are now needed to produce the same number of children surviving to maturity.[26] How-

ever, in the case of perceptions of levels of adult mortality there has been very little interest or research. Stearns has shown that public opinion polls in France, even as late as the 1940s, showed that a majority believed, totally incorrectly, that longevity had declined.[27] He has also demonstrated that a major cause of the long-standing opposition by the unions to the introduction of contributory pension schemes was a widespread and firmly held belief that very few workers would live to a retirement age of 60 when they might finally enjoy the benefits.[28]

Today in the developed countries there is probably a much greater awareness that seven out of every ten individuals born can expect to live to a retirement age of 65. There is now an extensive popular literature devoted to the possible perils associated with an aging population (although there is some confusion between the relative contributions of increasing longevity and declining birthrates to this phenomenon). But there is very little popular awareness of sex differentials in mortality. Women's magazines have yet to start running articles advising women to marry younger men in order to avoid widowhood. Yet under Australian conditions of 1975-1977 a woman of 30 should have sought a groom aged 24 if she wished the two of them to have the same life expectancy! Instead, the actuality was that in 1971 the average Australian woman married, at age 21, a man two years older than herself and could expect to have 40 years of married life and 10 years of widowhood, and thus to spend over one third of her life-span after the age of 50 in the widowed state.[29] These illustrative figures serve to provide a strong demonstration as to why women in developed countries do not, in fact, choose their partners in such a way as to give each spouse an equal chance of widowhood. For if women were to persist in marrying in their early twenties then they would need to select grooms in their mid-teens who would be likely to be still in school and certainly to have achieved limited maturity, training or earning capacity. Women would need to marry at least a decade later than they now do in order to make marriage to a partner with equal mortality risk a socially feasible proposition.

One of the very few people to have pointed out this problem of age differentials in marriage leading to prolonged widowhood is Bell. She quoted a typical American "lonely-hearts" advertisement: "Recently divorced, 53, affectionate, virile, tall, good-looking, yearns for the one utterly feminine, loving women in her 30s, 40s with whom he can share a beautiful new life". Her comment: "At age 50 this gentleman had a life expectancy of 23 years. (It is a little less now.) If he finds a woman of 35, her life expectancy will be 41.27. In other words he is affectionately offering her a statistical chance of 18 years of widowhood. And she will be widowed at an age when men of her own age will be looking for women in their thirties and forties."[30]

The reason why it is not socially acceptable for women to marry men who are significantly younger than themselves is the differential definition of age in men and women. Despite the fact that women live longer than men, women are regarded as being old at a younger age than men living in the same culture. This is why in most countries women are allowed or obliged to retire at a younger age than men, which is irrational in both demographic and economic terms. This differential definition gives an advantage to men at the expense of women. It multiplies the options for emotional satisfactions for men whilst diminishing those for women. It raises male prestige and self-esteem at the expense of females. All men benefit to some degree from this customary definition, whilst any woman who lives to middle age bears some of the cost.[31] If society is to have true equality between the sexes, redefinition of when men and women become old is one of the important points at which to start.

One issue is clearly bound up with the fact that women clearly lose one of their major roles at menopause. Traditional cultures place great stress upon women's reproductive function, but at least some of them also provide special roles for post-menopausal women as political leaders and grant such older women a wide range of freedoms not available to younger women. In a sense such older women become sexless elders no longer thought of pre-eminently as women or mother figures.[32]

Bart's examination of 30 traditional societies shows that there are six post-childrearing roles available to women: grandmother, mother or mother-in-law, economic producer, participant in government, performer of religious or mystical rites, and senior wife. In the only traditional societies where women's status declines in middle age this is because, as in the Western world, high status is accorded to sexually attractive young women. Where women are valued as grandmothers and for their specialized economic skills in production or household management, women's status always rises with age.[33] There are few greater contrasts in status than that between the mother-in-law in traditional society, with her extensive power over the younger generation, and the mother-in-law in European cultures who figures as the powerless butt of tired jokes. In Burundi the mother sings a triumphal song at her son's wedding: "I shall no longer go to fetch water; I shall no longer pound the grain". Here, as in village societies elsewhere, "the principle of increased power with age is valid throughout the life-span for women".[34] The impact of formal education and the decline of the co-resident extended family serves to reduce the power and prestige of older women. However, it should also be noted that the contrast between traditional societies and developed countries with cultures of European origin is exacerbated by the facts that co-resident extended families were not a feature of traditional Western European culture and that there was a whole tradition of distaste and fear of lone old women which culminated in witchcraft accusations.[35]

THE PROSPECT OF EXCESS MALE MORTALITY IN DEVELOPING COUNTRIES

Nearly all of the developing countries have moved towards a situation where male mortality exceeds female mortality. Despite defective data, it is probably true to say that more than nine out of ten developing countries have passed the cross-over point where female life expectancy at birth first exceeds that of males.[36] Very little attention has been given to the implications of this change. We do not know what the effect of excess female mortality is in those societies where it still prevails. It would appear that social arrangements are largely able to negate the impact of demographic realities. Thus, for example, polygyny flourishes in some of those societies where there is an overall deficit of

women. This apparent anomaly is achieved by a considerable age differential between the sexes at marriage rather than by an appreciable proportion of men who never marry.[37]

"In the high and moderate mortality situations where women often experience higher mortality than men at some ages at least, the *demographic* impact of higher female mortality on such life-cycle aspects as joint survival of spouses, widowhood, lifetime fertility etc. appears to be a rather moderate one. More important is the complex pattern of societal and cultural norms governing marriage formation and family life."[38] The age difference between husband and wife is a more important determinant of the probability of joint survival than the sex difference in mortality, particularly for marriage durations in excess of about fifteen years.

It is possible to produce historical examples of populations in which there was a marked excess of males over females. The decennial censuses of what is now Pakistan between 1901 and 1941 showed sex ratios for the total population which ranged between 118 to 122 males per 100 females. In India in 1971 there were 107.5 males per 100 females, a ratio which also applied in Bangladesh in 1974. Indeed, past the age of 55 the number of men in Bangladesh exceeded that of women by at least one third. Even in Sri Lanka, a country which has a much more favourable mortality situation for women, history is still reflected in the excess of males at older ages: in 1971 there were 127 males per 100 females at ages 60 to 64.[39] No one appears to have asked the question as to the effects of these extreme imbalances in sex ratios.[40]

There are various ways of using existing life-tables to look at possible patterns of sex ratios at different levels of mortality. For example, if the Coale-Demeny "South" models are used, but female mortality is matched with male mortality one level higher to provide for excess female mortality, then one can look at the number of survivors at age 20 under various mortality conditions.[41] Allowing females an expectation of life at birth as low as 20 years (males 22.3 years) then the survivors from 1,000 births of each sex at adulthood (age 20) are 355 females and 400 males. However, if women are assumed to marry older men, then the contrast is between 355 marriageable women of age 20 and 368 potential grooms of 25 or 339 potential grooms of 30 years. At these mortality levels women marrying at age 20 have an expectation of 31.6 additional years as compared with 29.8 for men aged 25, or 27.1 for men aged 30. With mortality levels as high as this women might well marry at 15 to men of 20, in which case there would be 381 brides for 400 grooms. In any case, an examination of a range of similar models shows that social modification can accommodate for the demographic variation and allow everyone to marry.

For one rural area in South India it is possible to demonstrate a rise in the age at marriage following a marriage squeeze resulting from changes in the age structure of the population consequent upon declining mortality for both sexes.[42] There were also important social factors at work, such as the increasing concern of parents to secure sons-in-law with formal educations and urban occupations and a growing concept of child dependency. The marriage squeeze was not the result of an overall excess of females in the population consequent upon sex differentials in mortality. Indeed the overall excess was only 105 females per 100 males, which is probably not perceptible to the average villager. It occurred because men were continuing to marry women seven years younger than themselves in a rapidly growing population, and thus there was an increasing excess of young females awaiting marriage. The effect of the broadening of the base of the age-pyramid in creating an excess of potential brides can be seen from the data for India as a whole. In India in 1931 there were 10 per cent more females aged 10-19 than there were males aged 20-29, even though for the population of all ages there were only 95 females for every 100 males. However, in 1971 there were 30 per cent more females in their teens than males in their twenties even though the overall ratio of females to males had fallen to 93 per 100.

Taking the figures for Karnataka (Mysore) State, the ratio of never-married men aged 15-54 to never-married women aged 10-44 was 1.38 in 1931, 1.19 in 1961 and 1.01 by 1971. (The figures for India as a whole were 1.25, 1.12 and 0.93.) In Karnataka the mean age of women at marriage rose from 15 years during the first quarter of the century to 18 years in 1971. Over the same period the age at marriage for men had barely changed from 24.3 to 24.8 years, and it is possible that since 1961 the male age at marriage has begun a slow decline.

Child marriages were more important when mortality levels were higher since parents wished to fix all their children's marriages before death and also to become grandparents before the wife was widowed. Thus mortality expectations influenced age at marriage. Formerly it was expected that a girl would be married before menarche and that a man would not marry much before 25. This was partly because sisters were supposed to be married before brothers and partly because frequent sexual intercourse before age 25 was felt to be debilitating and to impair the development of muscular strength. The age gap was also held to be necessary to give husbands sufficient dominance to resist their wives' sexual demands (in 1891 the average age difference was actually 10 years). In recent years the surplus of brides has resulted in a shift from bridewealth to dowry and has raised the age at marriage for girls as parents find it increasingly difficult to arrange suitable matches for their daughters. The point has even been reached where one sixth of women aged 20-24 and 3 per cent of those aged 25-29 are still unmarried. The creation of even a small spinster class could have very important social implications, although at slightly older ages it will certainly be more than counterbalanced by a declining proportion of young widows. Ample potential still remains for reduction of the surplus of marriageable females through convergence of male and female marriage ages. At the current rate of convergence of approximately one year per decade it will not be until 2040 that spouses will be the same age at marriage. Socially it is becoming increasingly easy to move towards this point since the population has already become accustomed to girls remaining unmarried after puberty and to men marrying at younger ages when a good dowry is offered. However, it could well be that the very heavy costs of having to provide dowries for daughters will slow down relative mortality gains for young girls.[43] For it must be remembered that the excess of marriageable females has occurred in a population where females are at a mortality disadvantage. Thus in 1961 the life expectancy at age one in Karnataka was

43.1 for females and 46.3 for males, a greater disparity than that for India as a whole. It can be seen that, in this instance at least, social factors are much more important in determining the sex balance of the marriage market than are demographic factors.

Wrigley has made a similar point in discussing German historical data.[44] In general one would expect an excess of unmarried males to result in an early marriage age for females and, conversely, an excess of unmarried females to delay their age at marriage. However, these general expectations are only met where social conditions are also favourable. Similarly, the proportions of men and women who never marry are not simply determined by the sex ratio of the population; social factors such as the frequency of remarriage and the permissibility of polygamy are also important. Certainly the overall sex ratio of the population has relatively little to do with the proportion who never marry in most countries. This is because mortality at older ages usually determines the overall sex ratio and it is the sex ratio at the common ages for marriage which is determinative. Thus the United States has a very marked excess of females in the total population, due to their greater longevity, but there are more men than women who never marry. In exceptional cases heavy mortality of young men in warfare will result in high proportions of women who never marry: the German Democratic Republic is the outstanding example of this phenomenon. (Significantly, the German Democratic Republic also has a high proportion of men who marry women significantly older than themselves.) Unless the imbalance between the sexes as they approach the age of marriage is very marked, due to exceptional circumstances such as war or massive sex-selective migration, variations in the age gap between spouses will be sufficient to allow almost everyone to marry.

One factor which needs to be recognized is that, in the absence of war, sex differentials in mortality are rarely so extreme as to seriously disturb the marriage market. Looking at the United Nations Population Division's figures for countries with reasonable life-tables and taking the difference in life expectancy due to mortality at ages 0-14: the extreme cases are India in 1970-1972 where males gained an advantage of 2.07 years and Honduras where, in 1973-1975, females gained 1.53 years.[45] This means that at ages 15-19 the gap between the sexes can range from 106 males to 95 males for each hundred females. Differences of this order can readily be accommodated to a social order in which everyone is expected to marry by mechanisms such as adjustment of the age gap between spouses; an expectation that widows will not remarry or the exclusion of certain categories of persons such as members of religious orders or "loose" women from those who are expected to marry would also have the desired effect. In most traditional cultures it has been more acceptable for men than for women to remain unmarried and this may well reflect former sex ratios in the population as well as the greater autonomy allowed to men.

Much the same could be said about the impact of sex ratios in the population upon labour force participation. There, too, social factors are much more important than demographic ones. It is true that parents with an unmarried daughter at home may be concerned at her lack of economic contribution to the household. This happened in nineteenth-century England, in certain classes of the population, although the cause of the imbalance was international migration of males rather than a mortality differential.[46] For South Asia, Dixon has investigated at length the wide range of social factors involved in the determination of the labour force participation of young unmarried women.[47] A number of very complex relationships are involved. For example, young girls may be kept at home because going outside to work is held to greatly reduce their chances of marriage. On the other hand, if girls can show themselves capable of earning significant sums they may become sought after as marriage partners. There may also be an interaction between the earning capacities of young women and the mortality experience of young girls inasmuch as parents may devote more resources to potential wage earners. This almost certainly happened in rural nineteenth-century England[48] and would also appear to have happened more recently in Hong Kong.[49] It may be that surplus young girls are not sent out to work but that their labour is used in the home so that older women with greater earning capacity or permissible mobility are able to work outside the home. In the case of young men it is even less likely that sex differentials in mortality by themselves have a significant impact on labour force participation. However, it is possible that where there is a shortage of males, especially at the family level, education of sons may be cut short so that they can help the father with his work.

At older ages widowhood may be a factor in encouraging or obliging women to enter the labour market and work away from home. Some developing countries have had extremely high proportions of young widowed women. The Indian census of 1931 showed the proportions of women aged 24 to 43 who were widowed ranging from 29 to 14 per cent, depending on region and caste. Social pressures on higher caste women not to marry were greater, as was the ability of their families to provide for women who had no husband to support them.[50] So long as the extended family system is in place and families are not too poor, widows will usually be spared the necessity of working for others outside the home, although their contribution to household agricultural production may be considerable as long as their physical strength lasts.[51] On the other hand the report of the Committee on the Status of Women in India presented an extremely depressing portrait of the situation of the 20,000 destitute widows of Benares: ". . . in the absence of any employable skills, most of them were depending on petty trades like making paper bags, packets of incense, selling pakoras etc., earning an average income of Rs. 15 to 20 per month".[52] Many urban widows in Bangladesh are similarly disadvantaged.[53]

The problem lies in a social system which assumes that every woman will always be the economic dependant of a man and that she therefore does not have to be able to support herself and her children. However, there are cultures around the world where women are expected to adopt independent economic roles and where widowhood is much less of a financial crisis. Sanjek presents data on members of such ethnic groups for several areas of Ghana and Guyana. He shows that in one Ghanaian urban area, irrespective of marital status, the majority of women from age 40 onwards live in households they head or share with other adult women.[54] Unfortunately labour force participation data for women in developing countries are usually highly defective, especially in rural areas, and normally are not

available in any case by marital status.[55] Once again the social factors which influence the frequency of divorce may be more important in determining female labour force participation rates than the demographic correlates of widowhood. "The Middle East has the lowest female labour force participation rates in the world, but among those women who do work for pay divorced women far outnumber other women, even widows. Thus, in the Syrian Arab Republic and Morocco, divorced women are employed in the urban economy at three times the rate for widows; in Egypt and the Islamic Republic of Iran there are two divorcees for every one widow at work for pay, and in Turkey, the divorced woman is five times as likely as the widow to work for pay. In Morocco, more than half of all formally employed women are divorced."[56] In the developed countries it is relatively rare for women to be widowed at the ages before retirement and most countries have pension schemes covering at least women with children. Thus here, too, labour force participation of older women is much more strongly influenced by marital breakdowns than by death.

In almost all societies the widow is considered to occupy a highly unenviable position. The Korean proverb which says that one can tell a widow's house by the bitter smoke coming from the chimney (because she has, by implication, no one to gather and dry wood for her) sums up the traditional view.[57] Extended families may well care for the old and infirm but the widow without close kin has always been in a very difficult situation. Modernization aggravates the situation because poor people find it harder to feed additional mouths in a cash economy and the more affluent experience new needs which make heavy claims upon their resources. There has long been an association between widowhood and begging, but widows are now less likely to find their own or their husbands' brothers prepared to save them from this plight.[58]

In most countries widowhood is the most common reason for women becoming household heads. Although data on widowhood are available from most censuses, very little attention has been paid to the position of widows. In traditional societies widows are often regarded as bad omens and neglected for that reason. Modern demographic studies have concentrated very heavily upon fertility, largely ignoring women not believed to be at risk of conception. Yet even for researchers and policy makers who are only interested in fertility and population growth, widowhood is very important, for one of the major motivations for childbearing is the desire to ensure that there will be enough children, and especially enough sons, to care for the surviving parent in old age. Women in developing countries who are significantly younger than their husbands expect to outlive them and attempt to make a realistic provision for this eventuality. In contrast, women in developed countries who are likely to survive their husbands even if they are the same age, appear to be much more reluctant to make a pragmatic preparation for widowhood.

For most countries the proportion of widows amongst all females aged 15 and above ranges between 10 and 12 per cent. The proportion of widows in a society depends on a number of demographic and social factors. Usually the most important of these are:

(*a*) The relationship between male and female death rates by age;

(*b*) The customary age difference between wife and husband;

(*c*) The acceptability of remarriage for widows;

(*d*) Extraordinary circumstances such as war and mass migrations;

(*e*) The proportion of women who never marry;

(*f*) The survival chances of widows as compared with wives of the same age.

It can be seen that, of these six factors, only two are directly related to the ordinary level of mortality in the society. Social customs are very important determining factors. It is true that widows will be unable to remarry if there are no men available as husbands, but the availability of husbands in this situation is also largely determined by conventions as to the limits of the acceptable age difference between spouses. Many traditional African cultures resolved the problem of widowhood by providing that the widow should be inherited by her husband's brother or by another male member of his family, and, if still of reproductive age, should become his full wife, continuing to bear children. (The Bible shows that this custom of widow inheritance, known as the levirate, was also practiced by the ancient Hebrews, but apparently only where the husband died childless.) Clearly, such a custom is only of general utility to widows where polygyny is also acceptable, allowing a brother who already has one wife to take on the responsibility of a second. The Guinea National Survey of 1954/55 was one of the very rare demographic enquiries to collect data on widow inheritance. Even though women were defined as inherited widows only if they had not yet had a child by their new husbands, 10 per cent of all women aged 40-44 and 5 per cent of all women aged 35-39 were classified as inherited widows.[59] Obviously the custom was common. In this context it served a dual purpose: it provided that all women had husbands and thus were integrated into extended households where they would have a place in old age, and it also ensured that the reproductive potential of the women was fully realized. In other African societies where there is less stress on the wife becoming a life-long member of her husband's family, the widow or even the post-menopausal wife is more likely to return to her brothers and the home where she was born.[60]

Were marriage patterns in which grooms are almost universally expected to be older than their brides originally a response to demographic reality in a world where men lived longer than women? This tradition is maladaptive in societies where women can expect to outlive men of their own age by five years or more and men of their husbands' age by a decade or more. Economic patterns are equally maldesigned for current demographic realities. Why should women be obliged to retire five years earlier than men while they can expect to live five years longer, suffering or enjoying their retirement? A Western tradition in which the husband goes to work while the wife stays at home to do the housework and raise the children may have been appropriate when there was a large brood of children to raise and housework required prolonged heavy manual labour. Now the wife who stays home to raise two children is underoccupied, while her husband may be subject to considerable life-shortening stress in his employment. Indeed, another unresolved question is how far women's current mortality advantage in the developed countries results from a passing occupational pattern in which, for a short period, most women were

spared from the necessity of having to go out and earn their own living.

A study of self-reported health perceptions in the United States shows that, contrary to popular belief, having three key roles (as employee, wife and mother) is associated with the best physical health for women.[61] There are two problems with interpreting this finding. One is that there is no necessary link between self-reported morbidity and mortality: men report themselves as being healthier than women but die earlier. The other is that it is currently impossible to say which is cause and which effect: does employment improve women's health or is it harder for unhealthy women to stay in employment? Despite confident predictions that adopting "male" roles will result in a less favourable mortality situation for women, the American evidence does not yet support this view. That may be because it is not the stress associated with paid employment that is in itself harmful but the reaction to that stress. If men continue to react to stress by turning to cigarettes, alcohol and fast cars it may be that women will be able to retain their favourable mortality so long as they maintain less dangerous or more therepeutic reactions to stress. Another factor in the future may be that men will improve their life chances by adopting life-styles more similar to those of women. Joint roles within the household in which both spouses share in child-rearing and in housework may well prove to be healthier for both sexes.

Demographic change has been so rapid that it is understandable that social change has not kept pace. In the United States in 1930 there were 1,006 men aged 65 and above for every thousand women; by 1970 there were only 722.[62] This means that a woman retiring in 1970 aged 60 had reached adulthood at a time when the majority of old people were men. It is thus easy to see why women have yet to fully adopt social behaviours appropriate to a world where almost two thirds of wives will die widowed and there are more than five widows for every widower.

Demographic consequences of the widening gap between male and female mortality

The immediate impact of the widening gap between male and female mortality in developed countries has been the creation of a marked excess of females, especially at older ages. In France in 1881 a 25 per cent excess of females occurred only after age 85 but by 1975 such an excess was already evident at age 60.[63] Intuitively one would expect that as women increasingly live longer than men there would be a higher proportion of widows experiencing ever longer durations of widowhood but the reality is certainly not so simple. Take the French case and the age group 60-64: in 1911 there were 21.2 widowers for every hundred married men and 77.7 widows for every 100 married women; in 1975 the comparable figures were 6.3 and 39.0. This pattern of declining proportions of widowed persons is similar for both sexes and for every age group from 50 to 89. It simply is not true that an increase in the differential between the life expectancy of males and females is matched by the same increase in the duration of widowhood. Life expectancy at widowhood must be calculated on the basis of the wife's age at widowhood. Men in developed countries generally die at ages when their wives have only relatively few years remaining to them.

Model calculations thus show that a decline in mortality for both sexes typically results in a decrease in the duration of widowhood because fewer young women lose their husbands. For example, if the age difference between spouses averages two years, and females enjoy a six-year life expectancy advantage at birth, then the average experience of widowhood will be 17 years when males have a life expectancy at birth of 40 years but only 14 years when the male life expectancy rises to 67 years. When male life expectancy has reached 67 years, then female life expectancy would need to increase by five years to produce as much as a one year addition to the duration of widowhood. Equally, because in a stable population the proportion of widows is directly linked to the mean duration of widowhood, rising expectations of life at birth and an increasing gap between the sexes result in a decline in the proportion of widows in the adult population. To take two extremes, when males have a life expectancy of 38.2 years at birth and females live two years longer, then 23.5 per cent of women are widows. However, when the male expectancy is 70.8 and females still have a two-year advantage the proportion of widows is only 11.7 per cent. Increasing the female advantage to 8.2 years at this low level of mortality only raises the proportion of widows in the female population to 13.2 per cent, which is hardly a dramatic increase. Widowhood is a much more common experience in developing countries than in developed ones.

Historical data for the Netherlands show the impact of excess male mortality on the life cycle of the family.[64] An early change was that the conjoint effects of declines in the age at marriage, levels of fertility and levels of mortality resulted in the creation of a post-parental stage after the last child had left home and before the marriage was dissolved by death. Soon after this, male mortality reached a plateau and ceased to decline while the decline in female mortality levels continued, thus creating a gap in life expectancy between the sexes. In the 1870s the sex differential in life expectancy was always less than one year once the first year of life was past. By the 1960s the difference was close to five years at most ages. From the life-tables it is possible to construct tables of expectations of married life for couples. In the 1870s a Netherlands couple who had been married for 20 years could expect 21 years more of life together; in the 1960s they could expect 26 years, but three of the gained five years were not due to any reduction in mortality but to younger marriages. This limited extension of the duration of marriage is understandable when one appreciates that between the 1870s and the 1960s the male expectation of life at age 40 rose only from 32.5 to 33.9 years, while for females the rise was from 33.0 to 38.5 years. In the 1870s a man had a 54 per cent chance of dying before his wife; the average age at widowhood was 61 for both sexes, and the average duration of widowhood was 15 years for males and 16 years for females. In the 1960s the man had a 66 per cent chance of dying first; the age of widowhood averaged 70 years for men but 67 years for women, and the average length of widowhood in the Netherlands was 11 years for males but 16 years for females.

A surplus of older women: the Australian experience

Clearly a mortality pattern that favours females will create a surplus of women and particularly, in the

conditions now current in developed countries, a surplus of older women. Thus in Australia, for example, while there are more males than females in all but one age group before age 65, at ages 65 and above there are 601,122 males and 828,278 females or 1.4 females for every male. At ages 65 and above there are 4.6 widows for every widower. Married men in this age group outnumber married women by over 100,000 because so many are married to younger women. Since there are three females who are not currently married for every not currently married male at ages 65 and over, even if everyone paired off, two thirds of women would be unable to find partners unless they could look to younger men.[65]

Overall in Australia, only 25 per cent of household heads are women, but in this older age group 42 per cent of household heads are women. This is chiefly because so many household heads at this age live alone (i.e., 44 per cent) and 75 per cent of those living alone are women.[66]

It would be wrong to regard all women aged 65 and above as problems even if they live alone; rather, it is the very old women (75+) and those who are ill or disabled who face special difficulties. For many people, living alone is a positive choice. A recent survey of aged Australians very definitely showed "the continued strength of the modified extended family. Older Australians typically maintain their own households but they have none the less strong bonds with children and turn to them rather than government when they need assistance."[67] The data from the survey showed that while half of older (65+) women had no spouse, only a quarter of men were in this position; eight out of ten of both sexes had at least one living sibling; equally, eight out of ten had at least one child alive and one third had three or more living children. The separation of the generations into their own households was clearly explained more by older people's own preferences than by any abandonment by children. More than two thirds of those surveyed said that older people who could no longer manage on their own preferred to stay at home with outside help, while only 8 per cent wanted to live with their children and only 7 per cent in nursing homes. Older people who had become vulnerable were more likely to share households than to move into institutions. Thus, nearly 40 per cent of widows aged 75+ live with others besides spouses, mainly their children but also their siblings, while only 15 per cent live in institutions.

Over 40 per cent of the aged parents in the survey had a child within 8 kilometres and nearly 90 per cent had one or more children living elsewhere in the same city and hence within reach by car. Interestingly, there was evidence that only children are especially likely to live near their aged parents. The availability of family members clearly reduced vulnerability of the elderly. Hence among those aged 75 and above, only 10 per cent of the married were in an institution, as compared with 24 per cent of the widowed and 41 per cent for the never married. Further the institutionalization rate among widows in this age group is reduced to 21 per cent for those with one or two children and to 18 per cent for those with three or more children. The majority of the aged who were not capable of caring for themselves in every respect were able to continue to live in the community because of the support of spouses and children.

While extended families did not share a single household, they preserved considerable intimacy. Aged parents on average enjoyed ten visits and ten phone calls per month from their children; only 12 per cent saw their children less than once a month. In an interesting reversal of the pattern that would be expected in a developing country, the survey showed that where financial help passed between aged parents and children it most commonly passed from the aged parents to their middle-aged children. There are poor widows who receive financial help from their children but more commonly the older generation have been able to make a sufficient provision for their old age, and beyond age 70 everyone receives a government pension which is not means-tested. Help from children is more likely to come in the form of assistance with performing household tasks and other necessary chores. For those with four or more children 66 per cent had recently had some help from them. For those with no surviving children 30 per cent had had help from other relatives (mostly siblings) while 28 per cent had paid-for services, and 10 per cent had been able to use government-subsidized services such as meals-on-wheels or home-help.

Contrary to popular belief, the potential for family support has actually increased during the twentieth century in Australia.[68] Earlier marriages between spouses closer in age to each other have contributed to greater joint survival. Although fertility levels have fallen, the proportion of individuals ever marrying and ever becoming parents has risen and the survivorship of children has increased.

The Future for Old Women

Women who are now entering old age in developed countries are in an especially difficult position. They grew up in an age when women were expected to be wives and mothers and little else; but they now live in a world where traditional values are very much under question, particularly where they relate to women's roles. The next generation may or may not choose to adopt traditional roles but they will at least have made a conscious choice in the matter, aware that there are other fates than domesticity and that many women who have gone before have discovered the need for self-sufficiency and alternative roles through divorce or widowhood in their later years. The older generation, however, are on the cusp "caught between the new wave of feminism and the tested approach to survival that has served them all their lives".[69]

Women now in their sixties and beyond probably suffer as much from "singleism" as they do from sexism and ageism. "Singleism" is belief that life is only worth while for people who live in couples and that anyone, but especially any woman, who has never been married or is no longer married, is incomplete and must live an unsatisfactory life. Clearly, any woman who enters widowhood with this belief is at a considerable disadvantage from the start. In so far as popular culture has begun to re-evaluate the advantages of being unmarried this has only been from the viewpoint of the young: "the swinging singles". It is only relatively recently that consideration has begun to be given to the advantages of the single life-style for all ages.[70]

This chapter has focused on the situation of the majority of the aged who are women. Conventional

gerontology has tended to ignore the majority status of women and the particular problems which they face.[71] This is not to ignore the fact that men appear to find it more difficult in practical terms to live alone than women do. The traditional roles of women in Western societies give them four advantages in widowhood: (*a*) they are used to performing all of the housework tasks; (*b*) the responsibility for maintaining kinship links is largely a female one; (*c*) grandmothers have a more accepted role than grandfathers; and (*d*) "female" recreations are generally more adapted to performance by persons with declining physical abilities and mobility.[72] As sex roles become less sharply segregated these advantages for women will be increasingly shared by men. There also appears to be a marked difference in the perceptions of fathers and mothers by adult children. A widowed mother is much more likely to be invited to live with one of her children (usually a daughter) than is a widowed father. It is not clear whether this is because elderly women are thought to be more self-effacing and useful about the house or because men cling to their independence with greater tenacity.[73]

The most important factor for women in adapting to the new demography of old age in the developed countries is the assumption of additional roles. Women cannot expect that there will always be a man at hand to perform traditionally male tasks. Clearly, the widow who cannot do the household accounts or change a light-bulb because her husband had always been responsible for these chores is in an especially helpless position. In some cases a son or daughter may be available to take on such tasks but in highly mobile, low-fertility societies it is increasingly less likely that a child will be within daily reach. Ability to carry out a wide variety of roles is of immediate practical utility. It also has the advantage that it makes adaptation to the new role of widow easier. It has, indeed, been argued that one reason why women live longer than men is that they are more used to change and adapt to it more readily than men who are more set in their ways and less capable of living alone.[74]

To suggest that women should deliberately adopt life-styles which will increase their ability to cope with widowhood is far from unreasonable in societies where 19 women out of every 20 marry and where married women can expect to spend 10 years of their lives in the widowed state. Owing to the shortage of males and especially of unmarried males at older ages only one widow in ten will have the opportunity to remarry.[75] It is evident that the development of solidarity amongst women becomes increasingly important in age groups where females are ever more clearly preponderant. A long-standing cultural tradition which teaches women to regard each other as rivals rather than colleagues is sadly counter-productive.

One major route to the improvement of the status of older women in developed societies is the destruction of a broad range of negative and inaccurate stereotypes. Fortunately it is no longer the custom to insist that women must be old and useless from the menopause onwards, as in the traditional French view that "an old woman is for nature only a degraded being, because she is useless to it". Despite popular beliefs to the contrary, European cultures did not traditionally pay much respect to the aged.[76] Old age was an especially terrible period for women because of the negative view of women past reproductive age which at its most extreme resulted in witchcraft accusations. Whilst almost all other traditional cultures offered a range of honourable roles which grandmothers could play, this was much less the case in Europe. Even now in North America and Europe the status of older people has improved more because of the pushing onward of the age at which people are defined as being "old" than because of any greater respect for the aged. It has become acceptable to insist that one is only as old as one feels.

One stereotype which appears to have been largely created by social scientists relates to the neurotic woman facing the "empty nest" stage of her marriage when all her children have left home.[77] Whereas in the United States in the 1890s the average woman was widowed before her last child left home, by the 1960s she could expect 17 years of the "empty nest" before her husband retired. When it was uncommon for women with young or school-aged children to seek employment, those who sought to create new roles when their children left home found that their lack of resources and experience were obstacles to creating new and satisfying roles. However, as paid employment has become commonplace even for mothers of young children this problem is moving towards resolution and women who have not sought such employment are mostly women who positively enjoy their domestic role.[78] The women's liberation movements may have largely neglected the needs of older women but they have promoted changes which will make life much easier for the next generation of old women.[79] Those who can create post-parental roles for themselves are making a good preparation for the future.[80]

One reason why the "empty nest" is often an unreal abstraction from reality is its base in a definition of the family which considers only co-resident family members. Even if the parent is living elsewhere, the middle-aged daughter may still acquire a new and time-consuming role as the support of an infirm parent.[81] Furthermore, for the individual woman, becoming a grandmother may be a much more significant life-cycle stage than her last child leaving home.[82]

ALTERNATIVE MODELS FOR THE FUTURE: INNOVATIVE RESPONSES AND NOVEL SOLUTIONS

Income

It would be unrealistic to discuss options for the future without recognizing that the range of options available is often restricted by the limited incomes available to older people who are no longer wage earners or who have never been wage earners. For example, mobility may be restricted by arthritis but the impact that this has upon social interaction will also depend upon the ability to pay for door-to-door transport. Low income in middle age becomes lower income in old age. Old women are poorer than old men. For example, in the United States in 1977 14 per cent of women over 65 lived in families with incomes below the poverty level as compared with only 8 per cent of older men. Women living alone, most of whom were widows, were the poorest of all. In 1977, 51 per cent of women aged 65+ living alone had annual incomes of $4,000 or less, the comparable figure for men was 36 per cent.[83]

Housing

Housing has a vital impact upon the options available to the aged. In part, housing options depend upon income: "geriatric ghettos" result from the elderly poor congregating where housing is cheap and there is ready access to shops and other facilities. However, another constraint beyond finance is the lack of innovative thought that has gone into the provision of appropriate housing. The example of Merrill Court in San Francisco shows how even an existing apartment building can form the basis for a community where there is a common facility such as a coffee lounge where nodding acquaintanceships can develop into "social siblingships". Fully 37 out of the 43 people living in this block were elderly widows with similar skills and resources but they still gave each other considerable mutual support.[84]

Sometimes adverse stereotypes also stand in the way of appropriate changes in living patterns. There is a myth that two women cannot share a kitchen without quarrelling. Yet there are many financial and practical advantages in two widows or elderly spinsters sharing a housing unit. Sometimes, especially in government-controlled housing, there are regulations which prohibit such practices. Group housing has become common among the young but it would also have many benefits to offer the old. Governments should "encourage supportive, low-cost, co-operative living arrangements that are self-governing and do not approach institutionalization".[85]

In most developed countries older people face a range of housing options from complete autonomy in one's own home, via retirement communities to institutions. American data suggest that about one in four old people will experience living in an institution catering for the aged before they die and that, owing to differential survival rates, two thirds of those living in such institutions will be women.[86] All the available evidence shows that autonomy is very highly valued by the aged. Often it is the provision of supportive services which allows older people to maintain their autonomy at home. Examples are meals-on-wheels, visiting nursing services, home-helps and house maintenance services. Such services not only fill deeply felt needs, they also impose much less of a financial burden on the community than the provision of subsidized institutional accommodation.

Social arrangements

It has already been suggested that innovative social arrangements may help to resolve many housing problems faced by the less affluent aged. Solutions such as newly acquired "sisters" also solve social problems. In Florida the Share-A-Home Association assists people to form new "families" of non-related older adults who share a house and the expenses of running it, and have paid staff to take care of finances, housekeeping, food and laundry. The advantages for the new family members are that they maintain freedom of choice while being associated with others who give affection and concern.[87]

Another innovative step has been the establishment of the Foster Grandparent Program.[88] The volunteers must be over 60 and have a lower level of income. They are paid a minimum wage to work with children in institutions, including those for handicapped and disturbed children. The one-to-one contact is usually of benefit both to the children and to the "grandparents" who have found a new role. The roles which older people can play as volunteers are often overlooked yet nevertheless very valuable. What is needed is a recognition that old does not mean obsolete or useless. Once again the stereotype does a disservice by cutting off options. Many voluntary organizations are in fact largely made up of students and young idealists and older people who no longer have to put their careers or their family obligations first in the allocation of their time.

NOTES

[1] United Nations, "Patterns of sex differentials in mortality in less developed countries", in *Sex Differentials in Mortality*, A. Lopez and L. Ruzicka, eds. (Canberra, Department of Demography, Australian National University, 1983), pp. 7-32.

[2] J. Vallin, "Sex patterns of mortality: a comparative study of model life tables and actual situations with special reference to the case of Algeria and France", in *Sex Differentials in Mortality*, pp. 443-476.

[3] R. A. Fisher, *The Genetic Theory of Natural Selection* (New York, Dover, 1958).

[4] M. Teitelbaum, "Factors associated with the sex ratio in human populations", in *The Structure of Human Populations*, G. Harrison and A. Boyce, eds. (Oxford, Clarendon Press, 1972), pp. 90-109, provides an excellent overall summary of theories as to the sex ratio at birth.

[5] Amniocentesis is a procedure which involves taking a sample of amniotic fluid from the uterus at about the 16th week of pregnancy in order to get a sample of fetal cells to examine for chromosomal abnormalities. The discovery of the sex of the fetus is usually regarded as incidental to this process in developed countries.

[6] A. Ramanamma and U. Bambawale, "The mania for sons: an analysis of social values in South Asia", *Social Science and Medicine*, vol. 14B (1980), pp. 107-110. Experience in China showed a similar preference for preserving male fetuses only: cf. Teitung Hospital, "Fetal sex prediction by sex chromatin of chrionic cells during pregnancy", *Chinese Medical Journal*, vol. 1 (1975), pp. 117-120.

[7] E. Hammel, S. Johansson and C. Ginsberg, "The value of children during industrialization: sex ratios in childhood in nineteenth-century America", *Journal of Family History*, vol. 8 (1983), pp. 346-366.

[8] S. Johansson, "Sex and Death in Victorian England: an examination of age- and sex-specific death rates, 1840-1910", *A Widening Sphere*, M. Vicinus, ed. (Bloomington, Indiana University Press, 1977), pp. 163-181.

[9] *Ibid.*

[10] R. Kennedy, "The social status of the sexes and their relative mortality rates in Ireland", in *Readings in Population*, W. Petersen, ed. (New York, Macmillan, 1972), pp. 121-135.

[11] G. Simmons and others, "Post-neonatal mortality in rural India: implications of an economic model", *Demography*, vol. 19 (1982), pp. 371-389.

[12] *Ibid.*, p. 384.

[13] M. Rosenzweig and T. Schultz, "Market opportunities, genetic endowments and intrafamily resource distribution: child survival in rural India", *American Economic Review*, vol. 72 (1982), pp. 803-815.

[14] L. Chen, E. Huq and S. D'Souza, "Sex bias in the family allocation of food and health care in rural Bangladesh", *Population and Development Review*, vol. 7 (1981), pp. 55-70. See also T. Poffenberger, "Child rearing and social structure in rural India: towards a cross-cultural definition of child abuse and neglect", in *Child Abuse and Neglect*, J. Korbin, ed. (Berkeley, University of California Press, 1981), pp. 71-95.

[15] N. Williamson, *Sons or Daughters: A Cross Cultural Survey of Parental Preferences* (Beverly Hills, Sage, 1976).

[16] But see M. Douglas, "Population control in primitive groups", *British Journal of Sociology*, vol. 17 (1966), pp. 263-272; R. Sauer, "Infanticide and abortion in nineteenth-century Britain", *Population Studies*, vol. 32 (1978), pp. 81-93; S. Scrimshaw, "Infant mortality and fertility behaviour in the regulation of family size", *Population and Development Review*, vol. 4 (1978), pp. 383-403.

[17] M. Wolf, *Women and the Family in Rural Taiwan* (Stanford, Stanford University Press, 1972).

[18] Williamson, *op. cit.*, pp. 111-115.

[19] Some historical data, however, are available in K. Pakrasi, *Female Infanticide in India* (Calcutta, Editions Indian, 1970); and L. Panigrahi, *British Social Policy and Female Infanticide in India* (New Delhi, Munshiram Manoharlal, 1972).

[20] A. Lopez and L. Ruzicka, eds., *Sex Differentials in Mortality* (Canberra, Department of Demography, Australian National University, 1983) provides an excellent overall view of current thinking in this area.

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[22] P. Cantrelle, "Mortalité: facteurs", *Demographie comparée* (Paris, Institut national de la statistique et des études économique (INSEE), Institut national d'études démographique (INED), 1967); L. Chen, "Maternal mortality in rural Bangladesh", *Studies in Family Planning*, vol. 5 (1974), pp. 334-341.

[23] H. Ware, *Women, Demography and Development* (Canberra, Development Studies Centre, Australian National University, 1981), pp. 57-66.

[24] F. Madigan, "Are sex mortality differentials biologically caused?", *Milbank Memorial Fund Quarterly*, vol. 35 (1957), pp. 202-223; R. Pressat, "Surmortalité biologique et surmortalité sociale", *Revue française de sociologie*, vol. 73 (1973), pp. 103-110.

[25] R. Kennedy, *The Irish: Emigration, Marriage and Fertility* (Berkeley, University of California Press, 1973), chap. 3, "Mortality and relative living standards", pp. 41-65.

[26] D. Heer and H.-Y. Wu, "The separate effects of individual child loss, perception of child survival and community mortality level upon fertility and family planning in rural Taiwan with comparison data from urban Morocco", *CICRED Seminar on Infant Mortality in Relation to the Level of Fertility* (Paris, Committee for International Co-operation in National Research in Demography (CICRED), 1975), pp. 203-224.

[27] P. Stearns, *Old Age in European Society* (London, Croom Helm, 1977), p. 20.

[28] *Ibid.*, pp. 49-74.

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[36] United Nations, "Patterns of sex differentials . . .".

[37] H. Ware, "Female and male life cycles", in *Female and Male in West Africa*, C. Oppong, ed. (London, Allen and Unwin, 1983), pp. 6-31.

[38] L. Ruzicka and H. Hansluwka, "Sex differentials in mortality: effects on the family life cycle and fertility", in *Sex Differentials in Mortality*, A. Lopez and L. Ruzicka, eds. (Canberra, Department of Demography, Australian National University, 1983), p. 333.

[39] Figures quoted from Ruzicka and Hansluwka, *op. cit.*, pp. 325-328.

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[43] Cf. B. Miller, *The Endangered Sex: Neglect of Female Children in Rural North India* (Ithaca, New York, Cornell University Press, 1981).

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[51] S. Vatuk, "The aging woman in India: self-perceptions and changing roles", in *Women in Contemporary India*, A. de Souza, ed. (Delhi, Manohar, 1975), pp. 142-163. It is of interest that these village women defined being old as having a married son and could not understand why the menopause might be considered a significant life-cycle stage.

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[63] The French data and the argument are drawn from H. Le Bras, "Some social and demographic consequences of widening sex differentials in mortality", in *Sex Differentials in Mortality*, A. Lopez and L. Ruzicka, eds. (Canberra, Department of Demography, Australian National University, 1983), pp. 297-310.

[64] G. Frinking, "L'incidence de la surmortalité masculine sur le cycle de la vie familiale", in *The Family Life Cycle in European Societies*, J. Cuisenier, ed. (The Hague, Mouton, 1977), pp. 277-283. The calculations are based on the over-simple assumptions that mortality is independent of marital status and that the mortality of husband and wife is independently determined.

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[66] *Ibid.*, table 53. The designation of the household head (person one) is left to the household. There were 155,975 households where the wife was designated the head while the husband was resident in the household.

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XII. INTERACTIONS BETWEEN MORTALITY LEVELS AND THE ALLOCATION OF TIME FOR LEISURE, TRAINING, CONSUMPTION AND SAVING OVER THE LIFE CYCLE

*Dov Chernichovsky**

Mortality, an event which arouses the deepest of human emotions, nevertheless leads to countless implicit and explicit decisions aimed at making the best out of life. In this chapter some basic elements of economic theory, pertaining to the household, are applied to speculation about the effects of changes or variations in mortality on key aspects of behaviour: work, training, consumption and saving. Theoretical notions are particularly important here, as they lead to interesting implications concerning secular gains in productivity and labour force participation that have yet to be fully studied. In strict economic terms, "to make the best out of life" involves man's aspiration to maximize his welfare through the wise allocation of scarce resources, the most fundamental of which, *time*, is the very essence of life. It thus becomes of prime interest to explore how perceptions of longevity—both as a resource and as a life to support—may affect behaviour and economic strivings.

The chapter begins by briefly laying out some of the conceptual foundations for the discussion. In subsequent sections, the effects of mortality decline on the allocation of time, education and saving are discussed and summarized.

DEFINITIONS, ASSUMPTIONS AND BASIC CONCEPTUAL CONSIDERATIONS

As the discussion employs a particular theoretical framework, some underlying assumptions and clarifications of terminology and approach are needed. These deal with the household, its behaviour or allocation of resources, and an operational definition of mortality for the purposes of this analysis.

The household, whether a nuclear or an extended family, is the basic socio-economic unit that makes decisions about allocation of resources and the welfare of its members. Economists usually view the household as a harmonious microcosm that makes deliberate decisions. This harmony means that the household "pools" the endowments of all its members to produce what is "best for all" in an altruistic sense. People decide on behalf of their kin, spouses and children in particular, as if they were making decisions for themselves. These views, which may be subject to considerable debate, constitute basic working assumptions for a systematic discussion of behaviour in a family context.[1]

The economic analysis of household behaviour can be summarized as follows. Household members engage in activities which produce "ends" or consumption commodities, including "leisure", which have utility. These commodities compete for the household's scarce resources, including time, because producing more of one commodity entails producing less of others.

The household undertakes production using time endowments of its members, and other resources, land and capital, which can be accumulated through either inheritance or investment. Capital divides into two forms: capital assets such as equipment, and human capital which constitutes primarily good health, education and skills. The technology of production, a key determinant of productivity, is embodied both in people's education and training, and in the equipment employed.

Whatever a household produces or gains in what is considered income at any period of time can be either consumed or saved and invested. Saving is considered a means for storing current income for consumption in the future. Investment is regarded as a process which aims at increasing the household's capacity to produce and consume in the future. In many instances, household saving and investment coincide, as when farmers use resources to improve their land.

Time is the most basic resource or endowment available. It is a finite resource which is used both to consume and to produce. When used in consumption, even of leisure, it is complementary to other final goods and services which are acquired through income.[2] From the viewpoint of consumption, time can often be considered an "end" in itself. When time is expended in production, it is employed in conjunction with other so-called factors of production. Of course, time can be used as an investment, the common one being schooling. In these cases time is considered as a "means" rather than an end.

Time is a peculiar resource in that one cannot actually save it, and its use is inevitable and irreversible. However, one can store goods, which are produced with time inputs.

The "institutional" division between time spent at work (production), in school (education) and on consumption (household activities and leisure) may be arbitrary. People work or spend in school a certain number of hours per day, days per week and weeks per year, and are expected or required to do certain things at particular times and ages.

A household's allocation of time between work and other activities is conditioned by its level of wealth, the relative attractiveness of work, usually measured by wages, and of course some subjective preferences. Peo-

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ple are believed to allocate their time to a point at which their satisfaction, obtained through additional consumption (current and deferred), derived from extra work, is equal to the satisfaction they would derive from additional leisure obtained by not working. The household allocates its income between consumption and saving or investment accordingly, balancing the expected return in the future against the forgone pleasure from current consumption. The cost of this trade-off is commonly measured by interest rates, which can be regarded as one of a set of prices which influence people's choice regarding the composition of household consumption over time.

This simplified conceptualization of the household's decision-making process is sketched in figure XII.1.

The interaction between saving and investment on the one hand, and allocation of time on the other hand, needs to be stressed in our context. This interaction has a time dimension as is illustrated in the figure. Households allocate time in conjunction with other inputs, and produce income which is subsequently divided into consumption and saving or investment. Hence, while the allocation of time, given people's productivity or wage level, is a determinant of consumption and saving, desired levels of consumption and saving may induce a particular allocation of time. Hence, we have here a rather circular or bi-directional relationship. It follows therefore that the allocations of time, consumption and saving or investment (including investment in human capital) are all simultaneously programmed as part of an overall plan for household members over some planning horizon which constitutes some concept of life-time.[3]

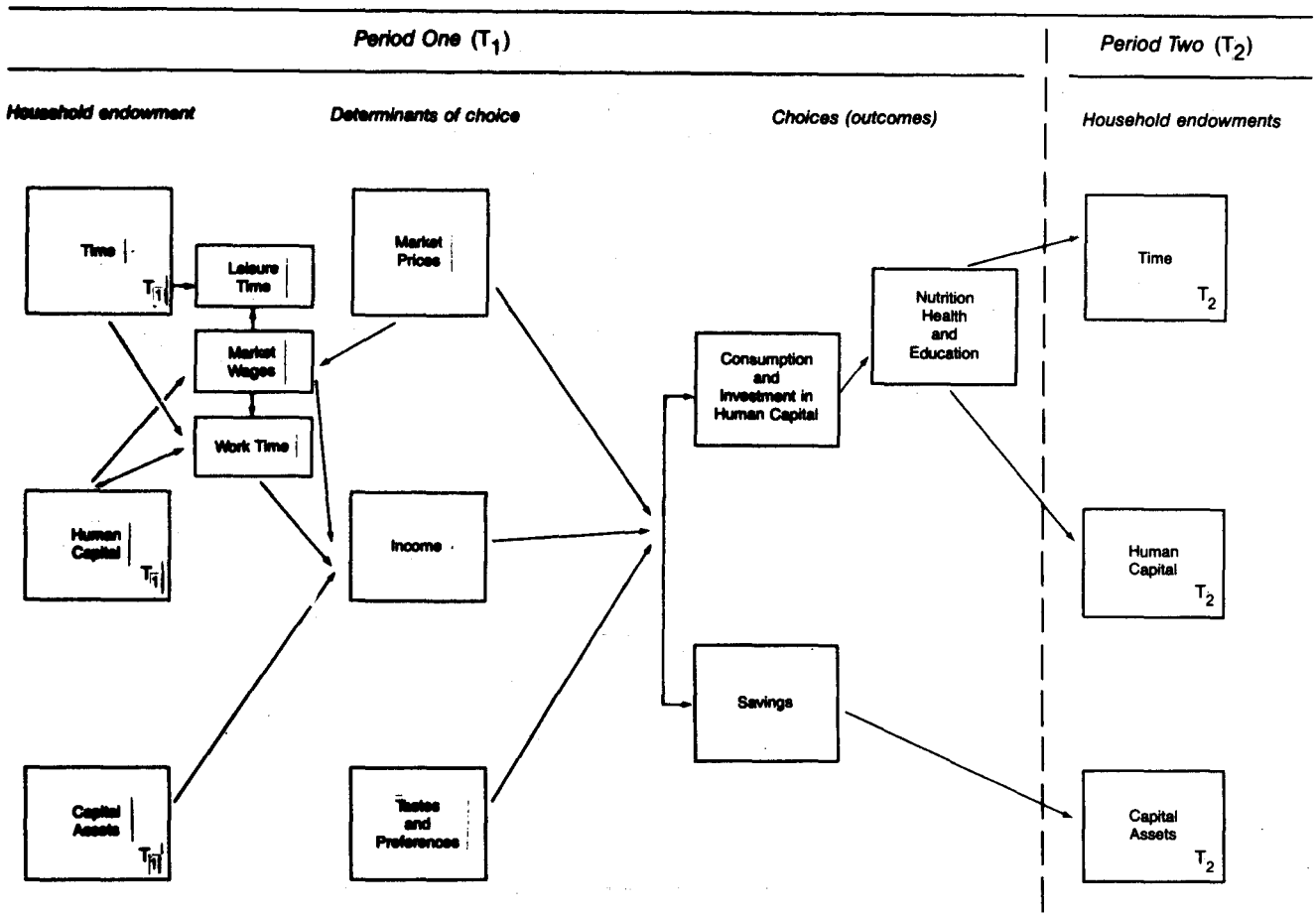
A decline in mortality means a rise in the life expectancy of a household member of a given age. From the viewpoint of the discussion thus far, this means a rise in the household's basic endowment or resource, time, as well as the amount of life to support. From a narrow economic perspective, a decline in mortality also means a rise in the certainty of participating in a scheduled event at a future age. "Certainty" is yet another economic resource associated with mortality decline that affects behaviour.

It is this increase in the time endowment and its implications for scheduling, given various mental, physiological and institutional constraints, as well as the added certainty about outcomes, that are believed to alter behaviour.[4]

Mortality and allocation of time

Allocation of time over the life cycle is customarily concerned with three sequential periods: schooling, work and retirement. Although common institutionally in industrialized economies, the clear-cut divisions between any two periods of activity are fairly arbitrary; people learn, work and pursue leisure throughout life. It is the intensity of each activity which varies with age for a

Figure XII.1. An economic conceptualization of the household's decision-making process



variety of biological and institutional reasons. The distinction between periods is used here, none the less, to facilitate the discussion. Intensity of activity will refer here to qualitative aspects of time use in terms, say, of better education and more productive work when correspondingly in school or at work. In this section we focus on allocation of time between work, leisure and retirement. Schooling is dealt with in a later section.

Retirement, often an institutional consideration, is crucial to this discussion. How retirement comes about in different social and economic settings is beyond the scope of this discussion. For analytical purposes two régimes are envisaged here. Under the first, people are obliged to retire at a predetermined age, irrespective of their mental and physical states. Under the second, retirement is voluntary.

A decline in *age-specific* mortality leads to an increase in households' time endowment: each member benefits from higher longevity, and for given levels of fertility, more members survive to successive ages.

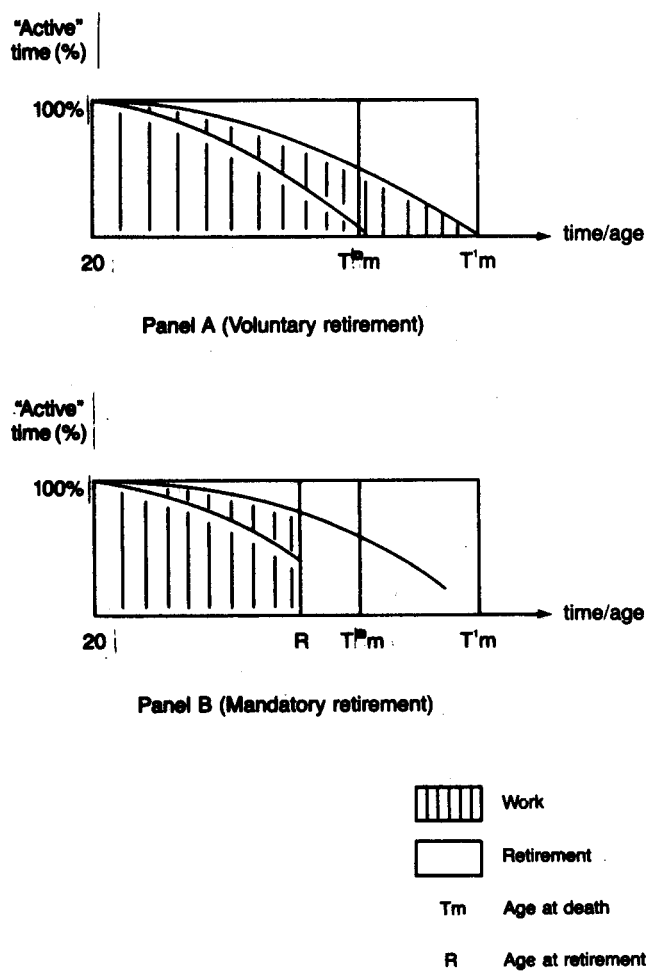
Assuming stationary fertility and increasing survivorship, in some steady-state fashion, the household will at any moment have absolutely more persons of school and working ages, as well as retired people. However, since rising survivorship usually has a relatively greater impact in younger age groups, the household will have relatively more children and working adults compared with retired persons. The discussion is none the less focused on adults who have to support longer life of their own. That is, this discussion ignores the "population issue" or the space dimension associated with lower mortality. Rather, it emphasizes the life cycle or time dimension.[5]

Without venturing into what might be considered a "household's life cycle", the effect on adults of higher longevity is sketched in the two panels of figure XII.2. In panel A, illustrating a situation where retirement is voluntary, longevity means potentially more working time, and certainly a higher *ratio* of the life cycle devoted to retirement. This is the case to an even more marked extent when retirement is mandatory, as illustrated in panel B.

The prospect is clearly one of relatively more retirement time; over the life cycle, leisure time becomes relatively abundant compared to time at work.

Since time is not transferable and income is, through saving and investment, consumption and retirement (time) can be equalized or averaged out over the life cycle through higher levels of saving and investment. Disregarding for the moment the ratio of savings out of income, a rise in level of saving for retirement can be brought about by relatively higher levels of production or income while in the labour force. Thus, all other things equal, increasing longevity will induce more worl

Figure XII.2. Cohort time allocation between work and retirement



and production, particularly where retirement is mandatory. There is, of course, the pressure to "bring forward" some of the relatively abundant retirement time.

Theory and evidence suggest that the burden of increasing savings tends to rest with women; women's work has been conventionally considered a way to protect or enhance household savings.[6]

Clearly, the only way to increase—while in the labour force—both saving, through higher production, and leisure is through higher levels of productivity, which augments time at relatively young ages. Hence, the quest to increase saving for retirement, and at the same time to benefit, throughout the life cycle, from longer life, leads to a fundamental pressure to increase productivity in both market and household (non-leisure) activities. This pressure is particularly high in settings where retirement is mandatory because, when retirement is an effective constraint, years in the labour force do not increase with longevity. One implication of this state of affairs is relatively higher "specialization" between market activities and leisure. People will tend to bunch the different activities.[7]

It should be noted that gains in productivity, if large enough, may offset the effect discussed thus far. For example, sufficiently high productivity (and income) may lead some individuals to early retirement. This view, whereby productivity is a derivative of the wish to allocate time, is not common. It is usually considered that gains in productivity initiate time reallocation.

To conclude the theoretical part of this discussion, it is postulated that, all other things equal, declining mortality will lead to (*a*) relatively higher specialization in allocation of time between work and leisure; (*b*) a rise in labour force participation, among women in particular; and (*c*) pressures to raise productivity as a way to offset (*a*) and (*b*). In addition, there will be clear social incentives to shift upward the age of retirement, and create state-funded social security schemes which relieve individuals from direct pressures to provide for retirement.

The test of these hypotheses may be next to impossible. We know that modernized and industrialized societies have been characterized by specialized or bunched "work" and "non-work" activities, retirement schemes, relatively high female labour force participation and, by definition, relatively high productivity.

A recent relevant account from Australia may be of interest here.[8] Between 1911 and 1981, life expectancy rose in that country on the order of 16 years for males and 19 years for females. During the same period hours per week worked and weeks per year worked have declined. However, total hours worked by households did not change much; in 1911, households worked 115,000 hours to support 1,006,000 hours of life, and in 1981, 110,000 hours to support 1,322,000 hours of life. This account reflects reduced hours of work and reduced labour force participation of males, balanced by increased market activity by females. Both males and females gained in terms of leisure, mostly from gains in life expectancy. Males have also increased the number of hours allocated to home activities, but not to the extent women have withdrawn from these activities.

Hence, we observe gains in leisure and almost no change in lifetime market activity, relatively more sharing in activities between males and females, and gains in productivity presumably facilitating the other phenomena. These changes—specifically, changes in productivity—may have been induced, in part, by declining mortality.

Mortality, education and training

Education is an investment. The demand for education is derived from the returns it produces. A decline in mortality leads to longer periods of educational benefits and thus returns from this kind of investment. Market benefits clearly last longer where retirement is not mandatory and people choose to remain at work than where regulations force them out at a specific age.

Another important aspect is certainty about returns from investment. As declining mortality means increasing certainty about scheduled events, it raises the certainty of returns to investment in education. This adds to the incentive to invest.

This last point is of particular importance, as investment in education is mostly in the form of children's schooling. Loss of investment is closely associated with child mortality and is therefore substantially affected during gains in expectation of life. As a result, the discussion in this section is divided between investment in schooling and subsequent learning or continuing education.

Falling age-specific mortality increases the returns of education and reduces the risk associated with losing the investment in schooling. This argument can be extended to a hypothesis that a rise in child survivorship will raise parents' desire to invest in schooling of any child, even at the expense of fewer offspring.[9]

In an effort to prove this hypothesis, the following rather tentative empirical test was performed. Data were obtained from a cross-sectional household survey carried out during 1967-1968 in the village of Ankodia, in the Indian state of Gujarat.[10] The 161 village households from which economic and demographic data were gathered reported 324 children between the ages 6 and 14, the compulsory schooling ages in India. As children in this village attended school irregularly, these data provided the opportunity to test the hypothesis.

An index defining the household's investment in children's schooling was developed based on comparison of schooling experience in the household with that of the village's schooling norms.[11] This index was used as a dependent variable in a linear regression estimated by ordinary least squares. The parents' attitude towards child mortality was approximated by the ratio of the number of children who have died in the family to the number ever born. This ratio was used as an independent variable along with household income, parents' education and father's occupation (civil servant or otherwise). The estimated coefficients are reported in table XII.1.

When controlling for income, parents' education and the father being a civil servant, the household's child mortality ratio has a statistically significant negative effect on the parents' investment in their children's primary schooling. Hence, within socio-economic strata identified by variables that presumably determine school-related abilities and tastes for schooling, households that experience more child mortality appear to provide less education for their living children. Unfortunately, we cannot determine whether the measured effect of mortality on schooling is only behavioural as

TABLE XII.1. REGRESSION ANALYSIS OF INDEX OF HOUSEHOLD SCHOOLING: ANKODIA (GUJARAT STATE), INDIA, 1967-1968

Independent variable	*Regression coefficient*	*t statistic*
Household income (rupees)	.00003	2.796
Father's schooling (years)	.04932	2.242
Mother literate (yes=1)	.22637	2.094
Father civil servant (yes=1)	.54790	3.755
Ratio of children who died to number born	−.49033	−2.118

NOTE: R^2, .28; F, 13.49.

postulated here; poor health leads to a lack of concentration, absenteeism and dropping out, and thus may affect schooling in some other ways than through parents' motivation. However, the fact that the household's socio-economic characteristics are controlled for, and that we relate the effect of children who died to the schooling of those surviving, lends more weight to the hypothesis postulated here.

The discussion in the previous section suggests that declining mortality, especially where retirement is mandatory, is conducive to higher productivity, which is commonly brought about by technological change, usually associated with investment in education. This is clearly an added incentive to invest in education. Technological progress puts stress on adult (continuing) education in what can be considered a vicious circle. Longer life and longer productive life in particular, as well as technological advance, create a growing need to maintain and raise the demand for higher and continuing education.

In this regard there is an interesting difference in implications between a régime of mandatory retirement and that of voluntary retirement. In the first case, length of productive life may not change much with increased longevity, and hence the demand for more schooling is associated with a desire for high productivity or improved technology. In the case of voluntary retirement, the desire for more schooling is associated with returns from longer productive life as well. To the degree that there is a trade-off between more working years and more productive work, the push for technological change is stronger in a régime of forced retirement.

Thus as a result of declining mortality we hypothesize that the demand for both schooling and continuing education will rise. The quest for keeping up with technological change and productivity may put added pressure on continuing education. Furthermore, this conclusion ties in with that of the previous section; in so far as education is considered a time-consuming (and even leisurely) activity, there will be an additional incentive to increase demand for education with rising survivorship.

A continuing trend of increasing school enrolment and educational attainment has been one of the most common characteristics of this century. It is postulated here that declining age-specific mortality may have been a major force behind this phenomenon, and a force which could be very important in the future for developing countries.

MORTALITY, SAVING AND INVESTMENT

Saving and investment have been defined as forms of abstaining from current consumption in order to increase productivity and consumption opportunities in the future. Special forms of investment are schooling and training, which have been discussed in the previous section. In this section, saving or investment in non-human capital is considered.

The incentive to increase the volume of savings for retirement, especially when retirement is mandatory, is clear. Under no retirement régime does work carry on in proportion to the rise in life expectancy. The volume of savings can rise through greater production and increasing proportions saved out of income. We focus here on the desire to save out of given income.

It is important to consider what happens to total saving over the life cycle. This consideration amounts to the question of whether family resources bequeathed to the next generation are larger under low mortality than high mortality rates. The hypothesis is that higher life expectancy is associated with a higher bequest to the next generation. This hypothesis rests on the basic assumption that the majority of people are risk-averse, and thus tend to secure "buffers" which are beyond their real needs. The size of this buffer is likely to rise with longer retirement periods.[12] Rising levels of savings for investment are consistent, of course, with the desire to enhance productivity.

Thus the hypothesis set forth here is that savings volumes and rates per household rise with declining mortality. To test this hypothesis is complicated and beyond the limited scope of this paper; however, circumstantial evidence is available.

Numerous studies show that savings rates are higher in high-income and industrialized countries which have the highest life expectations. To relate this evidence entirely to life expectancy in a simple fashion may be pretentious, as numerous other factors are involved. Tobin's elaboration on the Ando and Modigliani life-cycle saving model introduces survival probabilities as a parameter, explaining saving behaviour and capital accumulation. Tobin's model and an application of it to Peruvian data by Conroy show that increased survival probabilities and longer retirement bring about higher saving ratios and thus higher capital accumulation and economic growth rates.[13]

CONCLUSION

The above micro-economic discussion is a preliminary effort to explain how falling mortality levels create a variety of long-run pressures on individuals and households to reallocate resources over the life cycle. The discussion suggests that longevity is conducive to saving, schooling and training, and technological change. Rising survivorship is postulated to be a major force behind rising productivity because rising levels of productivity are almost the only means to spread consumption of goods and leisure over an increasing life span.

These basic hypotheses offer yet another explanation of both the industrial revolution and the demographic transition. Declining mortality is a catalyst for such revolutions, creating a self-reinforcing circle whereby technological change improves survivorship, which in turn spurs on technological change as a means of raising productivity.

From a social viewpoint, the line of thought just presented can explain the pressures for extended public education, investment in research and development, and

social security schemes, all in an effort to shift some of the financial "burdens" of declining mortality from households to society as a whole.

Declining mortality is, of course, also associated with changes in patterns of fertility and other demographic consequences which are not discussed here. Changes in age structures and dependency ratios have direct implications on the issues mentioned in this chapter. Future work might productively proceed to integrate the hypothesized relation between mortality and productivity to established theories of fertility decline.

NOTES

[1] For extensions of economic theory to study families see Gary S. Becker, *A Treatise on the Family* (Cambridge, Massachusetts, Harvard University Press, 1981); Yoram Ben Porath, "The F-connection: families, friends and firms, and the organisation of exchange", *Population and Development Review*, vol. 6, No. 1 (March 1980), pp. 1-30.

[2] This particular approach is based on Gary S. Becker, "A theory of allocation of time", *Economic Journal*, No. 75 (September 1965), pp. 493-517.

[3] Dov Chernichovsky, "Personal savings and family size: the unresolved issue", in *Economic and Demographic Changes: Issues for the 1980s*, Proceedings of the Conference (Helsinki, 1978), pp. 345-359.

[4] The discussion abstracts from the questions of how perceptions about mortality are formed, and their influence on individuals' and households' decisions. We are dealing here with long-term changes manifest across cohorts for which particular mortality patterns are facts of life. The discussion here is essentially a comparative analysis of economic pressures confronting different households which live under different mortality régimes.

[5] As far as household decisions are concerned, it is assumed that parents decide on behalf of their spouses and children as if they were all part of a single "self".

[6] Jacob Mincer, "Labor force participation of married women: a study of labor supply", in *Aspects in Labor Economics*, National Bureau for Economic Research (Princeton, New Jersey, Princeton University Press, 1962).

[7] Gregg H. Lewis, "Hours of work and hours of leisure", *in* John F. Burton, Jr., and others, eds., *Readings in Labor Market Analysis* (New York, Holt, Rinehart and Winston, 1971).

[8] Rodney Maddock and Michael Carter, *Hours, Leisure, and Wellbeing 1911-1981*, Working papers in Economic History, No. 19 (Canberra, Australian National University, 1983).

[9] For a more rigorous discussion of this point see Dov Chernichovsky, "The interrelationship between parents' investment in children's health and education: theoretical and empirical notes", Working paper 82-1 (Health and Welfare Economics Division, Ben-Gurion University, 1982).

[10] R. M. Patel, *Ankodia: Changes in Economic Life in a Tobacco Village* (India, Vallabh Vidyanagar, 1970).

[11] The index defines a household's investment in children's education as the ratio between the actual level of schooling of school-age children and the predicted level, given children's age and sex distribution, based on the community's schooling experience.

[12] Institutional arrangements for the old may mitigate and offset this incentive as they tend to "pool" risks and eliminate them from individuals.

[13] James Tobin, "Life cycle savings and balanced growth", in *Ten Economic Studies in the Tradition of Irving Fisher* (New York, Norton, 1976); Michael E. Conroy, "Population growth, life cycle saving, and international differences in steady-state optimal saving rate", *Demography*, vol. 16, No. 3 (August 1979), pp. 425-438.

Part Three

CONSEQUENCES FOR HEALTH-CARE SYSTEMS, INSURANCE AND PENSION SCHEMES

XIII. DECISION MAKING FOR HEALTH CARE IN DEVELOPING COUNTRIES

*Robert S. Northrup**

That good health is the objective of health-care systems should be evident, but all too often it is not. Health and its promotion are ignored, while the health-care system exhausts its resources in often fruitless combat with sickness and death.

In developing countries this apparent irrationality is particularly critical, as the resources available to the health sector are extremely limited. Yet in most such countries, the concentration of the system on sickness and death not only consumes resources which might be more effectively used in promoting health, but also actively inhibits health-oriented activities, while the unresolved competition between the two efforts makes ineffective and destructively inefficient even those measures which care for the sick.

The curative orientation of developing country health-care systems stems from the human tendency to deal with problems only after they arise. Prevention and health promotion require a future orientation, which in turn demands learning from past experience. Sickness is here and now, demanding attention and action today. We humans tend to seek care from the system after we get sick, not before, when it might be prevented. Cured, we forget our symptoms, and resume our previous unhealthy habits.

Patient demands for attention, in turn, have shaped the health-care system. Much of the system grew up over time as an unplanned response to the demands of those who sought care, that is, a response to morbidity and mortality. More recently health planners have attempted to make the system more rational and comprehensive, but have based their recommendations too largely on available morbidity and mortality data. In both the unplanned and planned processes there is thus the medical counterpart of that tendency to ignore the less insistent and rather different demands of health and prevention. Need and feasibility have lost out in competition with demand. The result is a sickness-care system, a death avoidance system, that devours resources rapaciously yet fails to produce a healthy society.

Developing countries can ill afford such sickness-care systems, which have become an increasingly unmanageable drain on the budgets of even the wealthiest developed nations. Their meagre resources demand careful planning to achieve maximum benefit, maximum health, within minimum budgets. This efficiency requirement, in turn, demands a different set of data, a set of health data different from, although inclusive of, the traditional and more easily available morbidity and mortality data.

We propose to describe the mortality and morbidity patterns and the sickness-care systems of developing countries, which have evolved in the context of a medical model based on patient demand and physician response. On the basis of the discrepancies between the illness patterns and the systems, we will discuss the disadvantages and deficiencies of mortality and morbidity data as a basis for planning a health-oriented care system. We will then propose an expanded data set, a set of health statistics, which might more effectively provide the basis both for planning and for management of such a health-care system.

MORTALITY

A major problem in using mortality data as the basis for health care system plans is a lack of valid and universal data. It is characteristic of developing countries that they are organizationally and bureaucratically underdeveloped. Recording and reporting of all deaths and selected illnesses demands a chain of organization down to the village and neighbourhood level, which is rarely present. As a result, the indigenous data available to planners are usually incomplete. They are also likely to be biased. Newborn and infant deaths are often unrecorded in countries where a newborn is considered a person and given a name only after surviving 40 days. Rural deaths are less likely to be recorded than urban if the appropriate government office is a four-hour walk away. Deaths among the poor will be missed if there is a fee for recording the death.

A medically trained individual is usually needed to determine the cause of death.[1] For this reason such data usually are submitted by hospitals or, less frequently, by health centres.[2] They are thus biased because they exclude those without access to such facilities.

For these reasons much of the information regarding illness is from limited studies or from those few developing countries which have dependable reporting systems. From those sources estimates of mortality and morbidity in less advanced areas can be made.

The pattern of mortality which emerges is dramatically different from that seen today in wealthier developed countries. Life expectancy at birth in low-income countries averages only 51 years, and in several it is less than 44 years.[3] This compares to an average of 61 in middle-income countries and 74 in industrial countries.

For the majority of the poor, those with per capita incomes below $US 150, life expectancy is estimated to be around 42 years, almost 30 years less than the potential for human life by United States standards.

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Grateful acknowledgement is made to James Bailey for editorial, and Jon Rohde for critical evaluation of the manuscript.

Some 72 per cent of the population of the 38 poorest countries is in this category.[4] In general, as income rises, life expectancy approaches asymptotically the industrialized countries' 74 years. Figure XIII.1 shows, however, that national policies may substantially influence this general pattern. Despite high per capita incomes in the oil-rich nations, life expectancy remains low there. In China, Cuba and Sri Lanka, countries where national policy has emphasized social rather than economic priorities, life expectancy is substantially above the rates expected at the low per capita incomes seen in those countries.[5]

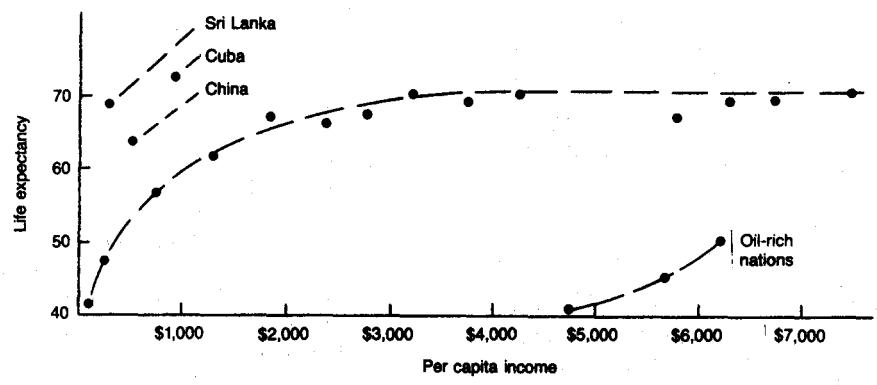
Reduced life expectancy in developing nations is primarily the result of high mortality among infants and children. Where improvements in life expectancy have occurred, they have been largely due to reductions in the death rate among these very young, rather than to an extension of life for the elderly. Indeed, improvements in life expectancy of those who have reached the age of 45 have been much more costly and difficult to achieve.[6] Recently the previous steady annual increase in life expectancy gains has dropped off, despite sharply increasing expenditure, from 0.6 to 0.4 years of life gained annually in less developed regions, and from a peak of 0.45 years to 0.1 in Western Europe.[7]

The very young are particularly susceptible to the interaction of poverty and disease. In 34 low-income countries with per capita income less than $US 300 in 1979 the reported infant mortality rates varied from 49 to 237 per 1,000 live births. In the poorest regions of developing countries, half of all children die during the first year of life.[8]

The infant mortality rate is commonly considered a better index of development than income, as it reflects the availability to the public of social benefits which would improve survival such as improvements in the environment, nutrition, education, or medicine.[9] Because of this, infant mortality along with life expectancy shows substantial variations in its relationship to per capita income, reflecting again national development priorities (fig. XIII.2). Rohde stresses that industrial development and urbanization may raise average per capita income, but may also raise infant mortality among the increasing numbers of urban slum dwellers as benefits fail to "trickle down".[10]

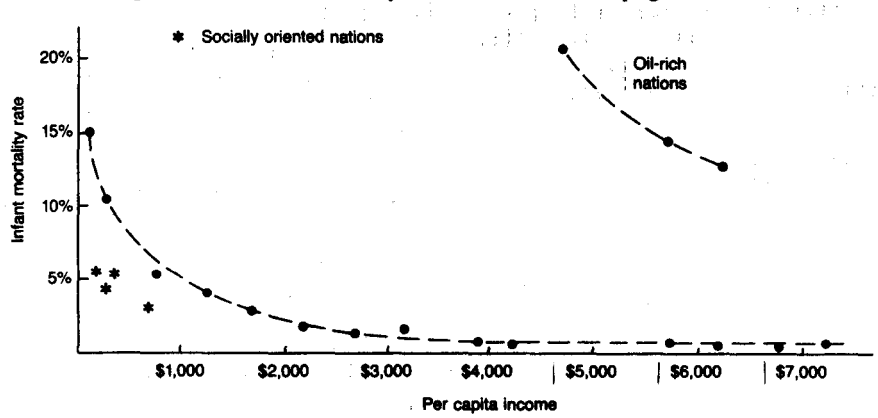
In most developing nations the high mortality rates of infancy continue into early childhood.[11] The relationship between infant and early child deaths is not constant, however, as table XIII.1 demonstrates. Similarly in Shanghai, during a period of improvement in a variety

Figure XIII.1. Life expectancy and income in developing countries



Source: Charles S. Pineo, David W. Schrare and G. Wade Miller, *Environmental Sanitation and Integrated Health Delivery Programs,* International Health Programs, Monograph Series No. 4 (Washington, D.C., American Public Health Association, 1981). Data for China, Cuba and Sri Lanka from World Bank, *Health: Sector Policy Paper* (Washington, D.C., February 1980).

Figure XIII.2. Infant mortality rate and income in developing countries



Source: Pineo and others, *op. cit.* Additional data for China, Cuba, India (Kerala State) and Sri Lanka from World Bank, *Health . . .*; and from D. Morley, J. E. Rohde and J. Williams, eds., *Practicing Health for All* (New York, Oxford University Press, 1983).

TABLE XIII.1. DISTRIBUTION OF DEATHS UNDER FIVE YEARS

Country	Year	Age (years) 0+	1-4
		(Percentage)	
Jamaica	1958	70.0	30.0
Indonesia	1980	62.6	37.4
Thailand	1962	57.3	42.7
Guatemala	1961	50.0	50.0

Sources: Samuel H. Preston, *Mortality Patterns in National Populations, With Special Reference to Recorded Causes of Death* (New York, Academic Press, 1976); Ratna, "Preliminary report: Household survey, February-April, 1980" (Indonesia, Health Ecology Research Center, Ministry of Health). Unpublished document.

of resources available to the poor, there was a dramatic fall in the overall proportion of deaths among infants and children with ultimately a greater improvement in the proportion of deaths in children 1 through 4 versus infants 0 to 1 as shown in table XIII.2.[12] This is a typical pattern of change as infections and malnutrition are overcome. The residue of more resistant mortality in the remaining neonatal period demands more than primary care during labour and delivery to show a response.

Table XIII.2 also shows how crucial it is for planners to be sensitive to the influence of presenting figures as proportions rather than absolute numbers or rates. In Shanghai adult deaths rose in proportion as deaths in the 0-5 age group fell. This might lead planners to shift their concentration to reducing adult mortality. Absolute numbers of adult deaths, however, probably rose very little during this period, and indeed the rate of death for any given age group doubtless fell. Planners must weigh carefully whether they wish to be most influenced by proportion of deaths in the various age groups (important for priority setting); by absolute numbers of deaths (to estimate burden of care); by rates (best indicator of specific response, best for comparison); or by factors other than pure mortality, such as cause (for targeting intervention). Planning for curative services must also consider variations in demand or utilization of such services for sickness at different ages or in females versus males. Parents might not seek care for a sick female baby, but would for a wage earner.

While reduced infant mortality is generally considered a sign of progress, Gopalan points out that reduced infant mortality rates may camouflage a shift to increased morbidity from malnutrition, chronic disease or recurrent acute disease such as is now seen in Kerala.[13] Again, the planner must take steps to assess this potential situation, and if it is present, be prepared to choose between higher mortality or a costly and suffering morbidity, such as that among the elderly population still alive owing to medical "success" in staving off death.[14]

TABLE XIII.2. DISTRIBUTION OF DEATHS IN SHANGHAI COUNTY BETWEEN 1960 AND 1980 (Percentage)

Year	0-4 year age group	Infants less than 1 year as percentage of 0-4 year age group	50+ age group
1960	28.6	58.8	51.8
1970	9.3	48.8	72.5
1980	5.1	73.6	82.0

Source: Gu Xing-Yuan and Chen Mai-ling, "Vital statistics", *American Journal of Public Health*, vol. 72, from supplement entitled "Health services in Shanghai County" (September 1982), pp. 19-23.

Mortality rates in children 5 to 14 are the lowest of those in any age group.[15] The deaths in this group, however, remain a significant percentage of overall deaths in countries where high fertility has led to a broad-based population pyramid (figure XIII.3), because of the large proportion of the population in this age group.[16]

Deaths within the age group of 15 to 44 are particularly important, as these are the children's parents and the productive workers of a country. While the rates and proportions of the deaths in this age group are low in the least developed countries (LDCs) in comparison to those of infants, the rates are higher than those in developed countries[17] and hence are, from an absolute perspective, avoidable through appropriate intervention. They also constitute a significant overall proportion of deaths and thereby also a significant load on the health-care system.

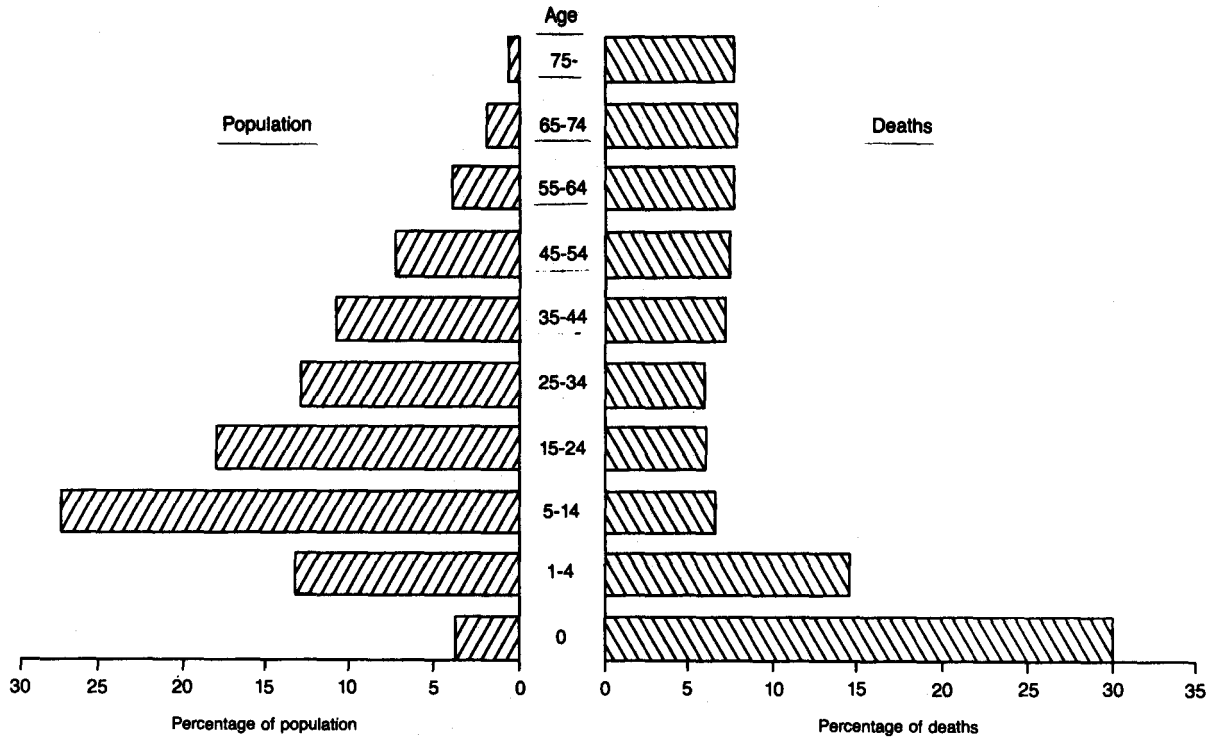
Deaths to those above age 45 account for a smaller proportion of overall mortality than in developed countries, and thus attract less attention from planners oriented toward mortality data. Nevertheless, this group provides 30 per cent of overall deaths or more,[18] and may constitute the most important group for service providers, as persons in this age group will be very likely to demand medical care when they are sick. Meanwhile, in some developing countries, their morbidity and mortality rates are increasing.

Cause-specific mortality figures are much more useful for targeted health system planning than the crude death rates or mortality-by-age figures discussed above. Where medical facilities and reporting are limited, however, such crude rates may be the only figures representing the whole population available to the health planner. Data from hospitals, the other usual source, are biased toward the potentially rather different causes of death experienced by those with access to hospitals; that is, the urban, wealthy and knowledgeable. To avoid this bias, demographers and health planners have extrapolated cause-specific death rates from developing countries with adequate recording and reporting to developing countries without those capabilities, adjusting for differences in growth rates, life expectancy and other factors.[19] A typical developing country pattern prepared in this fashion for Java, Indonesia, is seen in table XIII.3.

Grouping of the diseases in table XIII.3 has important implications for health-care services. In the infant age group, 57 per cent of the deaths are from infectious diseases, pneumonia or diarrhoea. Many of these deaths are either preventable through immunization programmes (tetanus neonatorum, measles, and diphtheria-pertussis) or subject to cure or mortality avoidance with simple early therapy (pneumonia with penicillin, diarrhoea with oral rehydration).

Diseases of infancy constitute fully 35 per cent of total infant deaths. A substantial although less clearly defined proportion of these diseases could be either prevented or treated; the extent and efficacy of treatment would depend on the sophistication of facilities available. Simple programmes to train village midwives in both appropriate management of normal deliveries and appropriate referral of abnormal ones have played a

Figure XIII.3. Distribution of population and deaths in Indonesia, 1975



Source: Terence H. Hull, Jon Rohde and Alan D. Lopez, "A framework for estimating causes of death in Indonesia", *Majalah Demografi Indonesia*, No. 15 (June 1981), pp. 77-125.

TABLE XIII.3. CAUSES OF DEATH IN INDONESIA, 1975

(Percentage of deaths in each age group)

	Age group					*Total*	
Causes of death	*0*	*1-4*	*5-14*	*15-49*	*50+*	*Percentage**	*Deaths (thousands)*
Respiratory tuberculosis	0.1	0.4	1.7	21.6	4.3	6.2	113
Certain respiratory diseases[a]	17.4	22.4	10.6	7.7	10.7	13.8	251
Other infectious and parasitic diseases[b]	14.2	24.5	30.0	10.0	3.3	12.9	235
Certain diarrhoeal diseases	25.7	25.7	7.0	2.3	2.8	13.3	241
Certain diseases of infancy[c]	34.9	-	-	-	-	10.5	191
Neoplasms	0.0	0.3	0.9	5.0	9.5	3.7	67
Cardiovascular diseases[d]	0.6	1.0	1.1	1.0	0.3	0.4	7
Certain degenerative diseases[e]	0.2	1.1	2.4	4.1	5.4	2.7	50
Complications of pregnancy	-	-	-	7.4	-	1.7	31
Motor vehicle accidents	0.0	0.1	1.1	1.0	0.3	0.4	7
All other violence	0.5	2.5	7.7	10.9	2.4	4.1	75
Residual[f]	6.2	21.9	32.0	17.6	28.8	18.6	339
TOTAL	100	100	100	100	100	100	
Absolute number of deaths in thousands	549	268	117	411	474	1 818	

Source: Adapted from Terence H. Hull, Jon Rohde and Alan D. Lopez, "A framework for estimating causes of death in Indonesia", *Majalah Demografi Indonesia*, No. 15 (June 1981), pp. 77-125.

*Sums may not equal 100 owing to rounding.

[a] Pneumonia in particular; also influenza, bronchitis.

[b] Measles, malaria, neonatal tetanus, diphtheria, pertussis, dengue.

[c] Congenital problems, injuries during labour, problems related to low birth weight.

[d] Including rheumatic heart disease.

[e] Diabetes, liver cirrhosis, renal diseases, peptic ulcers.

[f] Protein-energy malnutrition (PEM), unspecified diagnoses, also congenital malformations and senility. PEM constitutes about half of residual deaths in age group 1-4.

major role in reducing the number of these deaths.[20] Supplemental feeding programmes for pregnant women have reduced the incidence of low-birth-weight babies.[21]

In the age group 1-4 years, the percentage of deaths from infections, pneumonia and diarrhoea increases to 73 per cent. The same comments regarding prevention and early treatment apply here also. It should be noted that the percentage of residual deaths is 6.2 per cent in the infant group, but has risen to fully 21.9 per cent in this group. At least half of these are due to malnutrition.[22]

Heart disease, as might be expected, plays an increasing role in mortality in the older age groups, as do neoplasms. Tuberculosis and other treatable or preventable infectious diseases remain important problems, in contrast to the developed countries. Maternal mortality is fully 7.4 per cent of deaths in the age group 15 to 49. The large proportion of residual deaths in the 50+ age group is made up primarily of undiagnosed deaths and deaths from senility.

These figures from Java are representative of those in many developing countries. Certain areas in the world will demonstrate higher proportions of particular diagnoses. For example, in Bangladesh (Matlab) fully 26.2 per cent of all infant deaths in the period 1975-1977 were from tetanus neonatorum.[23] In Somalia[24] the same problem accounted for 29 per cent of an infant mortality rate of 182. Doubtless this can be accounted for by both local cultural practices dealing with the umbilical stump and a lack of any substantial penetration of immunization services to mothers in the areas surveyed.

Countries with a high prevalence of specific vector-born diseases may show a somewhat different pattern. In Africa, malaria has both a primary and supporting responsibility for much of the infant and child mortality. Payne observed that in areas hyperendemic from malaria, fully 50 per cent of infant mortality may be due to this disease.[25] Trypanosomiasis, schistosomiasis, Chagas' disease and oncocerciasis also may constitute significant causes of mortality.[26] Where present these diseases also demand inclusion in the overall health-care system for the country.

Morbidity

While avoidance of premature death is the apparent objective in customary health services planning, there are a number of reasons why morbidity patterns should be given equal if not greater weight in policy setting.

Morbidity is much more frequent than mortality, and is more sensitive to alterations in environment including availability of services.[27] This makes morbidity data from a continuous surveillance system particularly valuable as feedback to field teams for incentive and for use by supervisors setting work priorities or eliminating ineffective activities. Morbidity usually precedes mortality in the individual patient. Medical curative services are invoked as a means of avoiding mortality as well as disability. Hence, mortality is only a crude planning guide, and to the extent that fatal risk varies substantially by disease, death misrepresents the burden of illness in the population, and therefore the burden on the health-care system.

Reduction of avoidable morbidity and disability is a major objective of development, part of the desired improvement in quality of life. Every mother, for example, wants her child to avoid or be cured of unnecessary blindness from vitamin A deficiency even though it may not be fatal. Popular demand makes the management of morbid states, both those which are non-fatal as well as those which are potentially fatal, a key element in the cost of health-care services.

Many chronic illnesses reduce the ability to work, both through absenteeism and through decreased productivity of employed workers. These include schistosomiasis,[28] malaria, yaws[29] and hookworm infestation with resulting anaemia.[30] Ability to learn is also impaired by sickness and malnutrition.[31] Benefits from improvements in morbidity in the productive groups of the population may be more convincing to economists and development planners when attempting to justify investment in the health sector than benefits to infants or the elderly. These illnesses are under-represented on mortality lists, despite widespread prevalance, as they are characteristically chronic and infrequently fatal.

Grouping non-fatal diseases with fatal disease of similar origins (e.g. grouping ascariasis with typhoid fever as both diseases of faecal contamination) will provide a more complete picture of the benefits to be obtained by preventive efforts aimed at the underlying cause as compared with curative efforts aimed only at the resultant specific disease.

Finally, morbidity from one illness may be the underlying cause of mortality or morbidity from another. For instance measles may be the true cause of deaths occurring up to 9 months after the infection[32] yet labelled as pneumonia, diarrhoea, or malnutrition. Recognition of this fact is critical for targeting the true underlying cause for intervention, in this case measles immunization.[33]

Given these multiple reasons, it is particularly damaging to valid planning that true morbidity estimates are even more difficult than mortality data to obtain (even in developed countries). And, as with mortality data, usual collection methods may provide biased results. Use of available data from clinics, or admission and discharge data from hospitals, will tend to over-emphasize illness that occurs in those who utilize medical services (the more wealthy and better educated), more severe illness (hospital data), or illness in locations where services are located (urban). Surveys miss acute illnesses of brief duration or seasonal occurrence. As a result, valid morbidity data are rarely available to planners, particularly morbidity data from continuous surveillance.

Various studies do provide some information about probable patterns of morbidity, but also illustrate the problems of interpreting available data. Illness has been found to disrupt personal activities for roughly one tenth of people's time in developing countries.[34] This figure is substantially higher in certain populations, however. A group of pregnant women in rural Guatemala were ill during 49 per cent of the duration of their pregnancy,[35] predominantly from upper respiratory disease, anorexia, pains and headache. This figure was similar to that seen in children in a rural Mayan community of low socio-economic conditions.[27]

A rural health survey in India demonstrated a high prevalence of preventable and/or treatable diseases (table XIII.4). Diagnoses made in a primary health centre (PHC) out-patient department showed a somewhat similar pattern (table XIII.5). Note, however, the

TABLE XIII.4. SICKNESS AT THE TIME OF A GENERAL RURAL HEALTH SURVEY: NIALA, INDIA, 1974

Disease	*Morbidity rate (per 1,000 population)*
Anaemia	534.0
Respiratory disease	324.3
Nutritional deficiency disease	209.7
Trachoma	174.5
Dental caries	114.7
Helminthiasis	108.9
Conjunctivitis	59.0
Skin diseases	50.8
Diarrhoeal diseases	36.9
Pediculosis	22.1

Source: R. Sarma and S. K. Chaturvedt, "India", *Basic Health Care in Developing Countries: An Epidemiological Perspective,* Basil S. Hetzel, ed. (Oxford, New York, Toronto, Oxford University Press, Oxford Medical Publications, 1978), pp. 87-101.

TABLE XIII.5. DIAGNOSES IN RURAL INDIAN PRIMARY HEALTH CENTRES, 1974

Diagnoses	*Percentage*	
Bronchitis/bronchopneumonia	20.4	33.1
Common cold	10.7	
Bronchial asthma	2.0	
Diarrhoea	17.7	28.2
Dysentery	9.4	
Typhoid	1.1	
Scabies and ringworm	9.9	12.7
Abscess and boils	2.8	
Eye diseases	4.0	5.2
Trachoma	1.2	
Ear diseases	3.8	
Pyrexia	6.8	
Anaemia		
Night blindness		
Rickets	0.6	
Maramus		
Osteomalacia		
TOTAL	90.4	

Source: Sarma and Chaturvedt, *op. cit.*

absence of tuberculosis in both sets of data, and the absence of nutritional deficiency in the PHC list, where, presumably, illnesses were treated without assessment of weight or height of children.

The predominance of trauma in Pari Village (Papua New Guinea) (tables XIII.6 and XIII.7), in comparison with the above Indian data, documents the problems associated with all attempts to gather morbidity data. Presuming that a similar incidence of such injuries is present in the Indian community also, we note that the Indian survey, by its brief duration, failed to pick up acute injuries such as skin lacerations or cuts to the feet. In addition, the PHC centre out-patient clinic in India apparently was not used by the local populace for acute injuries, in contrast to the Papua New Guinea clinic.

All these data document the predominance of "minor illnesses", not likely to lead individually to death. These might be ignored by an efficiency-conscious planner. However, in repeated episodes, such minor maladies may lead to weight loss, failure to thrive, and high risk of mortality in children. Mata[36] showed clearly the impact of recurrent episodes of diarrhoea on weight gain in children, for example. As the child approaches and then falls below the threshold of severe malnutrition, the likelihood of death increases dramatically. Intervention, such as nutritional supplementation or use of ORT for diarrhoea,[37] which could break this infection-malnutrition cycle,[38] can be of critical importance in reducing both subsequent morbidity and mortality.

TABLE XIII.6. COMMON DIAGNOSES SEEN IN PRIMARY HEALTH CENTRE: PARI VILLAGE, PAPUA NEW GUINEA, 1969-1974

Rank	*Diagnosis*	*Episodes*	*Attendances*
1	Skin laceration	3 003	6 521
2	Cut to foot	2 019	4 594
3	Multiple skin sores	1 268	2 926
4	Single skin ulcer	1 214	3 510
5	Febrile URTI	1 183	2 293
6	Acute diarrhoea/vomiting	942	1 488
7	Acute sore eye	825	1 593
8	Nonfebrile URTI	818	1 245
9	Boil	699	1 971
10	Pneumonia	696	2 617
11	Cough	542	751
12	Burns	353	801
13	Influenza	351	829
14	Febrile sore throat	303	618
15	Otitis media	290	1 049
16	Ascariasis	284	471
17	Sprains and strains	270	421
18	Cellulitis finger, toe	263	875
19	Cellulitis and lymphangitis	257	704
20	Acute bronchitis	251	718
	TOTAL	15 831 (77% of all episodes)	13 995 (77% of all attendances)

Source: I. Maddocks, "Papua New Guinea: Pari village", in *Basic Health Care in Developing Countries: An Epidemiological Perspective,* Basil S. Hetzel, ed. (Oxford, New York, Toronto, Oxford University Press, Oxford Medical Publications, 1978), pp. 11-37.

TABLE XIII.7. SUMMARY OF DIAGNOSTIC GROUPS TREATED IN PRIMARY HEALTH CENTRE: PARI VILLAGE, PAPUA NEW GUINEA, 1969-1974

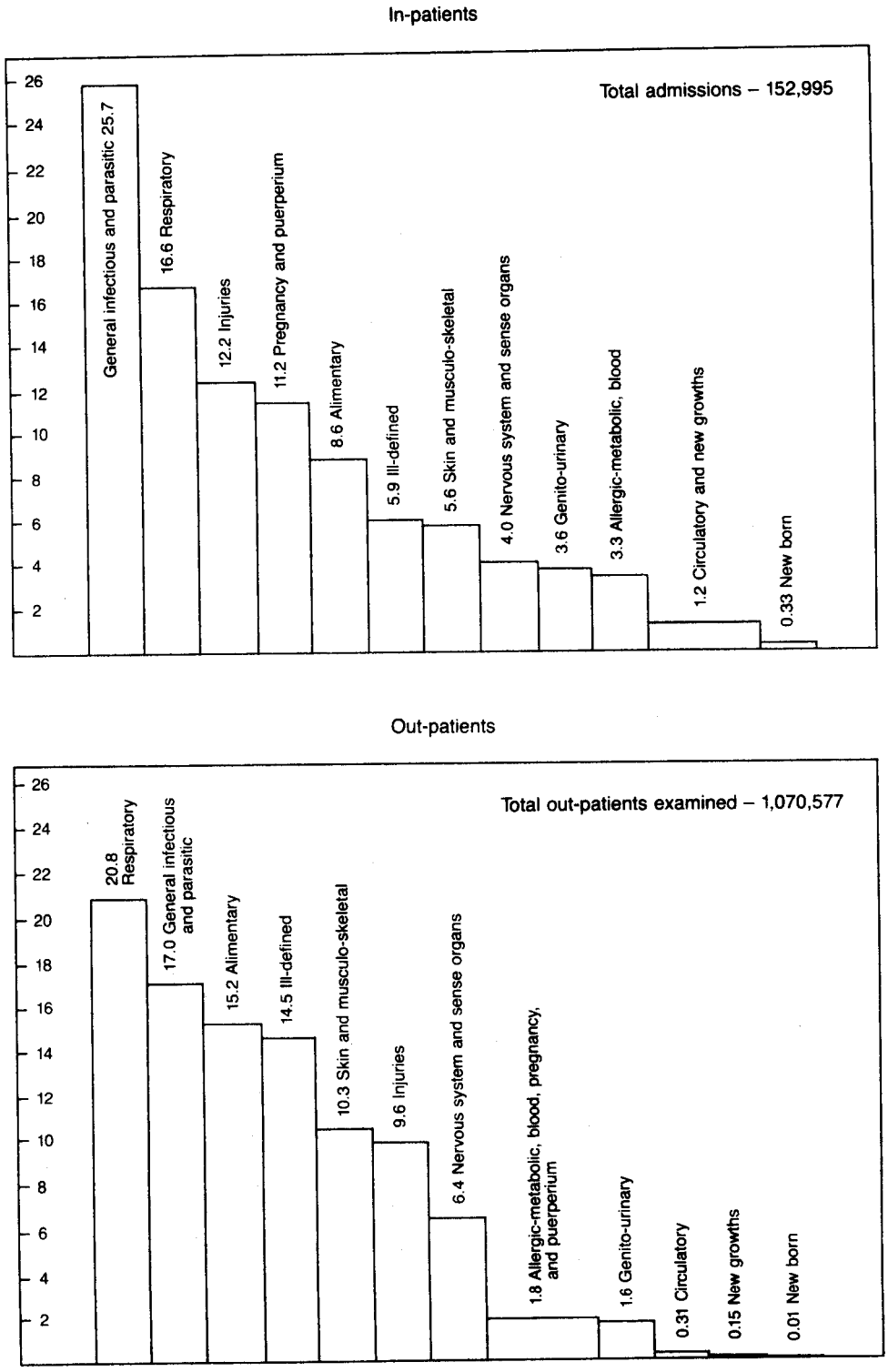
Diagnosis	*Percentage of all episodes*
Skin trauma	27.4
Skin infections	20.1
Acute respiratory disease	20.1
Diarrhoeal disease and abdominal pain	7.1
Eye and ear infection	6.2
TOTAL	80.9

Source: Maddocks, *loc. cit.*

A different pattern yet is seen in Kenyan hospital admissions (figure XIII.4). Compared with out-patient admissions, the in-patient data showed a higher frequency of infectious and parasitic diseases, injuries and diagnoses related to pregnancy, as well as diseases of the elderly including circulatory diseases and neoplasms. These diagnoses are proportionally much less represented in the ambulatory population in Kenya, and not at all in the most frequent illnesses charted in India or Papua New Guinea or in a sample of patients at a health sub-centre in Thailand.[39]

Another major group of missing diagnoses in available morbidity data are those for which treatment is sought from traditional healers outside the medical system. Rienks and Purwanta[40] describe seven diagnostic groups of this sort from rural Java. Some such disorders may be minor, but many overlap in the public mind with fatal diagnoses—failure to thrive, tetanus neonatorum, jaundice.[41] Where traditional healers and

Figure XIII.4. Causes of morbidity among in-patients and out-patients in Kenyan government hospitals, 1960



Source: N. R. E. Fendall, "Medical care in the developing nations", in *International Medical Care: A Comparison and Evaluation of Medical Care Services Throughout the World*, John Fry and W. A. J. Farndale, eds. (Wallingford, Pennsylvania, Washington Square East Publishers, 1972), pp. 204-248.

the problems brought to them are included in health-care system design (e.g. China),[42] the community impact of the health-care system can be expected to improve as its utilization for problems by the people improves and opportunities for prevention and health promotion increase.[43] Given the willingness of the population to pay for such traditional care,[44] financial support for the system can also be augmented in this fashion.[45]

Morbidity and mortality in primary care

Despite my contention that mortality and morbidity levels are less than ideal bases for planning health-care systems, it is important to note that a number of projects have demonstrated substantial impact from disease-specific programmes created in response to just such data. Berggren, for example, documented the reduction of overall mortality by 40 per cent in a census tract in Haiti through specific programmes for the area targeted against malnutrition, diarrhoea, tuberculosis and tetanus neonatorum,[46] and a flood of other primary health-care reports carry the same message.[47] Relative to the data in table XIII.3, Hull and Rohde[48] estimated that the Javanese crude death rate could be reduced by 29 per cent (14 to 10 per 1,000) and the infant mortality rate by 40 per cent (128 to 77 per 1,000 live births) if a number of such programmes were implemented aimed specifically at the major causes of death.[49] The measures used are a combination of primary prevention (health promotion, risk factor screening, and disease-specific prevention such as vaccination) and early effective medical therapy for responsive diseases, which may be termed secondary prevention.[50] With these fruitful technical approaches at hand, why is it that so few health-care systems in developing countries have made them the major elements of their programmes?[51]

Physician influence

Few health-care systems have been designed and managed to solve data-defined problems in the community; instead, most have evolved haphazardly in response to a variety of influences. Perhaps the primary influence determining the nature of health-care systems in developing countries is doctors.

Doctors are the key decision makers regarding health in most developing countries at both the individual and system levels. Yet their training in developing countries is notorious for emphasizing rare and Western diseases at the expense of common and indigenous ones. Faculty, trained in the West, teach what they learned there, in spite of, perhaps ignorant of, its lack of relevance.[52]

The clinical teaching process tends to ignore the simple and familiar in preference to the complex and rare. It is typical for the attending physician on the ward to ask the house staff to present the "interesting" cases, the rare or difficult ones, while the common disease problems are passed over as too simple to bear much attention, or already taught once before. Medical students rarely emerge from the medical centres with the ability to identify problems in the community or to learn their management. With sick patients on the teaching ward, the emphasis there is naturally on cure. It is thus hardly surprising that graduates are not knowledgeable or motivated toward prevention or health promotion,[53] and indeed may block efforts to provide such services as being a waste of effort and money!

The medical model also reinforces these patterns. In the medical model, the physician (or health-care system) is approached by the patient, who requests care, usually for illness, rarely for prevention. The physician graciously accedes to the request. How different this is from the relationship of health promoters to a rural mother! The promoter must request acceptance of his message by the mother, and face the real possibility of refusal. Little wonder that health-care providers prefer to stay in the clinics or hospitals and concentrate on cure. No one wants to have to "sell" good health.

Once the "contract" for care is established between doctor and patient, the provider is bound ethically to try to provide every treatment possibility which will help the patient. Where society rather than the patient pays the bill, the only limitation is availability of the modality. Thus we have coronary care, dialysis, and open heart surgery units in Jakarta or Kampala, despite the fact that these problems are proportionally rare among all illnesses in these countries.

This tendency is accentuated by the characteristics of those who seek care. They tend to be better educated, wealthier, and to live nearer the health-care facility, that is, in towns or cities. As such they too are rare types in their countries. Such patients tend to have diseases similar in nature to their middle- and upper-class counterparts in the developed nations, heart disease, cancer and the like. Their children are better nourished, immunized, have access to clean water and sewage or latrines, and thus do not become ill.

Facing few competing requests for preventive services, and insulated from the morbidity of the distant rural (or urban) poor, it is understandable that the physicians of the system should translate the problems of those who utilize their services into excellent facilities to solve them. Thus the hospitals in most developing countries consume nearly three fourths of the total health budget, yet serve as little as 5 per cent of the population. Only a sixth of most budgets in less developed countries is for health centres, dispensaries, preventive campaigns, and environmental health.[54]

Even where health systems include health centres or subcentres in the rural periphery, the manpower sent to those centres may continue to provide medical care as if they were in the urban, hospital-attached, ambulatory-care centres where many were trained, hence reducing their effect. The Lampang project in rural Thailand had little or no impact on health status, largely because even the community health-care workers trained in the project followed the medical model and emphasized treatment of disease, while missing preventive opportunities in nutrition and child health, water supply and sanitation.[55]

One might conclude that the physicians and the middle-class urbanites who get maximum benefit from the system are corrupt, using public funds for personal gain. I believe rather that the traditional medical model is at fault. Both physicians and consumers have been trained to believe that health is provided by clinical intervention after sickness occurs, rather than by prospective action to maintain or improve health. The patient arrives with his need, the doctor attempts to meet it as fully as possible. At that instant in time, it is not reasonable for the patient, and not ethical for the

physician, to consider the cost of their interaction to society at large.[56]

Individual or societal choice

The cumulative effect of many individually appropriate decisions can be the exhaustion of society's limited resources, with many failing to receive their share. Garrett Hardin[57] has posed the commons or community-owned pasture land as a model for this type of conflict between individual and societal needs in decision making where resources are limited. In the model, a householder knows that much further expansion of the total herd using the commons will overgraze and exhaust the pasture. Yet he also can calculate that adding one more cow to his own herd would bring substantial economic benefit to him (one cow's worth) but would be only a small additional burden on the total grazing capacity of the common (his cow divided by the number of cows in the total commons herd). His only choice is to add that cow: it would be irrational, against his own interest, to do otherwise. So he buys the cow. The problem is that each of the other householders goes through the same rational process and also buys an additional cow, until either the pasture is exhausted or until society steps in to prevent further consumption.

In the medical commons[58] a similar situation holds. The individual appropriate and rational decisions of a few patients seeking care and their physicians granting it result in exhaustion of the resources that are supposed to serve all of society. Where resources are particularly limited, this overuse may take the form of generalized ineffectiveness and incompetence. By trying to meet every need, both curative and preventive, compromises are made that result in no services being entirely effective. In one developing country, health ministers change as often as every six months. Consequent vacillation in policy priorities between rural and urban, between primary health care and hospitals, has led to both the prevention-oriented primary care system and the hospital care system being underfunded and ineffective, thereby inefficient and wasteful of even those few resources they receive (J. E. Rohde, personal communication).

To avoid this situation, choices must be made. John Evans aptly described the challenge facing responsible developing country Governments when he entitled his Shattuck lecture "Health care in the developing world: problems of scarcity and choice".[8] To allow a few doctors and their patients to overgraze the medical commons and monopolize the shared resources available is irresponsible for a Government that wishes to provide "health for all"—the World Health Organization goal for the year 2000.[59]

It is beyond the scope of this paper to discuss more fully the political commitment necessary to enforce such difficult choices. Such commitment has been demonstrated in China, Cuba and Kerala, but has been inadequate in most developing countries. The United Republic of Tanzania and a rural portion of Indonesia are eloquent examples of such failure of commitment.[60]

Priority setting

Making such choices rationally demands good data. Unfortunately even good mortality data have some drawbacks as the basis for planning an appropriate health-care system. One problem is that mortality data treat all deaths, and therefore all lives, equally. Having already invested substantially in education, physical support and parenting for individuals over age 15, for example, society may wish to give greater importance to their health problems and the interventions related to them than to those of infants or children. This would be in direct contradiction to the pediatric priority inherent in the "democratic" mortality data. Yet it may be very difficult for a society to publicly state that it wishes to favour adults over children, or the reverse; none the less the silence is eloquent.

The current pattern of urban, tertiary-care-weighted, Western illness-oriented medical care in developing countries reflects unstated priorities on the part of the Government, which wishes to ensure maximum survival for the educated, the urban, the middle class, government members and other societal leaders, and adults, over the illiterate, the rural, the poor, the landless, or children and babies. The decision to have a system with those priorities was not a deliberate one, but rather one by default, however, as described earlier. It would be preferable to have a data base which could better support deliberate decision making.

One approach to adding additional information to mortality data to assist in setting priorities is in use in Ghana. There the health planning unit included age at death in their calculation priorities, calculating the number of healthy days lost from each disease and the number gained through effective disease-specific interventions.[61] This approach favours actions that would improve survival of babies or children and thus gain larger numbers of healthy days, in contrast to interventions for a 60-year-old male, for whom an expensive treatment for heart disease may add only a few years of life. Hull and Rohde[62] proposed an alternative approach, noting that policy makers may wish to "save" mothers, key workers, the poor, specific age groups such as early middle age or children 5 to 14 years of age, or the educated élite who hold important leadership positions. The diseases occurring in each of these groups were then noted, for use in prioritizing interventions. Both approaches enhance the value of mortality data for deliberate, public decision making. Not included in either the Ghana or Hull-Rohde approaches is the potential for increasing days of disability with a given intervention, as mentioned earlier. Days of suffering or disability added by means of a certain intervention should be given negative weight in such calculations for allocation of resources.

Feasibility

Feasibility of potential interventions is also absent in pure mortality and morbidity data. Both technical and economic data are needed for feasibility determination. Where resources available for health are extremely limited, ineffective or costly, interventions that benefit only a few must give way to cheaper or more effective interventions which benefit many. This conflict often devolves to a choice between curative and preventive services; preventive services such as vaccination for tetanus and measles are effective and cheap compared to therapy for the same diseases. The Ghana health planners have incorporated this element into their approach by calculating days of healthy life saved per dollar spent on the intervention.[63] Walsh and Warren[64]

recommended selective primary care for infectious diseases based on prevalence, and morbidity as well as mortality, and feasibility, including a range of interventions in their high priority group—oral rehydration therapy for diarrhoeal disease, vaccination for measles and pertussis, and environmental control for malaria and schistosomiasis.

Despite the priority given to prevention, medical care must be an important part of every appropriate health system. China places "service to the people" as the first priority[65] implying its conviction that a health-care system must be responsive to felt needs as well as technically determined ones. Roemer[66] emphasizes that in a time when curative medicine is being designated as costly and ineffective, we must remember the major contribution to health which penicillin, sulfa, appropriate surgery, and many other modalities of cure have made. Furthermore, he notes that, while therapy for the chronic degenerative diseases of the West may be very costly and often not curative, INH for tuberculosis, for example, has enabled many in impoverished populations to recover good health without the need to advance economically first.[67] Such targeted medical treatment can be a short cut on the road to health. In addition, the enlightened provider can use the occasion of therapy as an opportunity to promote health and preventive measures. Both treatment and prevention, in proper balance, are needed.

Risk factors

An additional deficiency in the data base provided by mortality statistics is that it does not include identifiers which would allow pre-illness selection of high risk geographic areas or population subgroups with greater potential for morbidity and mortality, and thereby a greater need for preventive and basic curative services. Morbidity itself, for example recurrent diarrhoea in a 3-year-old, may constitute such a risk indicator. Economic status, land ownership, literacy, or location in a geographic region with low agricultural productivity should also be included in data for appropriate health system design. Even among adults, mortality rates may be strongly influenced by economic and related social factors. In Matlab, Bangladesh, mortality rates for children, adolescents, adults and the elderly (those over 75) all were significantly lower in families where the household head had more schooling, was a land-owner rather than a landless labourer, or had a larger house or owned over three cows as opposed to one or none. These mortality differentials were up to fivefold in children aged 1-3, and threefold or more in older age groups between advantaged and disadvantaged families, the greater differentials occurring during a period of food shortage.[68] Such disadvantaged families, with reduced physiologic and economic reserves, are particularly susceptible to nutritional and other deficiencies.[69] Because of this, they may constitute "sentinel families" from which regular observations of changes in morbidity and mortality may be used to determine when environmental or social changes have reached critical levels requiring government intervention.

Also, these mortality differentials at the micro level emphasize that national-level data showing progress in development may gloss over substantial pockets of developmental retardation at the community or family level,[8] that may demand special targeted efforts to link them to health care, nutrition assistance, or other resources.[70] Use of such risk indicators in planning will target the allocation of health-care resources to those recipients for whom services have the greatest impact and benefit.

Underlying causes of disease

Other factors even more directly involved in the causation of ill health, in some cases actual conditions of morbidity, are also absent or under-represented in the usual general mortality and morbidity statistics. Yet they are fundamental to planning health-care services, and are also amenable to direct attack by health sector activities. These include nutrition, fertility, faecal contamination of the environment, and ignorance.

1. *Nutrition*

Underlying most of the excess mortality in developing countries is undernutrition. As a cause of mortality it is substantially under-reported in national figures, where it is displaced by the more flagrant and acute terminal event such as diarrhoea or pneumonia. In reporting practice it is customarily relegated to the residual category and thereby "disappears" in mortality summaries.[71] Yet undernutrition is perhaps the most important cause of death among infants and children. In rural Bangladesh children below the 65 per cent cutoff of the Harvard weight for age standard, or below 70 per cent of the weight for height standard, experienced three times the mortality of their better nourished peers.[72]

In estimating overall the impact of malnutrition, Hull and Rohde[73] included all diarrhoea deaths, all pneumonia, half the deaths in the residual category, and half those due to diseases of infancy, through foetal undernutrition and low birth weight. They found that 68 per cent of all infant deaths and 80 per cent of all child deaths were due to the synergistic triad of malnutrition, diarrhoea and pneumonia. Puffer and Serrano ascribed 57 per cent of 35,095 infant and child deaths in Central and South America to malnutrition either as a primary or associated cause.[74] Furthermore, all non-fatal illness appears to contribute to undernutrition, which, in turn, predisposes the child to more frequent and more severe infection. Such illness includes measles,[75] pertussis, primary tuberculosis and diarrhoea.[76] Diarrhoea alone reduces growth by half.[77]

The influence of malnutrition begins before birth, where maternal undernutrition leads to rates of low birth weight from 13 to 28 per cent.[78] This then results in higher infant mortality. Guatemalan and Indian studies have shown fourfold increases in mortality in babies weighing less than 2,500 grams at birth.[79]

The shift from breast-feeding to bottle-feeding is a key element in both malnutrition and diarrhoea-related mortality. The incidence of diarrhoea was 3-10 times higher in bottle-fed babies and their overall death rate 3 times that of breast-fed babies in one study in South America where urbanization has stimulated a substantial shift from breast- to bottle-feeding.[80]

Acute shortages of food expose the chronic mortal pressure of undernutrition in subsistence populations. The 1974 famine in Bangladesh produced a 45 per cent rise in the crude death rate. Adults as well as infants and children died, and the highest mortality levels were experienced by the uneducated labourers and their

families.[68] In Burmese refugee camps mortality levels rose to 9 times their expected rates when food supplies were temporarily cut off.[81] Health system weighing programmes for children under five years can provide helpful warning of such pressure if included in a functioning reporting and response system.

The importance of nutrition to health is obvious. Any effective health-services planning approach must include nutritional information in its data base, ideally data from continuous surveillance. With such data systems must go the mechanisms to respond to changes in nutrition indicators with appropriate intervention.

2. *Fertility*

Another unreported, yet major, factor in mortality is high fertility, seen in most developing countries. Of the 37 lowest income countries, 29 countries had an average total fertility rate of 6 or over; 7 of the remainder were between 5 and 6; and only Sri Lanka (3.6) and Indonesia (4.9), both of which had active and effective family planning programmes, were less than those high values.[82] This compares with the total fertility rates of the 38 wealthiest countries of a mean of 2.1 (a range of 1.4 to 3.5). This high total fertility rate leads to the high infant and maternal mortality rates seen in those same countries, which could thus be reduced with an effective family planning programme. Morris[83] for the United States and Allman and Rohde for Chile and Thailand[84] noted that up to 27 per cent of the fall in infant mortality rates seen in those countries was accomplished by a shift of births from higher-risk younger and older mothers and high birth orders to lower-risk mothers by their use of family planning.[85] Hull and Rohde[86] point out that merely reducing the birth rate from 41 to 31 per 1,000 would reduce the overall estimated deaths in Java by 10.6 per cent, and the percentage of infant deaths from 38 to 30 merely by reducing the number of babies subject to death, without changing a single factor or service to those who are born. Thus an extremely effective way for the country to reduce its crude death rate as well as the proportion of infant deaths to overall deaths would be through an effective family planning programme.[87] Fertility rates, however, are not included in mortality data or morbidity data.

Birth spacing is also critical in infant and child health. The "maternal depletion syndrome" leads to foetal malnutrition and low birth weight in the offspring of the current pregnancy[88] while early weaning precipitates diarrhoea and malnutrition in the child of the previous pregnancy.[69] Infant deaths were 2.5 to 4.5 times higher in infants born less than one year compared to those born 2 to 3 years after a previous pregnancy (e.g. 225 compared to 50). Similarly, child mortality rates differed by as much as 500 per cent under similar circumstances in Lebanese and Filipino population groups.[89]

High fertility also is related to maternal mortality and morbidity.[90] A sharp and steady increase in the risk of death to mothers is noted after the third birth. Even where obstetrical care has reduced mortality, morbidity in high parity women continues to occur due to toxaemia, placental disorders, malpresentations, and haemorrhage.[91]

Larger families lead to more frequent use of abortion, with risk of attendant mortality as high as 6.7 abortion deaths per 1,000 live births.[92] Hull and others[93] estimated maternal mortality at 6.5 per 1,000 live births in Java. While deaths due to this cause may be few proportionally (e.g. 7.4 per cent in Java among all persons of ages 15 to 49, 1.7 per cent overall), each such death deprives a family of a mother, and as such is particularly important.

Morbidity during pregnancy, often related to pregnancy, has as well a consistent inverse association with birth weight. Mothers in four rural Guatemalan villages sick with anorexia, headache, or diarrhoea during more than 10 per cent of pregnancy days had 54 per cent more low-birth-weight babies than less morbid mothers.[21]

All those factors document the importance of fertility in planning health services, and of the need for pre-natal and obstetrical primary care, for referral care for obstetrical complications, and for an aggressive family planning programme in most developing countries. Again, the relevant data must be included in the planners' data set.

3. *Unsanitary conditions*

An additional cause of morbidity and mortality not definable directly by means of morbidity or mortality statistics is faecal contamination of the environment. In addition to diarrhoea, hepatitis, and poliomyelitis, many intestinal parasitic diseases are related to contamination of the environment by faeces. Provision of piped water,[94] even mere provision of soap and water with guidelines about washing hands and clothes, can reduce mortality from diarrhoeal disease and transmission of dysentery among contacts.[95] Privy construction in Costa Rica helped to reduce substantially the death rate from diarrhoea and enteritis while cholera incidence was reduced 70 per cent when water supply and toilet facilities were provided in a Philippine community.[96] These studies, by demonstrating changes in rates resulting from sanitation measures, illustrate the importance of data documenting local sanitation practices in planning appropriate health services.

4. *Ignorance*

Health-related behaviours stem from knowledge or belief. Hence, eliminating ignorance or unhealthy knowledge becomes very important in attaining health, particularly in a setting where substantial personal effort is necessary. Mosley summarized various studies indicating that children of illiterate mothers, by being unable to take advantage of additional resources offered by society, did not show reductions in mortality rates due to malaria or to diarrhoea as great as those of educated mothers.[97] Unclean water used in bottle preparation as well as inappropriate storage produces weaning diarrhoea and increased mortality in bottle-fed babies in many developing countries.[98] Rohde observed that a strong underlying "fear of the faecal peril" must be instilled in people before morbidity and mortality rates due to intestinal infections or parasites can be reduced to those levels seen in developed countries (personal communication). He further commented in his Parsons lecture that the mortality decline in the West in the early 1900s, attributed by many to economic development, may in fact have come about as handwashing and other healthy lifestyle practices became the norm in society.[99]

Neonatal tetanus results from unsanitary cultural practices surrounding childbirth. Diarrhoeal mortality results from mothers withholding fluids from their babies with diarrhoea, instead of administering to them oral rehydration solution or other appropriate solutions to stave off dehydration.

All the evidence points to the critical importance of knowledge and the critical role of ignorance in causing mortality and morbidity. Yet there are no measures of specific areas of ignorance among general mortality data to provide assistance in suitably targeting health services.

Health data for health systems

Current health-care systems follow a medical model and are based on mortality and morbidity demand by individual patients and the physician response thereto, rather than deliberate prospective planning. Due to lack of a functioning community data collection system, true mortality data covering all segments of the population are not available to planners routinely or continuously, but only by estimation and extrapolation. Even such extrapolated mortality data tend to perpetuate the current medical response to health needs, with its consideration of all lives (and all deaths) as of equal importance in decision making, its lack of data for feasibility weighting or conscious priority setting, and its absence of risk information for targeting activities. Also, the mortality patterns usually available to planners do not include the underlying causes of much mortality: undernutrition, hyperfertility, an unsanitary and faecally contaminated environment, and ignorance resulting in detrimental health-related behaviours. As such, the customary data tend to perpetuate the medical model in the care systems of developing countries, an *ex post facto* curative response to demand, rather than a prospective, prevention-oriented response to need. To attain a more appropriate health-care system, one based on a health model, health systems need, in addition to a mechanism for raising decision making to a societal level, an alternative, expanded set of data upon which to base planning. We may call this a set of health data.

Table XIII.8 lists a number of health data items. These are intended as examples, and should be expanded for particular geographic areas and problems.

To these health data have been added data which will identify families at risk. The classification of pregnant women by risk status using both medical and social factors has enabled pre-natal care providers in the United States to follow more carefully those women who have a greater likelihood of complications during pregnancy or morbidity in their newborns. Such a prospective risk-based approach is needed in general developing country health care, to identify those families who need more intensive educational input, extra social support,[100] special efforts to encourage participation in community health-related preventive programmes (e.g. weighing programmes for children, family planning, immunization), or transportation or financial assistance to improve access to medical care.

Certain morbidity data may serve also to identify such families or regions, such as frequent episodes of diarrhoea or respiratory illness in children, recent measles, night blindness, anaemia, or tuberculosis.

Key to the satisfaction and motivation of the medical provider is the opportunity to see change and recovery in his patients. The primary health worker delivering or supervising preventive care, particularly a physician, needs the same kind of feedback to maintain interest and enthusiasm in those activities. Mortality rates are too insensitive to change to provide such immediate feedback. Health data, on the other hand, can respond directly to health worker or community efforts, and thus can be used both to provide motivation and to steer future action. An excellent example is the BRAC programme in Bangladesh, where health workers became particularly effective when they were paid according to the degree to which mothers they had taught could answer questions about the use of oral rehydration therapy (ORT).[101] Such feedback is needed for communities as well as providers. To break the medical model, data and power must go to the people.

Table XIII.8. Basic health data set

Nutrition
- % mothers breast-feeding last child
- % children <60%, <70%, <80% weight for height, weight for age standards
- % children under 4 participating in weighing programme
- % children under 4 failing to gain weight at weighing
- % mothers gaining <10 kilograms during pregnancy
- % babies under 2500 grams birth weight

Immunity/Prophylaxis
- % 1-year-olds immunized with DPT
- % 1-year-olds immunized with BCG
- % 1-year-olds immunized with measles vaccine
- % pregnant women immunized with tetanus vaccine

Fertility/Maternal health
- % births <18 months from previous birth
- % births with birth order >3
- % births to women under 20 years of age or over 34 years of age

Total fertility rate for population
- % women aged 15-44 using contraception
- % deliveries assisted by trained midwife

Sanitation/Environment
- % families using sanitary latrine exclusively for defecation
- % families using potable/boiled water for drinking
- % families with convenient access to potable water
- % families with access to community water supply (rural and urban)
- % families with access to community excreta disposal (rural and urban)
- % families living in dwelling with >3 persons per room

Access to service
- % population living within 1 kilometre of primary health care provider

Ignorance
- % mothers who know correct preparation and use of oral rehydration for diarrhoea
- % mothers who know signs of pneumonia in child
- % mothers who know justification of vaccination
- % mothers who know reasons for breast-feeding as opposed to bottle-feeding

Risk identification parameters
- Income, income stability
- Education of mother, of father
- Land or livestock ownership (in rural areas)
- Land productivity
- Distance (in time) or cost of travel to health-care facility
- Certain morbidity data

Mortality and morbidity data are essential as well, however, as the outcome measures of the effectiveness of the whole system. In most developing countries neither unbiased morbidity and mortality data nor the recommended health data are collected and available routinely to planners or to field workers and their supervisors. To change these systems from demand- to need-driven systems, from haphazardly responsive and wasteful systems to systems rationally planned and maximally efficient in the use of scarce resources, a major priority of these countries must be, first of all, the routine collection of comprehensive health, mortality and morbidity data, even if additional investment is required to set up such a system. Secondly, these findings must be aggressively utilized, both in prospective planning at the national level and in regular day-to-day management through the chain of supervision down to the community and family level.

Although the collection, analysis and utilization of health data are expensive and complex, these functions are essential to an effective health-care system. Without them, we become like Alice in Wonderland, not sure of where we want to go, and therefore all too often ending up where we do not wish to be. Indeed, it will be possible to overcome the mortality and morbidity in developing countries and achieve "Health For All" only if health data are allowed to play a directing role in health-care systems in those countries.

NOTES

[1] An innovative approach at Ballabgarh, India, by Dr. Lalit Nath, established protocols for determining approximate causes of death, to be carried out by minimally trained lay persons. Agreement was high between causes obtained in that fashion and a subsequent diagnosis from a physician interview with the same family (personal communication).

[2] In Indonesia, health centres are not structurally involved in death recording, indeed are not even in the reporting channel.

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[4] Lee M. Howard, *United States Policy and Program on International Health as Related to Development Assistance*, draft No. 2 (Agency for International Development, Office of Health, Development Support Bureau, 1 February 1978).

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[6] M. D. Morris, *Measuring the Condition of the World's Poor: The Physical Quality of Life Index* (Dobbs Ferry, New York, Pergamon Press for the Overseas Development Council, 1979).

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[9] Morris, *op. cit.;* Ansley J. Coale and P. Demeny, *Regional Model Life Tables and Stable Populations* (Princeton, New Jersey, Princeton University Press, 1966).

[10] J. E. Rohde, "Why the other half dies: the science and politics of child mortality in the third world" (Leonard Parsons lecture, Birmingham, England, 1982).

[11] *Ibid.; World Development Report 1980* (New York, Oxford University Press for the World Bank, 1980).

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[13] C. Gopalan, " 'Child survival' and child nutrition", *Bulletin of the Nutrition Foundation of India*, vol. 5, No. 1 (January 1984), pp. 1-3.

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[17] Coale and Demeny, *op. cit.;* Preston, *op. cit.; World Health Statistics Annual, 1980;* Preston and others, *op. cit.*

[18] *Ibid.;* Ratna, *Preliminary Report, Household Survey, February-April, 1980* (Health Ecology Research Center, Ministry of Health, Indonesia), unpublished document.

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[43] Elizabeth K. Feierman, "Alternative medical services in rural Tanzania: a physician's view", *Social Science and Medicine*, vol. 15-B (United Kingdom, 1981), pp. 399-404; Carol P. MacCormack, "Health care and the concept of legitimacy", *Social Science and Medicine*, vol. 15-B (United Kingdom, 1981), pp. 423-428; Pierre Claquin, "Private health care providers in rural Bangladesh," *Social Science and Medicine*, vol. 15-B (United Kingdom, 1981), pp. 153-157; Roemer, *loc. cit.*

[44] Total Haitian expenditures for health, for example, are $8 per capita, while the official government health-care system expends only a fraction of that (J. Rohde, personal communication).

[45] Claquin, *loc. cit.;* "Sharing the costs of health care: conclusions of an international seminar held at Wolfsberg, Switzerland, March 1979," *World Health Forum*, vol. 2, No. 1 (Geneva, World Health Organization, 1981), pp. 85-95.

[46] Warren L. Berggren, "Reduction of mortality in rural Haiti through a primary health-care program", *New England Journal of Medicine*, vol. 304, No. 22 (May 1981), pp. 1324-1330.

[47] Howard, *op. cit.;* Rohde, "Why the other half dies . . . ", *loc. cit.;* Gwatkin and others, *loc. cit.;* M. Mujibur Rahaman and others, "A diarrhea clinic in rural Bangladesh: influence of distance, age, and sex on attendance and diarrheal mortality", *American Journal of Public Health*, vol. 72, No. 10 (October 1982), pp. 1124-1128; Ary Bordes, James Allman and Adeline Verly, "The impact on breastfeeding and pregnancy status of household contraceptive distribution in rural Haiti", *American Journal of Public Health*, vol. 72, No. 8 (August 1982), pp. 835-838; Ujjayant N. Chakravorty, "A health project that works — progress in Jamkhed", *World Health Forum*, vol. 4, No. 1 (Geneva, World Health Organization, 1983); V. Jagdish, "Primary health care in rural India," *World Health Forum*, vol. 2, No. 2 (Geneva, World Health Organization, 1981), pp. 218-221; David F. Pyle, *Voluntary Agency-Managed Projects Delivering an Integrated Package of Health, Nutrition, and Population Services: The Maharashtra Experience*, paper prepared for the Ford Foundation (New Delhi, March 1979); "Malaria and tetanus: turning back the tide", *Contact* (monthly bulletin of the Christian Medical Commission of the World Council of Churches), No. 74 (Geneva, August 1983), pp. 3-20; Charles S. Pineo, David W. Schrare and G. Wade Miller, *Environmental Sanitation and Integrated Health Delivery Programs*, International Health Programs, Monograph Series, No. 4 (Washington, D.C., American Public Health Association, 1981); D. Morley, J. E. Rohde and J. Williams, eds., *Practicing Health for All* (New York, Oxford University Press, 1983).

[48] Hull and Rohde, *op. cit.*

[49] Actions proposed are listed with the diseases they combat:

Tuberculosis: BCG, active case finding and pill therapy;
Infections and parasites: vaccines: tetanus (especially for pregnant women), DPT, measles;
Heart disease: diphtheria vaccine, penicillin prophylactic for RHD;
Pneumonia: early village treatment for tachypnea;
Diarrhoea: home rehydration (oralite solution);
Maternal mortality: pre-natal exams and anaemia control, access to transfusion;
Diseases of infancy: pre-natal nutrition supplements to mothers;
Motor vehicle deaths: traffic law enforcement, seat belts, helmets;
Residual: village food supplements for poorest 20 per cent.

See Hull and Rohde, *op. cit.*

[50] J. M. Last, "Scope and methods of prevention", *Public Health and Preventative Medicine*, J. M. Last, ed. (New York, Appleton Century Crofts, 1980), pp. 3-4.

[51] Rohde, "Why the other half dies . . . ", *loc. cit.*

[52] A conference in one developing country was attended by a physician trained in the United States at a sophisticated tertiary care centre. He presented practical aspects of using ultra-sonography to diagnose cardiac malfunction. The residents listening were intensely interested in this subject. No ultra-sonogram equipment was available in the hospital in which the conference was held. The professor was widely respected as being knowledgeable and up-to-date: that is, current with Western diseases, rare in that country, and with the techniques presented in Western journals. In the same hospital residents balked at serving in the newly-established oral rehydration unit. They complained that the cases were repetitious and therefore boring.

[53] K. Stuart, "Health for all: its challenge for medical schools", *Lancet* (February 25, 1984), pp. 441-442; W. Lathem, *The Future of Academic Community Medicine in Developing Countries* (New York, Rockefeller Foundation, January 1979), pp. 34-41.

[54] B. Abelsmith and A. Leiserson, *Poverty, Development and Health Policy, Public Health Paper No. 69* (Geneva, World Health Organization, 1978).

[55] *Summary Final Report of the Lampang Health Development Project, Vol. 1*, Lampang Health Development Project Documentary Series (Thailand, Ministry of Public Health Publication, 1981).

[56] A. Leaf, "The doctor's dilemma—and society's too", *The New England Journal of Medicine*, vol. 310, No. 11 (March 1984), pp. 718-721.

[57] G. Hardin, "The tragedy of the commons", *Science*, vol. 162 (December 1968), pp. 1243-1248.

[58] H. H. Hiatt, "Protecting the medical commons: who is responsible?", *New England Journal of Medicine*, vol. 293, No. 5 (July 1975), pp. 235-241.

[59] H. Mahler, "Blueprint for health for all", *World Health Organization Chronicle*, vol. 31 (1977), pp. 491-498.

[60] An excellent discussion of multiple countries and health-care systems is presented in Morley, Rohde and Williams, *Practicing Health for All, op. cit.*, including the localities cited.

[61] Ghana Health Planning Team, "A quantitative method of assessing the health impact of different diseases in less developed countries", *International Journal of Epidemiology*, vol. 10, No. 1 (1981), pp. 73-80; R. H. Morrow, "A primary health care strategy for Ghana", *Practicing Health for All*, David Morley, Jon Rohde and Glen Williams, eds. (Oxford, New York, Toronto, Oxford University Press, 1983).

[62] Hull and Rohde, *op. cit.*

[63] Ghana Health Planning Team, *loc. cit.;* Morrow, *loc. cit.*

[64] J. A. Walsh and K. S. Warren, "Selective primary health care", *New England Journal of Medicine*, vol. 301 (1979), pp. 967-974.

[65] Rohde, "Health for all in China . . . ", *loc. cit.*

[66] Roemer, *loc. cit.*

[67] Han Jia-jing and Yang Sheng-ji, "Tuberculosis control", *American Journal of Public Health*, vol. 72, from Supplement entitled "Health Services in Shanghai County" (September 1982), pp. 48-49.

[68] Stan D'Souza and others, *Socio-Economic Differentials in Mortality in a Rural Area of Bangladesh*, Scientific Report No. 40 (Dhaka, Bangladesh, International Centre for Diarrhoeal Disease Research, November 1980).

[69] J. D. Wray and A. Aguirre, "Protein calorie malnutrition in Candalaria, Colombia; I. Prevalence: social and demographic causal factors", *Journal of Tropical Pediatrics*, vol. 15 (September 1969), pp. 76-98.

[70] The interrelationship of these socio-economic factors and health, however, is not simple. Bairagi documented that a higher family income in rural Bangladesh was associated with better nutritional status only in the children of literate mothers. If the mother was illiterate, there was no improvement in the nutritional status of her children at higher income levels. (R. Bairagi, "Is income the only constraint on child nutrition in rural Bangladesh?", *Bulletin of the World Health Organization, 58* (1980), pp. 767-772.)

[71] Hull and Rohde, *op. cit.;* W. Henry Mosley, *Will Primary Health Care Reduce Infant and Child Mortality? A Critique of Some Current Strategies, With Special Reference to Africa and Asia*, paper prepared for the IUSSP Seminar on Social Policy, "Health Policy and Mortality Prospects", Paris, 28 February-4 March, 1983 (Jakarta, Indonesia, Ford Foundation).

[72] L. C. Chen, A. K. M. A. Chowdhury and S. L. Huffman, "Anthropometric assessment of energy-protein malnutrition and subsequent risk of mortality among preschool aged children", *American Journal of Clinical Nutrition*, vol. 33 (1980), pp. 1836-1845.

[73] Hull and Rohde, *op. cit.*

[74] Ruth R. Puffer and Carlos V. Serrano, *Patterns of Mortality in Childhood*, Scientific Publication No. 262 (Washington, D.C., Pan American Health Organization/World Health Organization Publication, 1973).

[75] Mortality rates from measles in Ecuador were 274 times those in the United States in 1960, primarily due to underlying malnutrition.

[76] N. S. Scrimshaw, C. E. Taylor and J. E. Gordon, *Interactions of Nutrition and Infection*, World Health Organization Monograph Series, No. 57 (Geneva, World Health Organization, 1968).

[77] Rohde, "Why the other half dies . . . ", *loc. cit.*

[78] Lechtig and others, *loc. cit.;* Mata, *op. cit.;* S. B. Roberts and others, "Seasonal changes in activity, birth weight, and lactational performance in rural Gambian women", *Transactions of the Royal Society of Tropical Medicine and Hygiene*, vol. 76 (1982), pp. 668-670; L. Iyanga, "Influence of the diet on the outcome of pregnancy in Indian women", *Proceedings of the 9th International Conference of Nutrition, Mexico, 1972* (Basel, Karger, 1974), pp. 48-53; F. W. Rosa and M. Turshen, "Fetal nutrition", *Bulletin of the World Health Organization*, vol. 43 (1970), pp. 785-795.

[79] J. P. Habicht and others, "Maternal nutrition, birth weight, and infant mortality", *Size at Birth*, CIBA Foundation Symposium 27 (Amsterdam, Elsevier-Excerpta Medica, 1975); P. S. S. Sundar Rao and S. G. Inbaraj, "A prospective study of infant mortality and congenital malformations in relation to intrauterine growth rates in South India", *Indian Journal of Medical Research*, vol. 67 (February 1978), pp. 245-254.

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[81] Stephanie Simmonds, Patrick Vaughn and S. William Gunn, eds., *Refugee Community Health Care* (New York, Oxford University Press, 1983).

[82] World Bank, *Health* . . . (1980).

[83] N. M. Morris, J. R. Udry and C. L. Chase, "Shifting age-parity distribution of births and the decrease in infant mortality", *American Journal of Public Health*, vol. 65, No. 4 (April 1975), pp. 356-362.

[84] James Allman and Jon Rohde, "Infant mortality in relation to the level of fertility control practice in developing countries", *International Population Conference, Manila, 1981* (Manila, International Union for the Scientific Study of Population, 1981), pp. 97-112.

[85] They point out that the proportional impact of such measures is greater when infant mortality is below 40 due to the elimination of neonatal tetanus, diarrhoeal malaria, and childhood infections, as well as approved pre-natal and interpartal care, access to safe water, absence of gross famine and provision of simple curative intervention.

[86] Hull and Rohde, *op. cit.*

[87] D. Maine, *Family Planning: Its Impact on the Health of Women and Children* (New York, Columbia University, Center for Population and Health, 1981).

[88] D. B. Jelliffe, *Assessment of the Nutritional Status of the Community (with special reference to field surveys in developing countries)* (Geneva, World Health Organization, 1966).

[89] A. R. Drirah and C. C. Standley, eds., *Family Formative Patterns and Health: An International Collaborative Study in India, Iran, Lebanon, Philippines and Turkey* (Geneva, World Health Organization, 1966).

[90] L. C. Chen and others, "Maternal mortality in rural Bangladesh," *Studies in Family Planning*, vol. 5, No. 11 (November 1979), pp. 334-341.

[91] World Bank, *Health* . . . (1980).

[92] Availability of family planning services in Chile led to a precipitous decline in maternal deaths due to abortion from 117 to 23 per 100,000 live births over the period 1965-1978.

[93] Hull and others, *loc. cit.*

[94] *Facts on Health Programs*, Pan American Health Organization Scientific Publication No. 227 (September 1971), p. 36.

[95] Pineo and others, *op. cit.*

[96] D. J. Schliessman, "Diarrheal disease and the environment", *Bulletin of the World Health Organization*, vol. 21, No. 3 (1959), pp. 381-386; Philippines Cholera Committee, "Field evaluation of environmental sanitation measures against cholera", *Strategy of Cholera Control* (Geneva, World Health Organization, 1971).

[97] Mosley, *op. cit.*

[98] D. B. Jelliffe and E. F. P. Jelliffe, "The uniqueness of human milk", *American Journal of Clinical Nutrition*, vol. 24 (1971), p. 968.

[99] Rohde, "Why the other half dies . . . ", *op. cit.*

[100] J. P. Shonkoff, "Social support and the development of vulnerable children", *American Journal of Public Health*, vol. 74, No. 2 (April 1984), pp. 316-322.

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XIV. RELATIONSHIP BETWEEN MORTALITY AND MORBIDITY LEVELS ACCORDING TO AGE AND SEX AND THEIR IMPLICATIONS FOR ORGANIZING HEALTH CARE SYSTEMS IN DEVELOPED COUNTRIES

*Marek Okolski**

A. AGE- AND SEX-SPECIFIC MORBIDITY AND MORTALITY PATTERNS

For decades, mortality levels in presently developed countries have been declining, with the result that the expectation of life at various ages has been going up. This has often been identified with improvement in the level of health, although the relationship between mortality and health conditions is not at all straightforward.[1]

The profound declines in mortality and morbidity levels went hand in hand with substantial changes in mortality and morbidity patterns. For instance, a considerable excess male mortality has developed in more recent times, reaching 6 to 8 years in the typical developed country. The death toll at ages below 5 years, which used to be comparable to (in fact higher than) that at older ages (50 years and more), has now become negligible, while the deaths of old people now dominate mortality statistics. This was only partly due to changes in age composition of the population; the main contributing factor was a particularly steep decline in child mortality, much steeper than the decline in death rates at other ages. Finally, there has been a dramatic shift in mortality pattern by cause of death. In the pre-transitional period two groups of causes alone—infectious and respiratory diseases—claimed about 30-40 per cent of deaths while the share of cardiovascular diseases, cancer and violent causes was about 15-25 per cent.[2] Today the situation is radically different: the latter three groups account for about 70-75 per cent of deaths and the former two cause only about 5-10 per cent of deaths.

Morbidity pattern

Morbidity statistics are scarce and incomplete, and little is known about either the incidence and duration of illness in particular countries or especially its consequences for health, disability or mortality. Some characteristics of the present morbidity pattern may nevertheless be sketched here.

The first feature of morbidity in developed countries is a higher incidence of female illness, disability and hospitalization, in spite of much longer life enjoyed by women.[3] The data for the United States (see table XIV.1) are probably representative of the developed countries.[4]

Secondly, the incidence of illness is positively correlated with age. According to a household survey conducted in France (1970) by the Institut national de la statistique et des études économiques (INSEE) and CREDOC, the morbidity rates (number of current illnesses per 1,000 population) increase rapidly with age for both sexes, exceeding the level of one thousand by around age 40 among males and even earlier among females. This is also true for almost all groups of diseases.[5] For instance, the ratio of rates for males and females aged 65 or more to the rates for those aged 16-39 are as follows (percentages):[6]

	Males	*Females*
Cardiovascular diseases	2.471	1.709
Diseases of the respiratory system	1.726	1.654
Diseases of the digestive system	1.335	1.290

A similar conclusion is suggested by the results of a household survey carried out in the Federal Republic of Germany (1974), where incidence of persons under medical treatment both as out-patients and in-patients strongly depended on age (leaving aside the 0-9 age group).[7] The data reveal what appears to be a third characteristic of morbidity patterns: that within each sex and age group there is a wide differentiation of incidence of illness according to type of disease. Cause-specific rates by age for the Federal Republic of Germany are presented in table XIV.2.[8] For the sake of comparison it might be mentioned that the ratio of the incidence of diseases of the respiratory system to the incidence of cardiovascular diseases was about 71 per cent for 40- to 64-year-olds; about 5 per cent for cancer; and 8 per cent for infectious and parasitic diseases. Similar patterns are found in France (table XIV.3).

Increasing frequency, with age, of chronic disease among total illness constitutes the fourth characteristic. Schwartz provides the following estimates.[9] In the

TABLE XIV.1. HEALTH CHARACTERISTICS AND UTILIZATION OF MEDICAL CARE SERVICES BY SEX: UNITED STATES, 1979

Health characteristic and utilization	*Number per 100 persons per year*		
	Female	*Male*	*F/M ratio (percentage)*
Restricted activity days	1 047	824	127
Bed-disability days	487	334	146
Acute conditions	228	201	113
Hospital days of care[a]	124	108	114
Physician visits	538	405	133
Dental visits	183	155	118

Source: Quoted from D. Rice, "Sex differences in mortality and morbidity: some aspects of the economic burden", in *Sex Differentials in Mortality, Trends, Determinants and Consequences*, A. D. Lopez and L. T. Ruzicka, eds. (Canberra, Australian National University, 1983).

[a] Excluding deliveries.

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TABLE XIV.2. DISTRIBUTION OF INCIDENCE OF MAJOR DISEASES KNOWN TO HAVE ENDED IN APRIL-MAY 1974,[a] BY AGE: FEDERAL REPUBLIC OF GERMANY

(Percentage of all diseases)

Type of disease	*All patients*	*Age of patients in years*			
		Below 15	*15-39*	*40-64*	*65 or older*
Respiratory system	25.8	57.7	39.9	18.4	11.8
Cardiovascular	22.5	1.3	8.0	25.9	36.4
Musculoskeletal system and connective tissue	12.1	1.4	10.2	15.8	13.6
Digestive system	10.5	6.4	14.0	12.5	7.8
Diabetes mellitus	5.5	0.4	1.3	5.7	10.0
Genito-urinary system	4.6	11.4	6.5	5.9	3.5
Infectious and parasitic	4.5	20.7	3.3	2.1	1.2
Cancer	1.0	0.3	0.6	1.3	1.1
Other	13.5	0.4	16.2	12.4	14.6
All diseases	100.0	100.0	100.0	100.0	100.0

Source: K. Schwartz, "Public health implications of stationary and declining populations", *World Health Statistics Quarterly* (Geneva, World Health Organization, 1983).

[a] Within four weeks preceding the inquiry.

TABLE XIV.3. CAUSE-SPECIFIC MORBIDITY RATES FOR MALES AND FEMALES AGED 40-64 AND 65 OR OLDER: FRANCE, 1970

Disease[a]	*Number of illnesses per 1,000 population*			
	Males		*Females*	
	40-64	*65 or older*	*40-64*	*65 or older*
Total	2 057	3 482	2 622	3 674
Ophthalmic	367	597	437	634
Cardiovascular	206	547	381	734
Digestive system	296	450	377	494
Bones and joints	260	430	331	494
Dental and occlusion	299	359	314	361

Source: T. Lecomte, D. Moyse and A. Yiz, *Morbidité différentielle* (Paris, CREDOC, 1978).

[a] Five leading groups of diseases have been specified.

Federal Republic of Germany (April-May 1974) this frequency was 9 per cent for persons aged below 15 and 27 per cent for those at 15-39 years, rising to 65 per cent at ages 40-64 and to 84 per cent in the group aged 65 or above. In the case of old people (65 years or more) almost 20 per cent stayed in bed for more than four weeks during their last cured sickness, while comparative figures for those aged 15-39 years was 7 per cent.

Disability

In developed countries, especially those where the aging process of the population has gone furthest, a rapid rise in the number of disabled persons has been recently observed. Persons with long-term disability are the group most exposed to the risk of developing a disease, but at the same time disability may be the result of a certain disease or may accompany that disease. In Poland in 1976, 90.5 per cent of permanent disabilities were due to various diseases (43 per cent to cardiovascular diseases, 13 per cent to diseases of the nervous system and mental disorders, 12 per cent to diseases of the musculoskeletal system, 6 per cent to diseases of the respiratory system and only 16 per cent to all other diseases) while only 9.5 per cent were due to occupational hazards and other external causes.[10]

According to surveys carried out in a number of developed countries, among the population aged 15 years or more it appears that one in every 10 or 12 persons is physically handicapped.[11] Table XIV.4 indicates that the prevalence of disability is higher among men than among women for most age groups, though females seem more susceptible to various diseases (cf. table XIV.1). As a result, in older ages (60 years or more), more than 25 per cent of men and usually more than 20 per cent of women are permanently disabled.

Impact of major causes of death on the expectation of life

The incidence of a particular disease has very little to do with its contribution to the overall death toll. This contribution might be assessed by using life-table techniques. From the data for Poland in table XIV.5 it is evident that the role of mortality related to cardiovascular diseases is many times greater than that of any other

TABLE XIV.4. PHYSICALLY HANDICAPPED AS A PERCENTAGE OF POPULATION OF GIVEN SEX AND AGE GROUPS: NETHERLANDS, 1971-1972; POLAND, 1978

Age in years	*Netherlands*		*Poland*	
	Male	*Female*	*Male*	*Female*
Total	8.3[a]	9.0[a]	6.9	7.2
0-17	2.0[b]	1.3[b]	0.8	0.6
18-44	1.7-6.7[c]	1.8-7.6[c]	2.9	2.4
45-49	9.9	9.1	10.1	9.5
50-54	14.8	13.2	16.1	14.8
55-59	21.3	15.9	21.9	18.5
60-64	29.0	19.8	26.1	20.2
65-69	23.3	21.6	25.4	20.7
70-74	25.7	32.2	26.7	23.4
75-79	31.8[d]	38.6[d]	33.9	27.4
80+			36.0	32.7

Source: J. T. P. Bonte, "Population changes, health and health strategies in developed countries", *Economic and Demographic Changes: Issues for the 1980s*, Proceedings of the Conference, Helsinki, 1980 (Liège, International Union for the Scientific Study of Population, 1979), vol. II; and State Population Commission, "Demographic situation of Poland: 1980 report" (Warsaw, 1980).

[a] Population aged 5 years or older.

[b] Estimate for 5- to 19-year group.

[c] Various 5-year groups from 20-24 to 40-44.

[d] Estimate for 75 years or older.

TABLE XIV.5. HYPOTHETICAL GAIN IN THE EXPECTATION OF LIFE AT BIRTH AND AT AGE 60 AFTER ELIMINATION OF DEATHS FROM SELECTED GROUPS OF CAUSES, BY SEX: NETHERLANDS, 1971-1975; POLAND, 1980

(Years)

Cause of death	Age 0		Age 60	
	Male	Female	Male	Female
Poland (1980)				
Cardiovascular diseases	7.6	8.0	7.0	7.7
Cancer	2.8	2.6	1.9	1.5
Violence	2.2	0.8	0.3	0.2
Diseases of the respiratory system	0.8	0.6	0.6	0.3
Diseases of the digestive system	0.5	0.4	0.3	0.2
Infectious and parasitic diseases	0.3	0.3	0.1	0.0
Netherlands (1971-1975)				
Cardiovascular diseases	6.7	6.4	5.9	6.3
Cancer	3.5	3.0	2.7	2.0
Accidents	1.2	0.6	0.2	0.3

Source: Central Statistical Office of Poland and Netherlands Central Bureau of Statistics.

cause-of-death group.[12] For instance, the disappearance of cardiovascular diseases would add 7.6 years or 11 per cent to the entire male life-span and 7.0 years or 45 per cent to the expectation of life at age 60. The respective percentage contribution of the second important group of causes—cancer—is 4 and 12 per cent. Similar conclusions can be drawn for the Netherlands. By contrast, one of the most common groups of diseases, i.e. diseases of the respiratory system, plays a rather meagre role in shaping overall mortality.

Cause-specific mortality pattern

In all societies age is a crucial factor affecting the chance of survival. Age-specific death rates are high for the early weeks or months of life, decline with age to age 10 or so and then increase, at the beginning at moderate pace and later rather fast, to reach very high levels at older ages. In developed countries where infant mortality is generally low they form a J-shaped curve as opposed to developing countries where the curve is more U-shaped. A corollary of these differences is that in developed countries the ratio of the expectation of life at birth (e_0) to the expectation of life at age one (e_1) and, obviously, all older ages, is generally greater than one. Not long ago in developed countries the value of e_1 exceeded that of e_0 and this is still so at present in many developing countries.

Although women appear to have more sickness than men, male mortality is higher in developed countries, and the excess male mortality, in particular in middle age, is increasing. Whereas around 1900 in European populations the male death rate at ages 15-40 was about the same as the female rate (in fact 5 per cent higher), in the 1950s the difference reached 50 per cent, and now in some countries of the region it approaches 100 per cent. The growing excess male mortality in all age groups is reflected in ever-larger differences between male and female life expectancies. The expectation of life at birth is nowadays at least six years (or 9 per cent) higher for females than for males. Up to around the age of 60 years the relative difference increases with age; at age 55 female life expectancy is more than 20 per cent higher than male e_{55}. In older ages, however, it diminishes slightly.

Chronic and degenerative diseases and external causes are the leading causes of death in the developed world. Cardiovascular diseases, cancer and violence alone account for more than two thirds of all deaths in most developed countries, the major individual cause of death being coronary heart disease. The mortality pattern by cause of death in developed countries is distinctly different from the pattern in developing countries, where the three above-mentioned groups of causes contribute slightly less than one third of all deaths. If a population with $e_0 = 70$ and an "old" age structure might be considered as a typical developed country, and a population with $e_0 = 50$ and a "young" age structure a typical developing country, then, in accordance with computations based on a series of United Nations models, the two relevant patterns by cause of death would be as in table XIV.6.

TABLE XIV.6. DISTRIBUTION OF DEATHS BY CAUSE: TYPICAL DEVELOPED COUNTRY AND TYPICAL DEVELOPING COUNTRY

(Percentage of all deaths)

Cause of death	Typical developed country[a]	Typical developing country[b]
All causes	100.0	100.0
Cardiovascular diseases	46.5	18.7
Cancer	16.4	5.6
Violence	5.2	4.3
Respiratory, infectious and parasitic diseases	6.5	34.1
All other causes	25.4	37.3

Source: Population Bulletin of the United Nations, No. 6 (United Nations publication, Sales No. 62.XIII.2).

[a] United Nations model, assuming $e_0 = 70$ and "old" age structure.

[b] United Nations model, assuming $e_0 = 50$ and "young" age structure.

Cause-specific mortality differs extensively by age. For example, in Poland in younger age groups (up to age 40 for males and 30 for females) deaths due to external causes dominate. In the female population aged 30-59, cancer appears to be the major cause, and at higher ages cardiovascular diseases become the leading killer. Among men the determining role of cardiovascular diseases in the cause-specific mortality pattern begins from age group 40-44 and increases dramatically with age.[13] As shown in Duchene's study, five different age-specific patterns by cause of death can, in fact, be observed in developed countries.[14]

Sex is also a significant differentiating factor for the cause-specific mortality pattern. In member countries of the Council of Europe age-standardized cause-specific death rates for males are usually more than 50 per cent higher than the respective female rates. The minimum and maximum male/female ratios for these rates and for selected major individual causes of deaths in the Council of Europe region in 1975 were as follows (in percentages): ischaemic heart disease, 179-273; cancer of the respiratory system, 310-1,215; motor-car accidents, 250-494; and cirrhosis of the liver, 121-371.[15] Differences between male and female rates change with age. The very steep decline of excess male mortality related to cardiovascular diseases can be observed as age increases, whereas the opposite is true for cancer. One might also notice that excess male mortality due to

external causes increases with age up until the age of 30, then it steeply decreases.[16] In many developed countries, however, excess male mortality for all major groups of causes, with the exception of cancer, is strongest in middle groups of age, most notably in the 35-44 group.

Selected factors in the present morbidity and mortality pattern

In summarizing present morbidity and mortality patterns according to age and sex in developed countries the following traits should be noted:

(*a*) High and presumably growing frequency of chronic diseases, among the older population involving a long period of bed-disability;

(*b*) High percentages of handicapped in middle- and older-age intervals;

(*c*) Large share of middle-age and particularly old-age deaths in total mortality relative to the share of infant and child deaths;

(*d*) Overwhelming domination of three groups of causes, i.e. cardiovascular diseases, cancer and violence, among all deaths, the first two especially for the middle-aged and elderly; low incidence of infections and parasitic diseases, except for children;

(*e*) Relatively high excess male mortality in general and also in the case of the major causes of death (in particular violence and cardiovascular diseases), most pronounced for middle- and old-age groups.

Many factors are responsible for the emergence of such patterns, which represent a radical deviation from pre-transitional patterns characterized by (*a*) a relatively high infant and child mortality; (*b*) sex parity (often, in childbearing age, excess female mortality); and (*c*) domination by communicable diseases and deaths caused by those diseases. The demographic transition itself provides one group of factors: the aging of population which followed the decreases in overall mortality and fertility increased the share of diseases typical of older people and the share of related causes of death. Moreover, the decrease in mortality related to communicable diseases which plagued children probably led to the emergence of a less restrictive mechanism of selection, more favourable to weaker individuals. Although saved at childhood, these individuals were doomed to live shorter than the average life in a given population, because they became the easiest target for degenerative diseases in middle or older age.

The other group is composed of environmental factors. Generally, modernization, which triggered the demographic transition, contributed to the betterment of the human environment (e.g. improved sanitation); hence, it had a direct impact on mortality decline. In the course of time, however, side-effects of modernization became more acute. In the workplace occupational hazards appeared connected with poisonous raw materials, noise, vibration, radiation, toxic waste and often the intensity of work itself. As a result, the incidence of accidents, occupational diseases and related phenomena, like absenteeism and disability of workers, increased. Many housing centres in large cities became too densely populated, contributing to increasing stress, mental disorders and violence. Some newly invented materials used in the construction industry posed a serious threat to human health (mostly carcinogenic effects). Factory-processed food started to be excessively contaminated with toxic agents whose very introduction was supposed to serve in easing the nutrition problem by improving agricultural production and processing and/or preservation of foodstuffs. Increase in incidence of some cancers, diseases of the digestive system, diseases of the nervous system etc. may be partly attributed to this factor. Finally, numerous diseases, in particular of the respiratory and digestive systems, and cancers became more widespread owing to changes in the natural environment, especially air and water pollution caused by industrial, agricultural, household and automobile wastes which accumulated faster than they could be neutralized.

Many diseases related to these environmental factors have a rather long gestation and the associated deaths do not come immediately. Symptoms of sickness appear after shorter or longer periods of exposure to these factors, and (leaving aside genetic changes possibly transmitted to the next generations) it is most likely that they assume an important role in the shaping of morbidity and mortality patterns only at middle and older ages.

Among environmental side-effects of modernization which affect mortality, a particular place is occupied by road accidents, perhaps the major violent cause of deaths in developed countries. Because relatively young people—mostly males—participate in road accidents more often than the others, and health or mortality consequences of the accidents are direct and rather quick, this factor is crucial for the mortality pattern of young adult men.

The third group of factors are various personal habits that have developed or became widespread in modern society. As with the changes in environment, the net effects of changes in life-styles on morbidity and mortality in developed countries have been beneficial. Although their impact cannot be quantified, better personal hygiene, more abundant and generally more diversified nutrition, and more comfortable housing have certainly contributed to lowering morbidity. Some new habits, however, have been detrimental. The most important from the viewpoint of health consequences is perhaps tobacco smoking. Many diseases are linked with this habit such as cancer of the lung, trachea and bronchus, ischaemic heart disease, coronary heart disease, arteriosclerotic peripheral vascular disease, bronchitis and emphysema. Excessive drinking of alcohol seems to have a serious impact on the incidence of cirrhosis of the liver and some other diseases of the digestive system, mental disorders, some cardiovascular diseases, violence etc. A paradoxical effect of the pattern of personal behaviour of modern man is increasing susceptibility to some diseases when he does not limit his appetite or control his diet, and uses his freedom not to do unnecessary physical exercise. Eating habits, in particular those resulting in obesity, as well as health practices and physical exercise, appear to strongly affect the incidence of cardiovascular diseases and some other diseases (e.g. diabetes mellitus), especially in the late-middle-age and old-age groups. According to the estimate made by the Department of Health, Education and Welfare in the United States, life-styles can be held responsible for more than half of the total loss in life expectancy at various ages and they are a cause of 50-70 per cent of deaths due to heart disease, cerebrovascular disease, accidents, suicide and cirrhosis of the liver.[17]

Environmental and personal behaviour risk factors are to a large degree responsible for increasing disability and also for the lion's share of premature deaths among the middle aged and elderly in developed countries. There is no efficient cure, however, against chronic diseases or violence associated with those factors once the human organism becomes affected. The only effective way to offset their devastating impact seems to be prevention, i.e. careful avoidance of risk, and modification of those habits and those elements of the environment that are dangerous to health and life.

The case of Eastern Europe (the CMEA countries)

Over the last 30 years or so, there has been a convergence of morbidity and mortality patterns and trends in developed countries,[18] when measured by highly aggregate indicators. A recent analysis, however, covering 20 developed countries of Europe outside of the Council of Mutual Economic Assistance (CMEA) revealed a number of significant differences between these countries.[19] The differences are known to be quite distinct even between countries of about the same level of industrialization, or between regions within a given country. The most notable divergence, however, from the overall trends in age-sex morbidity and mortality patterns in developed countries can be observed for the European member countries of CMEA. The following are the major features of mortality in the CMEA countries relative to other developed countries.[20]

(*a*) The latest trends in age-specific mortality rates and the expectation of life at various ages are distinctly less favourable than those in other developed countries. For males, life expectancies in the 1970s generally fell, while age-standardized mortality rates went up;

(*b*) Decreasing (or, at best, stabilizing) life expectancies for other ages than age 0 are in sharp contrast to what is happening in other developed countries. An analysis of trends in life expectancy at age 1 (e_1) for four groups of developed countries made by J. Bourgeois-Pichat (quoted in note 20) revealed that until around 1967 the e_1 levels tended to converge (for all groups the level of 71-72 years was reached in 1967), while in the period since 1968 sharp differences have emerged: in 1981 Japan achieved the level of 76 years (a considerable increase compared with the 1967 level); other developed countries outside of CMEA reached 74 (a moderate increase). CMEA developed countries other than the USSR show 71 (a slight decrease); and the USSR, 69 (a serious decrease);

(*c*) There has been a dramatic increase in mortality of adult men, in particular those in their forties. In some countries death rates for 40- to 49-year-old men rose by more than 50 per cent over a 15-year period; the male expectation of life at age 30 dropped by two to three years in Czechoslovakia, Hungary and Poland between 1960 and 1980, whereas it went up by five years in Japan, by two years in France and the United States and to a smaller degree in most other developed countries outside of CMEA;

(*d*) The decrease in infant mortality rate observed in the 1970s has been slower than before and slower than in other countries. In some cases no further progress has been achieved;

(*e*) Some case studies (e.g. Hungary and Poland) point to a sharp increase in mortality related to cardiovascular diseases, cancer and violence; the group particularly affected are 40- to 69-year-old men. For this age group not only has cardiovascular mortality risen, but also, since 1974, mortality due to all other causes. The trend observed in the CMEA countries is not only opposite to that in most other developed countries but, even more surprisingly, it has taken place at surprisingly high levels of mortality.

The divergent mortality trends in the developed world which became obvious in the second half of the 1970s are said to result from the deterioration of living standards, health care and, in general, sanitary conditions in the countries of CMEA at a time when the situation was improving in the other countries concerned.[21]

B. Typical responses of health-care systems to the present morbidity and mortality patterns

Although forms and functions of health-care systems as well as modes of financing them vary from one developed country to another, the development of health care in modern times has led to the emergence of a system whose general features are similar in most developed countries.[22] The similarities stem from more or less the same objectives that have been the guiding principle of the development of a modern health-care system since its beginnings in the second half of the nineteenth century. These were: environmental sanitation, control of communicable diseases, provision of curative medical services for sick individuals and promotion and dissemination of medical know-how. The key role in this process has been assumed by national Governments with their ministries or departments of health and comparable structures at the local (regional, community etc.) level. From the outset, activities of Government health institutions at both national and local levels included: sanitary measures related to environmental determinants of health, prevention of communicable diseases, curative medical care, social reform promoting better health, comprehensive medical care for the poor, running medical schools and training personnel, appointing health officers, supervision of the quality of medical equipment and drugs, monitoring and analysis of the state of health and the functioning and effectiveness of health-care systems etc. As societies advanced in their cultural development and were able to devote more resources to health care, these activities and functions evolved; health interests widened, giving way for other governmental bodies along with non-governmental organizations to join in. Ultimately specific strategies of health care have been developed, and health has become a subject of national and regional planning.

The present systems, however, are often sharply criticized for their inability to recognize the whole range of health problems, to design appropriate strategies and to curb decreasing efficiency. It is felt in many countries that health-care systems, after a long period of spectacular achievements, no longer fulfil societal expectations, and therefore require fundamental changes.[23] To suggest the proper direction of such changes requires a brief presentation of major common characteristics of health-care systems and evaluation of the degree to which those characteristics might be held responsible for their generally poor performance.

Owing to the efforts to find the best ways to cope with the problems stemming from changing morbidity and mortality patterns, health-care systems of various nations have developed distinctive characteristics, but they also display numerous similarities. Striking among such similarities in many developed countries is a relatively high degree of centralization of planning and policy making combined with fairly decentralized management. Such a juxtaposition, however, is usually accompanied by a diversity of organizational forms and structures.

As a rule developed countries strive to cover whole populations by health-care systems and to reduce the regional, class and other disparities in access to the system. But in spite of distinct progress in health care and a reduction in mortality in recent decades in most developed countries, studies undertaken in some of them point to growing social-class differences. For instance, in England and Wales the relative difference between standardized death rates for working-aged males in the highest and the lowest of five social classes increased from 52 to 78 per cent between 1921-1923 and 1970-1972. In England, Scotland and Wales severe class differences exist in respect of chronic sickness among working males, health defects in school children, infant mortality rates, use/need ratios (ratio of frequency of medical consultations to indices of sickness) and so forth.[24]

The major responsibility in provision of health care is assumed by Governments. The ever-growing role of Governments is reinforced by the growing importance of functions for which they are a natural and most efficient executor, such as planning and programming, co-ordination and control and financing of at least some critical undertakings (e.g. research).

Specific legislation is necessary to remove obstacles to easy access to health care (e.g. compulsory health insurance for at least the poorer groups of population involving different forms of financial participation), and to protect certain groups (e.g. pregnant women, infants and the disabled). Legislation is also often aimed at controlling certain diseases (e.g. tuberculosis, venereal diseases, typhoid, smallpox). Such legislation is usually a crucial backstopping factor in solving particular health problems because it sets priorities for the health-care system and, through the concentration of means, it allows for an efficient use of scarce resources.

Health-care systems contain various levels, forms and activities. Usually at the lowest (community) level primary care units operate. Above this there is a hierarchy of specialized care organized within a district, regional or national framework. At each level health units belonging to private or public sector may co-exist. Private services which dominate in many countries outside of CMEA are often of higher quality and much more expensive, and thus are restricted to a richer part of the population. In a number of countries there exists a parallel extended network of health-care units which are closed to the public and organized on an industrial basis, quite often fully independent of the Ministry of Health. In some CMEA countries this form is replicated for such occupations as miner, metallurgist, policeman, railwayman and seaman, or for some enterprises (some of them selected because of particularly detrimental conditions of work but many others privileged because of their economic or political importance) involving almost the full range of medical activities and specializations.

There has recently been in developed countries a gradual shift of health-care functions from primary health care (PHC) units to specialized care units, usually hospitals. This tendency was part of a more general phenomenon, according to which the emphasis in health care is usually unevenly distributed between promotive, preventive, curative and rehabilitative activities. In the past the lion's share of resources and activities was allotted to prevention (mass vaccination, quarantine in case of epidemics, general sanitary measures), while at present curative activity seems to dominate. Large hospitals located in cities supported by networks of outpatient clinics, often employing specialists of almost all medical professions, have become a standard core of health care in developed countries. The attention that prophylaxis and rehabilitation attract from health-care systems is disproportionately small relative to curative activity. In fact, promotion of health still remains a rather theoretical postulate and rehabilitative services are most frequently limited to narrow groups of population and are readily available only in a number of the richest countries. The prevalence of curative medicine might be explained in Peter O'Neill's words:

> "In the years since the Second World War the vast increase in resources devoted to health care have enabled the richer countries . . . to take advantage of the progress in biomedical research. This has produced a whole new range of effective drugs and high-technology medical equipment. The benefits derived by particular groups of patients from these advances have been immense. . . . Progress in anaesthetics and asepsis, in new surgical procedures and drugs has made possible the treatment of the very sick, who in the past could look forward only to death or a miserable existence. . . . The public, encouraged by doctors and led by politicians, has demanded hospitals. The presence in every city was taken to be a symbol of 'modern civilization'."[25]

The domination of health-care systems by curative activity can thus be related to the heavy reliance of most of these systems upon high technology. The new medical technologies were primarily developed and applied in such areas as surgery (including post-surgery care and monitoring systems), radiology, pharmaceutical products and laboratory support. Most of the new technologies involved the use of highly sophisticated equipment which in turn required more maintenance and technical expertise. Apart from this, new medical specializations emerged which were linked to modern techniques of monitoring, testing and curing, and some of the old generation of medical staff had to be retrained accordingly. The reliance upon high medical technology, however, was in practice reduced to the curative sector. Hence there developed a strong faith in new hospital technologies as a solution to major health problems, leading to a system that became increasingly costly and difficult to handle.

Finally, an important feature of health-care systems in a majority of developed countries is what might be described as a lack of coherence and insufficient comprehensiveness. The systems themselves are not integrated and lack co-ordination between preventive, curative and rehabilitative activities. This is also true even within

the curative sector in those countries where hospitals or clinics are subordinate to various authorities (central or local, public or private, Ministry of Health or other ministries). Furthermore, the health-care systems tend to limit themselves to the narrowly viewed health problems. The systems are remarkably autonomous, and their activities are rarely linked to social policies, neither do they attempt to interfere in or monitor the actions taken in other spheres which may affect health.

The functioning of such health-care systems has numerous consequences which undermine their efficiency or even hinder in solving certain health problems. Only a few of those consequences which seem most important and typical for developed countries will be discussed hereunder.

1. Mutual independence of various spheres and aspects of health care, related to diversity of organizational forms and structures, results in impaired co-ordination and lack of synchronization.

2. Lack of internal and external co-ordination as well as excessive autonomy bring about a situation in which in most developed countries there are no clear health policies, no effective structure for health planning, and no sound basis upon which the real health needs of populations in respect of their geographical, social and demographic characteristics could be assessed.[26] As a result, within central and local authorities, health authorities assume the entire responsibility for health, leading to a failure to recognize the degree to which processes in the areas dealt with by other authorities (e.g., environment, industry, agriculture, social security, transport and culture) might affect health. Furthermore, even within the area of health there exist largely uncontrolled proliferation and fragmentation of the services. In many countries the systems of health care are dominated by specialists and as a result lack co-ordination among health services, in particular co-operation between primary and secondary sectors, as well as out-patient and in-patient care. This results in the wastage of human and physical resources, and a limited coverage of health needs. One of the consequences is also the insufficiency of systematic and comprehensive analyses, and in effect an adequate diagnosis of the health needs of the population.

3. The essential disadvantage of a combination of centralized planning and decentralized management are: waste of resources and bureaucratization as an increase in centralization prompts bureaucratization and discourages good standards of health services, whereas an increase in decentralization reinforces wasteful management.

4. Dysfunctionalities and disproportions are therefore inherent in the development of present health-care systems (such as hypertrophy of bureaucracy, improper allocation of material and human resources and waste of resources in the face of many non-satisfied needs). For instance, the relatively prominent role of the curative sector and of related sophisticated technologies in health care involves: (*a*) ever-increasing costs which limit the possibility of development of the other spheres and widening of participation in and access to the system; (*b*) an excessive specialization at the expense of primary health care.

5. The wide use of high-level technologies in curative medical care raises costs of this sector, restricting the resources available to other sections, and requires a growing number of specialized staff, mostly located in hospitals, leading to neglect of prophylaxis and setting new barriers to access to health care. The dominance of a disease-oriented approach often results in inattention to health problems considered to be of secondary importance. As a result, attempts by health-care organizations to monitor the health status of a population, identify affected groups or particular risk factors, assess the effectiveness of intervention etc. are often dispersed and biased according to the actual priorities and prevailing approach of a given health-care system. It is a paradox that the centralized health-care systems in developed countries which are predestined to successful pursuit of mass-scale preventive activities are preoccupied with individual cases and use most of their resources on curing individual patients.

6. The much lesser weight attached to preventive and rehabilitative care favours the situation in which the health consequences of aging (e.g. high incidence of disability) are nearly overlooked, and no advantage is taken of relatively cheap and effective preventive measures (at both environmental and personal levels) related to chronic and degenerative diseases and external causes of death. On the other hand, however, the demand created by growing numbers of elderly stimulates the development of the curative sector, especially in-patient care, thus further distorting the health-care structure. This is particularly so in those countries where welfare, rehabilitation etc. are subordinated to health authorities (e.g. the CMEA countries). Worse, this phenomenon tends to greatly increase the share of health-care expenditure in gross domestic product, contributing to public disillusionment about the capabilities of the whole health-care system.

7. The disadvantage of the present anachronistic legislation is that it is deeply rooted in conditions existing when communicable diseases dominated. In few countries does the legislation take account of new health hazards and their impact upon the related risk factors which determine current morbidity and mortality patterns.

8. Excessive costs, numerous disproportions, organizational inconsistencies and anachronistic legislation deepen the difficulty in access to a health-care system by certain groups.

In many countries there have recently been attempts to rethink and restructure the strategies of health care[27] though these have not yet been systematic or comprehensive. These attempts mostly concern preventive health care and take the form of specific preventive programmes. Such programmes are hardly novel: their prototypes were more or less co-ordinated actions designed to protect maternal and child health. Due largely to these programmes, the infant mortality rate in the most advanced countries has dropped from about 150-200 per 1,000 to about 10-15 per 1,000, probably the greatest achievement of health care in modern times. The new programmes, however, are rarely directed to specific age groups. Rather they refer to particular diseases or causes of death. Among the best known are programmes concerned with the following diseases or causes of death: alcoholism, cardiovascular diseases, cancer and accidents.[28] Some actions with a broader scope are also undertaken, such as antismoking programmes or tightening of environmental control.[29] These programmes involve a whole range of measures, including intensified research on risk factors, health hazards

and population groups affected, new legislation, continuous health monitoring of the population at risk, dissemination of information about desired personal behaviour patterns and about detrimental health effects of certain habits, strengthening of environmental protection etc. In many countries substantial resources have already been devoted to implementation of the new programmes. Preliminary evaluations testify that they could be successful and extremely efficient even in the short run.[30] Such a positive conclusion, in turn, is a strong encouragement to further extend programmes which aim at prevention of the most common diseases and other causes of death in developed countries.

Some developed countries strikingly lag behind in the effort of health-care systems to cope with the actual health problems. This particularly refers to a number of CMEA countries (e.g. Poland, the Soviet Union) which have not only failed to fully recognize the challenges stemming from the new morbidity and mortality patterns but also encounter numerous obstacles in controlling the diseases which have already reached low levels, as well as in maintaining the already achieved health care standards.[31] Moreover, owing to some more general reasons, even the ideological principles of the systems of health care had to be abandoned, at least in a few of these countries.[32] For instance, in Poland fundamental social reforms introduced after the Second World War included an entirely new concept of health care. The State, without intending to deprive any group of access to medical service, declared a class-based policy of health care. This meant a concentration of effort and resources on the health of the workers, in particular those employed by big industry. In reality, however, industrial health services existed in a rather truncated form, confined to a section, albeit a substantial one, of workers without even covering their families. In the course of time the original health care principles, according to which big-industry workers were to be privileged, gradually lost their meaning. Because of the deteriorating material and human base of the health-care system, the system developed privileged forms, intended for members of the various élites and their families, while industrial medical services became more and more bureaucratized, and workers' health was increasingly exposed to occupational hazards, poor living conditions, malnutrition and inconveniences.[33]

The budgets of health-care systems in the CMEA countries are, as a rule, low and in some cases recently their share in net national income has declined.[34] Moreover, there are a growing number of crowded, dilapidated and unhygienic hospitals. Qualified medical staff spend a considerable part of their time on low-level medical and administrative tasks, and medicines and medical equipment are constantly in short supply.[35] From time to time massive efforts are considered in CMEA countries to improve the coverage, the resources and the efficiency of health-care systems but they rarely prove to be successful. Recently, a complex programme of fundamental changes in the organization of health care has been formulated in Poland, in which, *inter alia,* the decentralization of medical services and a leading role for community-level health care have been assumed. Poland's involvement in the WHO-sponsored strategy, "Health for All by the Year 2000", has been also underlined.[36] This effort, however, like many of its predecessors, might be doomed to remain an unfulfilled intention, because in the proposed programme, the means for its realization in terms of human and material resources, skills and technologies have not been indicated. Moreover, it is a well-known feature of centrally planned economies of some CMEA countries that, owing to scarce resources and permanent excess demand, priority in allocation of resources is given to the so-called productive sector, and during the implementation of subsequent national plans or programmes, the targets set for the health-care system are constantly corrected downward and in the end seriously underfulfilled.

In spite of some remarkable examples of new intervention programmes and growing awareness among health authorities as well as societies of the need for fundamental changes in the system of health care, little has been achieved in designing and implementing new systems capable of satisfying present needs and solving current problems. The need is for a comprehensive, fully integrated and long-range strategy, assuming consciousness and participation (self-care) of all people. One of the preconditions for specifying such changes and later for their successful design and implementation, however, appears to be the launching of a network of information and research units which would be able to provide current and thorough analyses of morbidity and mortality patterns and related health hazards.

In the meantime—because life does not tolerate a vacuum—failures of the present health-care systems to cope with many acute health problems and the related disappointment of the societies has given rise to a blossoming of various alternative forms of health service. In some countries with the prevalence of centralized public health care there has occurred a steady increase of demand for health services rendered within the private sector, quite frequently outside of the insurance schemes and of the control of health authorities. Particularly conspicuous is the sudden revival of paramedical practice pursued by countless chiropractors, herbalists, osteopaths etc. This remarkable phenomenon can be observed even in some countries where health-care systems offer free medical services to all citizens (e.g. Poland).

C. The potential "case load" arising from present age/sex patterns of morbidity and mortality

Although many alternative policy packages could be proposed to change the existing health-care systems in developed countries, it is possible to compile a far from exhaustive list of measures that at least should be considered. Clearly, any mix of measures actually chosen by a given country would depend on its particular demographic and health situation, its affluence, its willingness to eventually devote more resources to health care, its specific view of the desired priorities within the health-care system etc. Before proposing a list of measures, we will discuss the consequences that recent and expected demographic changes, especially those pertaining to the morbidity and mortality patterns, might have for health-care systems. These consequences will be hereafter referred to as the potential case load.[37] As demographic transition nears its end, population growth in an increasing number of developed countries becomes ever closer to a stationary state, and in some of them a negative growth has already appeared or is soon expected. Assuming no major changes in the age

composition of the population, this factor alone would ease the current pressure on health-care systems by slowing down the increase in demand for health services and drugs, training medical personnel, investing in new hospitals etc. These might be true for at least some sectors of the health-care system.[38]

The aging of population, by increasing the share (and number) of old people, will generate a greater demand for geriatric care, in turn requiring at least a proportionate rise in geriatric facilities and personnel. Bearing in mind the higher incidence of illness among the elderly than in other age groups, the aging of population would also result in increased incidence of illness per head of population, as well as a high proportion of sick old people among all sick persons. For instance, it is expected that in the Federal Republic of Germany 59 per cent of all sick people will be aged 60 years or more when the population reaches a stable age distribution, with birth rate close to that observed at present.[39] Moreover, because of its specificity, a substantial extension of geriatric care would stimulate radical changes in the organization and modes of provision of the relevant services, particularly in view of the ongoing shift in treatment of the sick and care of the elderly from families to institutions.

On the other hand, the decrease in fertility and, in many cases, in the absolute number of births, which is one of the underlying factors in the aging of population, would lead to diminished demand for maternal and child care. Consequent narrowing of obstetric and pediatric services may ultimately make a section of the relevant medical staff and some facilities redundant. Furthermore, a decline in children's share (and numbers) in the population would be associated with a reduction in demand for some curative services, including diseases of the respiratory system, infectious and parasitic diseases, diseases of the genito-urinary system and diseases of the ear and eye. Experience of some countries which recently underwent a sharp decline in fertility indicates, however, that it should not be too hard to retrain personnel and adapt obstetric and pediatric facilities to other uses.

Finally, the changes in age composition, actual and projected, imply a growing excess of females over males in the population and a relatively faster increase in the size of female population, because the sex disparity in risk of death increases with age. This is leading to a rise in demand for gynaecological services and medical care for the health problems of middle-aged and older women.

The Netherlands may serve as an illustration of the possible effects of aging of the population on the demand for health services. If the age-specific demand coefficients remained unchanged during some 10 years, then in 1985, according to the expected age structure of the population, inpatient days in general hospitals per total population would be higher by 2 per cent for men and 5 per cent for women, admissions at nursing homes per total population would be higher by 15 per cent, nursing services at home per total population would increase by 6 per cent and the number of physically handicapped per total population would increase by 7 per cent.[40]

Apart from the contribution that changes in population size and age structure make to the potential case load which health-care systems face in developed countries, an even more important factor may be the changes in mortality and morbidity patterns which proceed hand in hand with the demographic transition and the aging of population. The increase in the role of chronic diseases, especially among the elderly, appears to be of foremost importance. This factor would result in an increase in demand for inpatient services, especially nursing care, either at home or in hospitals or other health-care institutions, and an increase in numbers and degree of specialization of medical personnel dealing with chronic diseases. Fundamental long-range choices between home and hospital care, preventive or curative measures etc. will have to be made in this connection.

The prevalence of chronic occupational diseases among middle-aged people poses specific tasks for industrial health-care institutions. These tasks include, *inter alia,* effective prevention of occupational diseases and rehabilitation of persons cured. A partly overlapping issue would be coping with the growing numbers of sick or disabled people affected by degenerative diseases. Sickness and disability among the economically active cause severe losses in production of goods and services. Health-care systems, to help offset these losses, would need to engage in intensive rehabilitative activity to minimize the incidence of recurrent diseases and premature death.

The determining role of chronic or degenerative diseases for current morbidity patterns and the domination of these diseases along with violence among the causes of death can be related to a relatively new phenomenon: the high incidence of premature deaths due to these causes for middle-age and old-age populations. It has recently become obvious that only promotive and preventive health care could lead to diminishing premature deaths of adult persons. Better promotive and preventive care, however, would in many instances require drastic changes in environment conditions and life-styles. This in turn implies the need for complex action involving changes in legislation, national planning procedures and priorities, education, personal habits, health insurance schemes and organization of health-care systems themselves. The diversity of tasks can be specified in this respect according to age/sex groups of population at risk. For instance, prevention of alcoholic diseases would particularly refer to middle-aged men, prevention of road accidents to young men and prevention of diabetes to middle-aged women.

Declining infant morbidity and mortality would amplify the importance of tasks posed for health-care systems by declining fertility, mostly by decreasing the demand for curative care and for pediatricians and child-care facilities. Simultaneously, the recent rise in incidence of premature and/or low-weight births in some developed countries would require more perinatal care as well as more promotive care directed at mother's health before and during pregnancy.

The other important consequences connected with the shift in morbidity and mortality patterns arise also from the decrease in the incidence of infectious and parasitic diseases and their related deaths. This decrease can be expected to continue, if only because of the decline in fertility and in the share of children in the population. Further decrease in morbidity and mortality rates related to infectious and parasitic diseases would dramatically reduce the demand for the related health care, especially hospital services (closed wards).[41] Hopefully a substantial part of the existing personnel, equipment

and buildings would be transferred to provision of other health services.[42]

The case load which national health-care systems should ideally be bearing in the face of changing age and sex patterns of morbidity and mortality would imply, therefore, a huge endeavour of enormous complexity, requiring meaningful alterations in the scope, functioning and organization of health-care systems. Ultimately, the very concept of health care would be extensively modified as a result of those alterations. What must be changed are not only the structure of health-care systems and the functions of each of their sectors but also the role played by and the utility of all types of health-care resources. In many instances health promotion and preventive care would be the major means of health care. This would refer to the circumstances leading to high incidence of premature and low-weight births, to widespread degenerative and occupational diseases, to growing numbers of violent death or disability etc. Promotional and curative activity, though, would cease to be the sole responsibility of health-care institutions. On the other hand, the curative sector would be slowly relieved of dealing with infectious diseases and, in particular, with such numerous premature cases of cancer or cardiovascular disease, and its involvement in curing diseases of infancy and early childhood would be greatly lessened. The importance of treatment of persons suffering from chronic diseases and disablement would increase considerably, however, even if the form of the treatment may be greatly altered. As old age and disability become even more widespread in developed countries, equal right would be given to rehabilitative care, and an access to rehabilitation would be easy for all who require it. As far as health-care resources are concerned, the trend towards even more narrow specialization of health personnel would be reversed, and the importance of the general practitioner would be restored. Medical personnel would need to be more flexible and capable of performing diversified functions (informative, consultative, social advisory, diagnostic and other strictly medical). Material resources (equipment, buildings etc.) would also have to be flexible and multi-purpose. Finally, health-care systems would require appropriate technologies which could be accessible to the general practitioner and the patient himself, and used on a mass scale. Those technologies would above all be applicable to diagnostics and monitoring of health conditions of the population. At the same time technological progress would take place in early detection of health hazards in the environment, food products, construction materials, household appliances, drugs etc.

D. Challenges to health-care systems

The above characterized case load faced by health-care systems is by no means an obligatory target to fulfil. The extent to which it will be implemented would depend upon many conditions, especially on perception of and importance given to health problems in particular countries. Perhaps there is not even one country, however, which would not assign the highest priority to health care in the future. How would a society that made human health a top priority look? The answer given by Erik P. Eckholm to this question is as follows:

"To begin with, in such a society the circumstances of conception and gestation would maximize the changes to each child being born robust and well equipped to survive the perilous early months, and of subsequently leading a long, healthy life. . . . Since prospective mothers would consume well-balanced diets throughout their own lives and adequate dietary supplements during pregnancy, the number of premature or underweight births would be minimized. Pregnant women would not smoke, would not take potentially hazardous drugs, and would not be exposed to toxic chemicals or radiation on the job or at home.

". . . Nutritional basics would be universally understood; children would be raised on diets that encouraged neither undernutrition nor overnutrition and, from an early age, physical activity would be integral to daily life. Adults would eschew excess calories and fats in their diets, avoid heavy drinking, and get plenty of regular exercise. . . . The number of potentially hazardous environmental agents in circulation would be slashed; only those chemicals that had been rigorously tested for long-term health effects would be added to foods and other products. Smoking would be considered antisocial, and the cigarette smoker would gradually become an extinct species. Workers' health would be strongly protected; if in some cases safeguards and vigilance in the workplace could not guarantee workers reasonable peace of mind about their health, consumers would simply do without particularly dangerous materials and products. Factories would spend what is necessary to eliminate hazardous pollutions. Only low-polluting vehicles would be allowed on roads; and, in urban centers, the widespread use of bicycles and public transportation would offset driving restrictions."[43]

Health-care systems, in order to achieve or even to approach such a situation, will have to undergo fundamental reorganization. In particular, the very concept of health care will have to evolve in such a way as to cover the areas of human activity which so far have remained beyond its scope. The necessary changes have been already indicated in various national or international declarations and documents, and in some scientific works.[44] Below only a brief review of the most commonly raised postulates is given.

The new concept of health care should be based on a holistic approach which would unify health with a widely conceived concept of well-being, as well as clearly specify and co-ordinate the care (tasks, resources, activities etc.) at each of all three basic levels: national (or regional), community and individual. The following are the major traits of health-care systems corresponding to such a concept.

Complex programme of health care

A comprehensive health-care policy fully consistent with social policy would be formulated at national (or regional) levels in which all fundamental health problems and groups of population at risk are properly identified. In particular, health-care institutions along with other Government, public and private organizations should work out a programme which would set priorities in the field of health care, long- and short-run strategies and specific targets, as well as the responsibilities of various authorities, communities and individuals. Central planning of health care should not go beyond

certain reasonable limits because of the risk of excessive bureaucratization.[45]

An independent body concerned with health and other social problems should be set up at the national or regional level to constantly monitor and study health hazards, disseminate information on health of the population and sanitary and social conditions in particular localities or groups, harmonize various local initiatives and actions which might affect health, help in decision making etc.[46]

Platform for co-operation

The responsibility for health care of non-health institutions should be specified and extended. At present quite frequently government policies in such areas as foreign trade, agriculture and taxes support unhealthy life-styles or in some countries (CMEA countries being a noteworthy example), by concentrating single-mindedly on growth of output, contribute to the deterioration of the environment and to increasing environmental health hazards. In striving to change the current situation Governments and public and private organizations should arrive at a consensus about the preconditions of better health, i.e. abandonment of reckless personal behaviour, careful use of technologies, improvement in investment priorities, and reforming social systems, and they should be charged with specific targets in pursuing such a strategy of better health. The common platform for such action might be national and regional development plans and corresponding social policy.

Decentralization — more community care

In the face of the growing failure of costly large-scale and centralized undertakings of health-care systems to cope with contemporary health problems, decentralization of the present systems and strengthening of the role of primary health care (PHC) appear to be a necessity. In its modified form PHC should secure an easy access for all community members and pay equal attention to prevention, cure and rehabilitation. Therefore, the units of PHC should be adequately equipped and consist of persons of many professions (e.g. general practitioner, mid-wives, social workers, psychiatric nurses, psychologist, auxiliary technical staff etc.). Because of excessively rising costs of health care, both self-reliance and self-management within particular communities involving wide participation of the people in management of PHC seem necessary. A very fundamental change in the functioning of health-care systems is recommended:

> "Community-based health systems should be established or developed. In these, primary health care will be the central function, backed up by hospital services, including facilities for referral of patients to more specialized institutions and for supervision, guidance, and logistical support. Resources for national health services, at the moment concentrated in cities and on specialist services, should be redistributed to ensure the accessibility of acceptable services to all groups of the population. A particular effort is needed to ensure the quality of care: that services are far more human, personal and relevant to real community and family needs. This requires the involvement of other organizations and groups related to health, a maximum of self-reliance and participation by the individual and the community, and a new understanding of the role of health workers. The health team, and particularly general practitioners, nurses and midwives, will have to be trained and retrained in the spirit of full community care. In addition, in order to promote the full participation of local communities, health information and education of both the population and the health professions must be an important part of the system. Putting the system into effect should be a priority in underserved areas, and particularly declining inner city areas and rural areas with low population."[47]

Prevalence of community care in health systems would, *inter alia,* mean a drastic shift in proportions between curative and preventive activities.[48] Many costly procedures (e.g. organ transplants, cancer surgery, artificial organs etc.), though they increase medical bills and save some individual lives, bear only marginally on the general health situation. Massive funds related to disease control have minor influence on morbidity and mortality trends although they could bring about significant changes if only a part of them was transferred to disease prevention. The channelling of some resources from the curative to the preventive sector of the health system, however, would require a basic change of attitude to health among medical personnel, and the adaptation of existing facilities and equipment to new functions.

Moreover, systems based on community care would also involve more emphasis on out-patient and nursing home treatment which without losing a high standard would be much less expensive than in-patient services. With availability of better drugs, easy-to-operate equipment and proper guidance, home care could be in many cases more beneficial to health than staying in hospital.

Provided that the general practitioner is equipped with small, fast-operating, highly mobile and easy-to-handle medical tools and devices, the proposed retreat from specialist to general practitioner and out-patient services should not be viewed as a backward trend but rather as a symptom of a more advanced care.

A wider concept — self-care

Within the concept of community care a crucial role must be played by people as individuals who should take over the responsibility for their own health from the health system. This is because no strategy which involves individual members of society can be imposed from above. This being so, the holistic principle in pursuing better health and the concept of self-care should be widely accepted and established. The involvement of individuals in self-care should include continuous awareness about their own health based on a combination of factors of physical and spiritual well-being and those that might endanger it (diets, exercise régimes, regularity of sleeping and eating, tobacco smoking etc.), active participation in curing disease, and knowledge of how to cope with disability. Furthermore, healthy people, in particular, adults, should look after the young and the elderly, the sick and the handicapped, to be taken care of when their turn comes. On the other hand, the state of chronic disease or disability of a given person and his or her specific needs should be understood and fully accepted by his or her friends or relatives. All these put together would undoubtedly constitute a new philosophy of health care.[49]

New meaning of rehabilitation

The care of the handicapped or permanently disabled should combine health and social aspects of their predicament. Proper consideration should be given to the problems of the disabled and elderly when planning and implementing health and social services. Special networks formed within the framework of community care should allow for active involvement of these groups. In many cases the disabled could, through self-support, eliminate some of the psychological effects that prevent them from taking an active part in social life, and the unique skills and knowledge possessed by the elderly, thanks to their past experience, should enable societies to appreciate their value.

In order to become feasible and efficient, such an ideal and entirely new system of health care should be extensively supported by changes in other spheres, some of which are listed below.

Extending analytical and research networks

Up-to-date statistical analyses of the health situation, new health hazards, groups of population affected, regional and social disparities, efficiency of health systems etc. should be carried out regularly. Since those analyses would be the basis for health planning, health medical education, education for health etc. they must be produced in a language understandable to all and their conclusions made available to all. At the same time more research should be done to identify further environmental, genetic and life-style risk factors. Improved methods should be developed for the early detection, proper diagnosis, timely treatment and successful rehabilitation of the most dangerous diseases which would augment the strategies of community care and self-care. This also requires an improvement in information channels.

New legislation

Gaps in current legislation need to be filled: *inter alia,* those governing norms for water, soil and air pollution; laws which concern the systematic screening of new chemical products or foodstuffs for potential health effects; regulations concerning the sales promotion practices for such commodities as cigarettes and alcohol; the laws pertaining to road traffic and transportation safety;[50] and those related to safety in the work place. In extreme cases any subsidization of those who produce goods detrimental to health (including some food products such as saturated fats) might be eventually banned, or higher taxes on such products introduced. Also the publicity given in the mass media to certain unhealthy habits, careless life-styles and violence should be sharply curbed.

Legislation might also directly influence the personal behaviour of the citizens in ways that would encourage them in healthier life-styles and more involvement in preserving their own health. Certain privileges or social bonuses might be made available only to those who fulfil specific health requirements. For instance, already in some countries (e.g. France, Hungary, Scandinavian countries) the sum of maternity benefits or eligibility to child-care allowance depends on the frequency of the mother's prenatal examinations.

New systems of health and social security

The intention to radically alter health-care patterns by emphasizing promotion and prevention at the expense of curative care will remain a token one if the relevant insurance schemes are left unchanged. In many instances the current schemes do not respond to preventive needs; they pay only when the doctor treats a patient. Appropriate new insurance systems would require and pay for regular check-ups, systematic consultation with the doctor regardless of health status, and other preventive measures. This is a complicated (if currently feasible) task in view of a continuing excessive increase in health budgets taking place under the circumstances of present imperfect insurance schemes with which many countries seem unable to cope any longer. On the other hand, it should be borne in mind that increased costs of preventive health care might be—after some time—more than offset by the reduction in expenditures on curative services thanks to the improvement in health of the population concerned.

In order to introduce new schemes which would fit the proposed health strategy, new mechanisms must be created to channel vast financial resources from other sectors to the health-care system, while safeguarding measures protecting other socially important sectors from deterioration.

Education for health

The awareness of health risks should be imposed on all members of society from their early childhood. This is a precondition for a strategy of community care and self-care to be successfully implemented. To make the health problems comprehensible to all, instructions and instructors must change. In this connection the schools and mass media should be given particular responsibility for instilling an awareness of health problems in society. The package of recommended changes in personal behaviour would include the avoidance of obesity and unbalanced diets, abstinence from tobacco smoking, alcohol and abuse of drugs, the taking of regular physical exercise etc. However, the change in behavioural patterns would unavoidably mean the neutralization of deeply rooted cultural influences. This, in turn, would require stubborn, long-range efforts from all individuals, communities and Governments.[51]

Improved social infrastructure

In many instances changes in social infrastructure are needed in order to enable the people to look after themselves and to implement the strategy of self-care. These, for example, would consist of properly situated and marked pedestrian crossings, improved illumination of streets, more parks and other places where people could take exercise, and better provision for the disabled in terms of household appliances (e.g. easy-to-hold pans), access to public utility places (theatres, shops, lavatories etc.), design of apartments, stairs, telephone boxes, lifts and other facilities.

Appropriate technologies

In principle this problem concerns technologies directly applied to health problems. In fact, no new breakthrough in medical technology is essential for achieving

better health. Many of the above proposed changes, however, would require that new technologies for monitoring risk factors, disease detection, surgery and rehabilitation be developed, or already existing technologies be modified accordingly. The task would consist in creating appropriate health technologies, i.e. small-scale, mobile and easy-to-handle medical equipment, efficient drugs, rehabilitative devices for a wide range of disability etc.

Obviously, in reality, the changes in health-care systems would not normally cover all the spheres just mentioned, although in some countries they might go far beyond the above suggested list. Also the timing of the changes would vary from country to country. The scope and timing of changes would depend upon many factors, including the relative weight attached by societies to non-health objectives of social development, the actual level of health care, the degree of regional and social inequality in access to health services, the present involvement of the bottom of the organizational hierarchy of health systems in formulating and pursuing health targets, the pace of the aging of population, the character of population policy enforced or envisaged in a given country etc.

None the less, any society would have to face the fundamental choices concerning the restructuring of the health-care system, related to the case load posed by the present age/sex morbidity and mortality patterns. No Government would be able to escape those choices which in some cases might take the form of an alternative: improving the quality of life at the expense of rapid economic growth or accelerating the rate of growth at the expense of better life. The former solution would imply top priority for prevention and rehabilitation and lower priority for curative care, and it would promote technologies for detecting and signalling abnormalities in environment and personal behaviour, as well as protecting health. It would promote health and ultimately result in the decline in the incidence of diseases and violence, and of premature deaths. The latter solution, by contrast, would be concentrated on disease treatment and reducing morbidity and mortality levels through sanitary and medical measures. The technologies preferred would be those coping with the most severe disease conditions and those increasing the chance of survival of the sick and disabled. It seems that the former solution, although by no means inexpensive or spectacular in the short run, would be much closer to the above sketched strategy of reorientation and reorganization of health systems and it would better match the underlying case load. Short-sighted Governments, however, might incline to the latter solution, which pays off earlier and perhaps does not require immediate sacrifices in living standards and life-styles. Discussions of this question by international organizations, Governments, health authorities and interest groups from different countries and dissemination of the relevant information throughout the world appear to be a prerequisite for making the right choice.

NOTES

[1] For a detailed analysis of the recent mortality trends and differentials in developed counties, see *Levels and Trends of Mortality since 1950* (United Nations publication, Sales No. E.81.XIII.3 and corrigendum), chap. 2.

[2] For example, in 1906 in Spain, still a pre-transitional country, the share of the first two groups was 33.4 per cent, and the share of three other groups was 15.6 per cent. For this and other examples see: H. Bunle, *Le mouvement naturel de la population dans le monde de 1906 à 1936* (Paris, Institut national d'études démographique (INED), 1954).

[3] This seemingly paradoxical phenomenon is discussed extensively and explained in: L. M. Verbrugge, "The social roles of the sexes and their relative health and mortality", *in* A. D. Lopez and L. T. Ruzicka, eds., *Sex Differentials in Mortality: Trends, Determinants and Consequences* (Canberra, Australian National University, 1983).

[4] That females are more likely than males to be sick, disabled and, particularly, to have a higher rate of acute conditions is confirmed by recent studies conducted in England, France, Scotland, Switzerland and Wales. See e.g. J. Brotherston, "Inequality: is it inevitable?", Galton lecture, 1975; C. O. Carter and J. Peel, eds., *Equalities and Inequalities in Health* (London, New York, San Francisco, 1976); O. Jeanneret, "Sex differentials in mortality and health care delivery", *in* Lopez and Ruzicka, eds., *op. cit.;* T. Lecomte, D. Moyse and A. Yiz, *Morbidité différentielle* (Paris, CREDOC, 1978).

[5] "In the group of infectious and parasitic diseases no clear relationship was observed, while in a few other groups positive correlation appeared only above the age 2." See Lecomte and others, *op. cit.*

[6] *Ibid.*

[7] K. Schwartz, "Public health implications of stationary and declining populations", *World Health Statistics Quarterly*, vol. 32, No. 4 (1979).

[8] A word of caution should be given regarding these rates. Striking differences between morbidity rates observed in various populations studied by means of interview-type surveys clearly point to a relatively low reliability of data gathered from such surveys. For instance, in 1979 at Reims, France (140,000 inhabitants), the rates for population aged 65 or more were about one fifth of the rates computed for all France in 1970. See C. Serment, *Morbidité et conditions de vie* (Paris, CREDOC, 1982). The other important symptom of poor quality of survey data, based primarily on a subjective feeling of a respondent, is a negligible incidence of cancer shown in all morbidity surveys.

[9] Schwartz, *loc. cit.*

[10] The State Population Commission, *Demographic Situations of Poland: 1980 Report* (Warsaw, 1980).

[11] J. T. P. Bonte, "Population changes, health and health strategies in developed countries", *Economic and Demographic Changes: Issues for the 1980's*, Proceedings of the Conference, Helsinki, 1980 (Liège, International Union for the Scientific Study of Population, 1979).

[12] The example of Poland as a representative of East European countries seems particularly interesting here. The recently observed increase in adult mortality in Eastern Europe can be almost entirely attributed to the increase in death rates related to cardiovascular diseases.

[13] M. Okolski and B. Pulaska, *Recent Mortality Patterns and Trends in Poland* (Warsaw, University of Warsaw, Department of Economics, 1982).

[14] J. Duchene, "Un essai de modélisation de la répartition des décès selon l'âge et la cause dans les pays industrialisés" (Louvain-la-Neuve, Cabay, March 1980).

[15] G. Caselli and V. Egidi, "Nouvelles tendances de la mortalité en Europe", *Etudes Démographiques*, No. 5 (Strasbourg, Council of Europe, 1981).

[16] G. Wunsch and A. Lambert, *Life-styles and Death-styles: Differentials and Consequences of Mortality Trends*, Université Catholique de Louvain, Département de Démographie, Working Paper No. 103 (Louvain-la-Neuve, Cabay, July 1981).

[17] See E. Nightingale, "Prospects for reducing mortality in developed countries by changes in day-to-day behavior", *International Population Conference, Manila, 1981*, vol. II (Liège, International Union for the Scientific Study of Population, 1981).

[18] G. Wunsch and A. Lambert, *loc. cit.*

[19] G. Caselli and V. Egidi, *loc. cit.*

[20] See E. G. J. Bourgeois-Pichat, "L'évolution de la mortalité dans les pays industrialisés", paper presented to the INED-IUSSP Seminar on Social Policy, Health Policy and Mortality Prospects, Paris, 28 February–4 March 1983; J.-C. Chesnais, "La durée de la vie dans les pays industrialisés", *La Recherche*, No. 147 (September 1983); J.

Dutton, "Changes in Soviet mortality and patterns, 1959-77", *Population and Development Review*, vol. 5, No. 2 (June 1979); P. Jozan, "Some features of mortality in the 1970's in Hungary" (1982), unpublished manuscript; M. Okolski and B. Pulaska, *loc. cit.*

[21] See J. Bourgeois-Pichat, *loc. cit.*, and J.-C. Chesnais, *loc. cit.*

[22] See, e.g., M. J. Roemer, *Comparative National Policies on Health Care* (New York, Marcel Dekker, 1977); M. W. Freymann, "Public health", in *International Encyclopedia of Population*, J. A. Ross and others, eds., vol. II (New York, London, The Free Press, 1982); W. Hobson, ed., *The Theory and Practice of Public Health*, 5th ed. (Oxford, New York, Toronto, Oxford University Press, 1979); World Health Organization (Regional Office for Europe), *Health Services in Europe* (Copenhagen, 1965); J. Fry and W. A. J. Farndale, eds., *International Medical Care: A Comparison and Evaluation of Medical Care Services Throughout the World* (Wallingford, Pennsylvania, Medical and Technical Publishing, 1972).

[23] See for instance the following works: M. W. Freymann, *loc. cit.*; M. Lalonde, "Beyond a new perspective", *American Journal of Public Health*, vol. 64 (April 1977); P. O'Neill, *Health Crisis 2000*, (London, William Heinemann, 1983); A. Letourmy, "Politique de santé et inégalités sanitaires", in *Conceptions, mesures et actions en santé publique*, Les colloques de l'Institut national de santé et de recherche médicale (INSERM), vol. 11 (Paris, INSERM, 1982); K. Tymowska and C. Wlodarczyk, "Reforma w ochronie zdrowia i opiece spoleczznej" (Reform in health care and social welfare), in *Uslugi spoleczne* (*Social services*), A. Lukaszewicz, ed. (Warsaw, Panstwowe Wydawnictwo Ekonomiczne, 1984); World Health Organization (Regional Office for Europe), *Regional Strategy for Attaining Health for All by the Year 2000* (EUR/RC 30/8) (Copenhagen, 1980).

[24] See J. Brotherton, *loc. cit.*

[25] O'Neill, *op. cit.*, p. 2.

[26] All this may stem, *inter alia*, from underdevelopment of the analysis-of-health situation and of the performance of health-care systems. See A. Mejía, "World trends in health manpower development: a review", *World Health Statistics Quarterly*, vol. 33, No. 2 (Geneva, World Health Organization, 1980).

[27] The most notable examples are works concerning Canada, published in 1974 and 1977 by Lalonde, and the report issued in 1979 by the United States Surgeon General and the accompanying or following documents prepared by the United States Department of Health, Education and Welfare and Department of Health and Human Services. See M. Lalonde, *A New Perspective on the Health of Canadians* (Ottawa, Office of the Canadian Minister of National Health and Welfare, Government of Canada, April 1974); M. Lalonde, "Beyond a new perspective", *American Journal of Public Health*, vol. 64 (April 1977); United States Department of Health, Education and Welfare, *Healthy People, The Surgeon General's Report on Health Promotion and Disease Prevention* (Public Health Service publication No. 79-55071, Washington, D.C., 1979). Noteworthy is also a recently (1984) published work by Tymowska and Wlodarczyk, *loc. cit.*, which constitutes a distinct exception in the CMEA countries.

[28] See e.g. L. Breslow, "Health intervention programmes and their implications for mortality in developed countries: cardiovascular disease", paper presented to the INED-IUSSP Seminar on Social Policy, Health Policy and Mortality Prospects, Paris, 28 February–4 March 1983; J.-C. Chesnais, "L'efficacité de la prévention des morts violentes dans le monde industriel: les leçons de l'expérience", IUSSP Seminar on Social Policy . . .; P. Ducimetière, "Expériences de prévention dans le domaine de la pathologie cardiovasculaire", *Conceptions, mesures et actions en santé publique*, vol. 11 (Paris, INSERM, 1982); F. Hatton and others, "Les programmes d'intervention sanitaire et leur conséquences sur la mortalité cancéreuse dans les pays développés", Seminar on Social Policy . . .; B. Junod, "Conception, niveaux d'évaluation et perspectives d'extension du programme national Suisse de recherche sur la prévention des maladies cardiovasculaires", *Conceptions* . . .; M. Kornitzer and others, "The Belgian Heart Disease Prevention Project: modification of the risk profile in an industrial population", *Circulation*, No. 61 (1980); E. Nightingale, *loc. cit.*; J. Tuomilento and others, "Evaluation of intervention programmes aiming at reducing major causes of mortality and morbidity in adulthood", Chaire Quetelet (Louvain-la-Neuve, Cabay, May 1982).

[29] See e.g. M. Blanc, "Effets à long terme des programmes d'intervention contre le tabagisme", IUSSP Seminar on Social Policy . . .; E. P. Eckholm, *The Picture of Health: Environmental Sources of Disease* (New York, N. W. Norton, 1977); M. W. Freymann, *loc. cit.*; E. Nightingale, *loc. cit.*; P. O'Neill, *loc. cit.*

[30] See works cited in notes 28 and 29.

[31] Therefore the optimistic expectations and evaluations of the organization of health-care systems and the perspectives of health improvement in those countries, expressed not only by the Soviet and Eastern European authors but also by some Western writers (see e.g. M. W. Freymann, *loc. cit.*, and J. Fry and W. A. J. Farndale, eds., *loc. cit.*), have proved to be unwarranted.

[32] This point has been forcefully developed in: Ch. Davis, *The Economics of the Soviet Health System* (London, Wharton, August 1982).

[33] See M. Sokolowska, "Health as an issue in the workers' campaign", *Crises and Conflicts: The Case of Poland 1980-81*, Sisyphus, Sociological Studies, vol. III (Warsaw, Polish Scientific Publishers, 1982).

[34] In developed countries the average expenditures on health over the past ten years have been 5-6 per cent of national expenditures. In the USSR, however, the share of expenditures on health care in the net national income was 4.3 per cent and it remained almost constant throughout the period 1965-1980. In Czechoslovakia it oscillated between 4.0 and 4.5 per cent; in Yugoslavia it declined from 6.7 per cent in 1976 to 5.6 per cent in 1980; while in Poland, after a long period of decrease which ended in 1978 (3.8 per cent), a sudden increase has been recorded (5.8 per cent in 1981), the latter mostly due to a considerable drop in the net national income. See A. Mejía, *loc. cit.*; K. Tymowska, "Systemy finansowania sluzb zdrowia w wybranych krajach kapitalistycznych i socjalistycznych (Systems of financing of health services in selected capitalist and socialist countries) (Warsaw 1983), unpublished manuscript.

[35] See, e.g., V. P. Korchagin, "Problemy ekonomiki zdravookraneniya v usloviyakh rasvitogo sotsialisma" (Moscow, 1980), unpublished doctoral dissertation, quote from Ch. Davis, *loc. cit.*; and M. Okolski, "Factors associated with the recent rise of mortality in Poland", Seminar on Social Policy . . .

[36] See "Projekt reformy systemu ochrony zdrowia i opieki spoleczznej" (Blueprints of the reform of the system of health care and social welfare), Komisja d/s Reformy Gospodarczej. Zespol XIII Sfery Uslug Spolecznych (Warsaw, April 1983), mimeographed.

[37] The concept of case load often denotes the specific requirements posed before the health-care system (e.g. number of specialists, out-patient visits, hospital bed days etc.) by a given pattern of morbidity and mortality, and it has clearly a much narrower meaning than adopted here.

[38] A simulation study up to the year 2030 for the Federal Republic of Germany indicated, however, that in conditions of declining population it is still possible to have a deficiency in the supply of health personnel, although some of the teachers in medical schools might be redundant. See K. Schwartz, *loc. cit.*

[39] See K. Schwartz, *loc. cit.*

[40] See J. T. P. Bonte, *loc. cit.*

[41] This would be so provided no increase occurs in the incidence of communicable diseases of viral origin classified, according to ISCD, in other groups than infectious and parasitic diseases (e.g. bronchitis).

[42] It might be mentioned here that in some developed countries there still exists a relatively high incidence of tuberculosis, especially among socially underprivileged groups. More resources need to be allotted to the preventive care associated with this disease, especially among those most exposed (i.e. children and adolescents from poor families).

[43] E. P. Eckholm, *loc. cit.*, pp. 206-207.

[44] Of foremost importance in this respect is the World Health Organization document *Regional Strategy for Attaining Health for All by the Year 2000*. See also D. Deliège, "Participation de la population au système de santé", *Cahiers de sociologie et de démographie médicales*, No. 4 (1982); P. O'Neill, *loc. cit.*; M. Lalonde, "Beyond . . . "; A. Letourmy, *loc. cit.*; K. Tymowska and C. Wlodarczyk, *loc. cit.*

[45] Mejía suggests that the present disillusionment with planning of health-care systems stems from advocating sophisticated planning methods unfit to the national information systems, not taking into account social, economic and political constraints, and the detachment from other planning processes. See A. Mejía, *loc. cit.*

[46] An interesting endeavour of this type has been the establishing of a network of Les observatoires régionaux de la santé in France.

[47] World Health Organization, *Regional Strategy* . . .

[48] It should be stressed, however, that in some countries (CMEA countries being the most noteworthy example) this should go hand in hand with a radical improvement in curative health care.

[49] Brotherston correctly remarks that in some social groups, contrary to health planners' expectations, the concept of self-care and the underlying assumption that if services are made available, individuals in need will use them, are not justified. Therefore, "it is insufficient simply to provide better services or assume that they will be fully used by those who most require them; we have also to make sure that these services are appropriately deployed and are really used by those in greatest need". See J. Brotherston, *loc. cit.*, p. 98. Two interwoven ways of overcoming this problem seem advisable: more education for lower social groups in order to improve their awareness of health problems, and social reforms resulting in more equity.

[50] For example, one possible intervention to lower the fatality rates from excessive consumption of alcohol is the random breath testing of motorists, introduced in the Australian states of New South Wales and the Australian Capital Territory in December 1982. If the level of blood alcohol revealed by these tests exceeds a certain figure (.05 in New South Wales, .08 in the ACT) a stiff fine is imposed. It appears to be mainly as a result of this new policy and the associated publicity that the number of fatalities in traffic accidents fell by 24 per cent in these states in 1983, compared with the average of the three preceding years. (Derived from data in Australian Bureau of Statistics, "Road Traffic Accidents Involving Fatalities, Australia" (Cat. No. 9401-0).)

[51] This is, of course, a condition *sine qua non.* In order to successfully promote healthy living habits, new methods are also required which would prevent psychological stress leading to unhealthy habits.

XV. IMPLICATIONS OF LEVELS AND DIFFERENTIALS IN MORTALITY AND MORBIDITY FOR INSURANCE AND PENSION SCHEMES

*Bernard Benjamin**

This volume is concerned only with mortality trends and differentials, and as a consequence this chapter is intended to deal with the effects of mortality improvement alone upon the insurance industry. It is a little difficult to isolate the influence of mortality improvement from that of other demographic factors such as family formation and dissolution, fertility and family size, economic activity and even immigration and cross-cultural influences. The effect on insurance contracts of these factors taken together have been discussed elsewhere[1] where it has been suggested that long-persisting high unemployment in the countries of advanced economic development and the consequent restriction of the length of the paid working life may be one of the most important influences on life assurance contracts and especially on pension benefits and costs. Here we will ignore other influences and consider only the effect of mortality improvement. (It is implicitly assumed that barring widespread warfare on a near-world scale the possibility of mortality deterioration may be ignored, though certainly at the time of the World Population Conference, 1974, at Bucharest, some observers considered that further improvement in adult mortality was unlikely.)

THE SCALE AND NATURE OF MORTALITY IMPROVEMENT

It is necessary to distinguish between two different scenarios:

(*a*) That mortality rates in the different sex-age groups continue to decline only at their present pace;

(*b*) That there may be a dramatic acceleration in the pace of improvement.

It will, further, be necessary to consider what increased longevity may mean in terms of health and vitality. Does it mean that people are remaining free of disabling or potentially fatal disease *longer* or only that sick people are kept alive by improved maintenance therapy, with perhaps only some or even no mitigation of their disability? To deal with this last question it is necessary to separate morbidity from mortality, as Pollard has done,[2] and moreover to look at this separation over a period of time as has not yet been done (the author is attempting to examine secular changes in the age incidence of those diseases which may be loosely, very loosely, described as "terminal"). The difficulty is that apart from certain diseases that are registered, either voluntarily or compulsorily, such as malignant neoplasm, diabetes, multiple sclerosis, the data are restricted or lacking, at least for any prolonged period of observation. The tentative suggestion from the current failure of sickness rates in later adult life to improve is that disease incidence is not, as yet, following the improvement in longevity. Comfort,[3] though sanguine of very great future improvement in survival, has warned that "postponement of the onset of present type old age by 10 to 20 per cent will not reduce the duration of oldness or (probably) change the pattern of age disability".

It seems unlikely that this caution will modify the reaction of insurers to the decline in mortality rates, except to the extent (see later) of expanding the market for the life insurance of impaired lives and for sickness insurance.

THE SCALE OF MORTALITY IMPROVEMENT

To examine the present scale of mortality improvement and possible accelerations in the fall of improvement, England and Wales will be used as a model simply as a matter of convenience since for the purpose of looking at the implications for the cost of social security (one form of insurance) the author, in collaboration with Elizabeth Overton,[4] has fairly recently closely examined the improvement in that country which, though perhaps not showing quite such remarkable mortality improvement as some other countries, is fairly typical of the countries of advanced economic development.

For this exercise three projections of mortality rates were made.

Projection No. 1. A gloomy view of mortality prospects

This projection assumed very little further improvement in mortality except at ages under 15 where a somewhat slower rate of improvement than that indicated by present trends was projected. Above age 15 the rate of improvement was close to zero. It was assumed that adult men and women would go on finding new ways to kill themselves (as they have in the past) despite all that medicine might offer.

It was considered that this was an unlikely prospect, but that it provided a lower bound to the widening funnel of uncertainty in the future. The percentage 40-year improvement rates are shown in table XV.1.

A life table based on this projection was calculated but it hardly seems necessary to reproduce it here since, as might be expected, it represented very little change from the latest national life table (ELT 13) for 1971. A few comparative values of expectation of life are shown in table XV.2.

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TABLE XV.1. PERCENTAGE REDUCTION IN MORTALITY RATES OVER A 40-YEAR PERIOD: PROJECTION NO. 1

Age	*Males*	*Females*
0-4	60	60
5-9	45	50
10-14	40	40
15-19	6	10
20-24	4	9
25-34	0	4
35+	0	0

TABLE XV.2. VALUES OF EXPECTATION OF LIFE FOR ENGLAND AND WALES IN 1971 (ELT 13) AND FOR 2011 FROM PROJECTION NO. 1

	Expectation of life			
	Males		*Females*	
Age	*Projection 1 (2011)*	*ELT 13 (1971)*	*Projection 1 (2011)*	*ELT 13 (1971)*
0	71.3	69.0	77.3	75.25
15	56.9	55.84	62.7	61.78
25	47.3	46.32	52.9	52.01
45	28.4	27.44	33.7	32.88
65	13.0	12.18	16.9	16.10
85	4.3	4.14	5.3	5.02

Projection No. 2. Medium assumption

This was based on the trend of age-specific mortality rates for England and Wales in the past two decades which had, at all ages, been approximately such that each year's rate bore a constant ratio to the rate for the previous year, i.e. that for any particular sex/age group the logarithms of the death rates followed a linear trend with time. It was assumed that this trend would continue. The trends were established by orthodox statistical methods which need not be described here. From those trends estimates were made of the likely improvement rates that should be applied to the latest available death rates for England and Wales, i.e. those for 1977, to project rates for the year 2017. These improvement rates, shown as percentage reductions from the 1977 levels, are shown in table XV.3. The improvement rates concurrently assumed by the Government Actuary for national population projection purposes are also shown in table XV.3. The age-specific mortality rates in 2017 emerging from this projection have been put into the form of an abridged life table and specimen values of expectation of life are shown in table XV.4.

This projection will be considered later in the chapter.

Projection No. 3. Extreme assumptions

To take an extremely optimistic view of mortality improvement prospects: table XV.5 shows, in life-table form, the present apportionment of the risk of dying from the different specific groups of diseases which are of particular interest (and which for males account for 87 per cent of the total deaths).[5] Dealing first with males the following extreme assumptions were made as to possible changes over the next forty years:

(*a*) That deaths from congenital malformations and disease of early infancy are reduced to one third of their present numbers, the lives saved being assumed to die over all ages in proportion to the total deaths of the life table as finally modified in relation to the specified causes;

TABLE XV.3. ASSUMED REDUCTION IN MORTALITY RATES OVER 40-YEAR PERIOD (1977-2017) FOR ENGLAND AND WALES: GOVERNMENT ACTUARIES PROJECTION (GAD) AND FROM PROJECTION NO. 2

(Percentage)

	Males		*Females*	
Age	*GAD*	*Projection 2*	*GAD*	*Projection 2*
Infant mortality	25	70	25	70
1-4	25	70	25	70
5-9	25	65	25	65
10-14	25	62	25	65
15-19	0	27	0	43
20-24	12	30	14	32
25-29	17	45	25	50
30-34	10		25	
35-39	10	40	10	42
40-44	0		1	
45-49	0	17	0	19
50-54	0		0	
55-59	6	21	3	14
60-64	15		10	
65-69	20	26	14	26
70-74	17		16	
75-79	15	22	17	29
80-84	13		18	
85-89	13	15	19	20

TABLE XV.4. ILLUSTRATIVE VALUES OF EXPECTATION OF LIFE FOR 2017 FROM PROJECTION NO. 2

(Years)

	Expectation of life	
Age	*Males*	*Females*
0	74.4	80.4
15	59.8	65.8
25	50.2	55.9
45	30.8	36.4
65	14.9	19.3
85+	5.0	6.6

(*b*) That as a result of a drastic reduction in the level of cigarette smoking some 90 per cent of all deaths from cancer of the lung and bronchus, and one third of all deaths from ischaemic heart disease prior to age 65 (the proportions currently attributable to smoking)[6] are saved and proportionately redistributed by age in the finally modified life table;

(*c*) That as a result of improved therapy and maintenance the whole of the remaining deaths from ischaemic heart disease, from cerebrovascular lesions, and other heart and circulatory diseases are deferred by ten years;

(*d*) That as a result of environmental improvements including the avoidance of cigarette smoking, all deaths from bronchitis, emphysema and asthma are prevented and redistributed;

(*e*) That all deaths from cancer, other than cancer of the lung, are avoided by the introduction of new therapy, these deaths being redistributed to other causes;

(*f*) That the risk of death by accident remains unchanged, some environmental improvements being balanced by the appearance of new hazards (excluding nuclear hazards);

(*g*) That the small residuum of deaths from tuberculosis and diabetes remains as at present;

TABLE XV.5. DEATHS, BY CAUSE, IN POPULATION OF LIFE TABLE (RADIX 10,000): ENGLAND AND WALES, 1971

Age	*Tuberculosis*	*Cancer of lung, bronchus*	*Other cancer*	*Diabetes*	*Ischaemic heart disease*	*Cerebrovascular lesions*	*Other heart and circulatory diseases*	*Bronchitis, emphysema and asthma*	*Congenital malformations and diseases of early infancy*	*Accidents, poisons, violence*	*Nephritis*	*Senility*	*Other diseases not specified in this table*	*Total*
MALES														
0- ...	—	—	1	—	—	—	1	1	132	6	—	—	57	198
1-14 ...	—	—	11	—	—	1	—	1	25	28	1	—	1	68
15-24 ...	—	—	10	—	—	1	3	1	2	58	1	—	14	90
25-44 ...	2	14	51	2	69	14	22	6	4	85	4	—	40	313
45-49 ...	2	25	38	2	94	14	17	8	1	22	2	—	21	246
50-54 ...	2	49	63	2	154	24	28	18	1	22	2	—	36	401
55-59 ...	4	86	104	4	230	42	46	38	1	25	4	—	53	637
60-64 ...	4	139	151	6	334	79	73	72	1	25	4	—	85	973
65-69 ...	6	167	202	8	443	136	116	117	1	26	5	—	124	1 351
70-74 ...	5	171	226	12	491	198	162	154	1	25	5	1	184	1 635
75-79 ...	4	117	218	12	471	235	196	153	—	23	6	3	237	1 675
80-84 ...	3	47	148	8	326	208	189	104	—	23	5	8	229	1 298
85+	1	18	91	5	252	190	204	69	—	22	4	20	239	1 115
TOTAL[a]	33	833	1 314	61	2 864	1 142	1 057	742	169	390	43	32	1 320	10 000
FEMALES														
0- ...	—	—	1	—	—	—	1	1	99	5	—	—	44	151
1-14 ...	—	—	9	—	—	1	1	1	25	14	—	—	—	51
15-24 ...	—	—	7	—	—	1	2	1	2	17	1	—	8	39
25-44 ...	1	6	77	3	10	15	18	5	3	33	3	—	37	211
45-49 ...	1	9	71	1	14	14	15	4	1	13	1	—	22	166
50-54 ...	1	14	100	2	29	22	22	8	1	13	1	—	30	243
55-59 ...	1	20	132	3	55	37	34	13	1	16	2	—	42	356
60-64 ...	1	26	167	7	109	64	52	19	1	17	3	—	61	527
65-69 ...	1	29	195	12	196	117	86	26	1	21	4	—	99	787
70-74 ...	2	29	228	20	310	213	153	35	1	29	5	1	158	1 184
75-79 ...	2	23	244	23	436	340	257	46	1	44	6	4	265	1 691
80-84 ...	1	14	204	20	444	411	361	44	1	49	5	16	298	1 868
85+	1	10	193	16	577	590	593	57	1	75	6	67	540	2 726
TOTAL[a]	12	180	1 628	107	2 180	1 825	1 595	260	138	346	37	88	1 604	10 000

Source: B. Benjamin, "The aging population", annual Woodhead Lecture, 1979. Unpublished document.

[a] Chance (per 10,000) of dying of the disease.

(*h*) That all deaths in the unspecified cause group are deferred for ten years, except those in the first year of life which are assumed to be prevented.

The total result of this redistribution of deaths is shown in table XV.6 in the form of values of expectation of life.

TABLE XV.6. ILLUSTRATIVE VALUES OF EXPECTATION OF LIFE FOR 2017 FROM PROJECTION NO. 3

(Years)

Age	Expectation of life	
	Males	*Females*
0	81.3	87.1
15	66.8	72.5
25	57.2	62.7
45	38.2	43.3
65	20.3	24.5
85	7.6	8.7
100	2.5	2.5
105	—	—

Modifications to the relative risks of dying from different diseases would normally require the use of multiple decrement methods to allow for the simultaneous operation of competing risks from the various diseases, but in view of the very arbitrary assumptions of projection 3 refined methods were regarded as out of place.

A special word must be said about the mortality of females. The current mortality trend for females is a deteriorating one at middle ages. Women have now been copying the smoking habits of men sufficiently long to begin to incur the penalty of rising death rates from lung cancer and ischaemic heart disease. So things may be going to get worse before they can get better (this has been implicitly taken into account in projection No. 2). Nevertheless, having drawn attention to this possibility it was considered possible to apply the same projection No. 3 assumptions as for men.

The percentage reductions in mortality rates over forty years implied by projection No. 3 are shown in table XV.7 for comparison with tables XV.3 and XV.1.

These are very large reductions in mortality rates, even compared with the substantial reductions shown in table 3, derived from the medium projection No. 2, but there are many observers who would not regard them as over fanciful.

Table XV.8 brings together representative values of expectation of life from both projections Nos. 2 and 3 and compares them with corresponding values from life tables ELT 7, 10 and 13 relating to mortality rates around 1906, 1931 and 1971 for England and Wales.

The main conclusions to be drawn from table XV.8 are:

1. Up to the present time the most striking improvements have occurred at very young ages. At the turn of the century 140 out of every 1,000 new born babies died before the end of their first year of life; in 1971 this proportion had been reduced to 13 per 1,000. This increased the expectation of life at birth by some 20 years. In contrast life expectancy at age 65 had increased, for males, only from 10.8 to 12.2, though for females it increased by rather more, from 12.0 to 16.1.

2. If present trends continue (projection No. 2) life expectancy at birth will increase over the next 40 years for males to 74.4 and for females to 80.4; and life expectancy at age 65 will increase to 14.9 and for females to 19.3. These are real, but not striking, improvements and they are not likely to add much impetus to the changes in insurance practice which are already in process.

3. But if the extreme assumptions of projection No. 3 were to be proved to be justified, this would be a different story altogether. As compared with 1971, for both sexes there would over 40 years be an increase in life expectancy of about 11 years up to age 45. Even at age 65 the increase is still 8 years. This is a very large improvement in a measure that has in the past moved only very slowly with time.

TABLE XV.7. REDUCTION IN MORTALITY RATES OVER A 40-YEAR PERIOD (1977-2017): PROJECTION NO. 3

(Percentage)

Age (years)	Males	Females
0-4	72	75
5-9	48	43
10-14	38	23
15-19	41	27
20-24	38	51
25-29	12	20
30-34	19	33
35-39	15	29
40-44	51	60
45-49	67	71
50-54	77	80
55-59	67	71
60-64	68	73
65-69	70	73
70-74	70	74
75-79	62	70
80-84	61	69
85-89	55	61
90-94	47	54
95-99	25	– 5
100-104	66	66

TABLE XV.8. EXPECTATION OF LIFE AT REPRESENTATIVE AGES FROM ELT 7 (1906), ELT 11 (1931) AND ELT 13 (1971) AND FOR THE YEAR 2017 FROM PROJECTIONS NO. 2 AND NO. 3

Age	Males					Females				
	1906	*1931*	*1971*	*2017 (P. 2)*	*2017 (P. 3)*	*1906*	*1931*	*1971*	*2017 (P. 2)*	*2017 (P. 3)*
0	48.5	58.7	69.0	74.4	81.3	52.4	62.9	75.3	80.4	87.1
15	47.3	51.2	55.8	59.8	66.8	50.1	54.3	61.8	65.8	72.5
25	38.9	42.5	46.3	50.2	57.2	41.5	45.6	52.0	55.9	62.7
45	23.3	25.5	27.4	30.8	38.2	25.5	28.3	32.9	36.4	43.3
65	10.8	11.3	12.2	14.9	20.3	12.0	13.1	16.1	19.3	24.5
85	3.5	3.5	4.1	5.0	7.6	3.9	4.0	5.0	6.6	8.7

Changes in Life Insurance Already in Progress

Before discussing the effect upon life and pensions insurance of future mortality changes it is necessary to look at the changes that have been brought about by past improvements.

Fifty years ago, England and Wales was still in the grip of a world economic depression and the level of living was lower than now. Except for the rich, money available for saving of any kind was limited. What money was available was (apart from short-term needs) devoted first to the then most important need of providing for the risk that the main economic supporter of the family should die before the end of his working life (in those days very few wives were in paid employment outside the home).

This risk was then considered to be very real. According to the national life table for 1931 (ELT 10) the percentage of men aged 25 likely to die before their 65th birthday was 19, not alarmingly large and not appreciably greater than now (ELT 13 gives 18 per cent). But there was also the risk of permanently disabling illness. The partial social security system ushered in by the Contributory Pensions Act of 1925 was still in its infancy, and in any case benefits were only at subsistence level. Moreover, there was little public awareness of the fact that death rates had been steadily falling for many years. Life assurance still therefore fulfilled its original role of spreading the economic risks of early deaths and the emphasis tended still to be upon whole-life or longer-term endowment assurance; often, because of the lower premium to be paid, without participation in profits (i.e. the "bonuses" that were periodically added to the sum assured in the case of "with-profit" policy holders). There were two types of business each protected by separate legislation:

(*a*) So-called industrial life assurance policies on which the premiums were paid usually weekly, certainly more frequently than at three-monthly intervals, and were collected by company agents who called at the household dwelling. These policies were designed for the lower-paid. The sums assured were small, often no more than the cost of burying the deceased—indeed they were often referred to as "funeral insurances";

(*b*) "Ordinary" life assurance for the better-circumstanced, with larger sums assured and a choice of participation or non-participation in profits. The premiums were usually annual but certainly not more frequent than quarterly.

Change had, however, been taking place. The better-paid non-manual workers were beginning to take a shorter-term view and to consider other purposes of life assurance than merely the protection of the family against the consequence of the untimely death of the assured. The purely "savings" element in life assurance was beginning to appear with the growth in popularity of shorter-term endowment assurances. [The "endowment" assurance is one in which premiums are limited to a fixed term—in the early years 20 or 25 years was commonly chosen—and the sum assured is paid either on the death of the assured or on his survival to the end of the term]. This shorter-term view was engendered partly by the already lessening fear of early death and partly, as a result of the depression, a feeling of distrust of longer-term investment. The change was given impetus by an increase in disposable incomes as economic recovery began, making more money available for saving. New purposes for assurance emerged; endowment assurances were used to cover house mortgages issued by the life company (effectively in one composite contract), or to provide benefits ("family income") over a period of years in the future, when children would be requiring extra money to be spent upon them for education and training for employment. Assurances were beginning to be regarded as forms of saving designed to meet the various points of possible financial stress during the life cycle of the family. Average sums assured rose in volume; "industrial insurance" began to diminish in volume.

There was little or no pensions business, as such, contracted by insurance offices. Occupational pension schemes were few and largely confined to those working in the public services, central or local. Some arrangements were funded (the excess of current contributions over current outgo being invested for future liabilities) while others were operated on a pay-as-you-go basis (current pensions being paid out of current contributions), any shortfall being made up by the employer; some were contributory while in others (e.g. the civil service) the cost was taken into account in fixing salaries below what would otherwise be paid. Most company pension arrangements were based on voluntary undertakings by the employer, i.e. they depended on the goodwill and the continued prosperity of the company.

Lastly there was one important feature of the 1930s—inflation was not of any significance and partly in consequence interest rates were low.

After 1948

After the end of the Second World War of 1939-1945 the changes outlined above in relation to life insurance became more widespread and quickened in pace. The insecurity engendered by the war—the destruction of buildings, the sudden deaths of young men and women, the interruption of careers, the separation of families—added a further element of pressure to the movement.[7]

But there was now a new element—the probability that for a long time there would be significant monetary inflation; prices would continue to rise and money would continue to fall in value. Methods of dealing with inflation (for example by linking the sum assured to units in an indexed fund) are not within the purview of this chapter and will not be discussed. Suffice it to say only that inflation added to the pressure already created by improved survival prospects for shorter-term assurances. In recent years there has been a growing demand for very short-term contracts—as short as five years—with the option of renewing for a further period on terms more favourable than if an entirely new policy were to be taken out. The significant feature of this development was that Life Offices were now less concerned with insurance as such than with fulfilling a savings role in competition with the banks and the Building Societies. And indeed such competition *ought* to be available.

Impaired Lives

The Life Offices have always been prepared to consider, at special premium rates, proposals for life assurance coverage of persons with certain types of medical impairments of a permanent or quasi-perma-

nent nature, e.g. diabetes. One aspect of the decline in mortality has been the more effective medical care and therefore the improved prognosis of such impaired lives and indeed the increased number of different types of impairment that it is economically feasible to cover. The premium loading is arrived at by an addition of scores (for separate components of impairment) from a rating manual. The technical method is not of interest here. What is of interest is the significant increase in the coverage of the manual over the years—it is now a very wide-ranging document in proportion to the wide range of impairments that are now regarded as insurable. It is worth commenting here that one question about improved longevity still remains to be answered. Is the improvement due to the postponement of onset of impairments to later ages (by improved medical care, raised level of living, healthier life-styles etc.) or is it simply due to the improved maintenance and therefore prolonged survival of impaired lives? In terms of quality rather than mere length of life, this is a very important question.

Occupational pensions

A steady growth began in the provision of occupational pensions. There was pressure from below because improved survival meant that a longer period of retirement than formerly expected had to be budgeted for. There was pressure from above, since employers recognized that a pension scheme would form an attraction to new staff and would also provide an incentive for existing staff to remain loyal to the company. There were two main types of schemes:

1. The entirely in-house scheme, either on a pay-as-you-go basis or self-administered contributory scheme on a funded basis with supervision by trustees and actuarial guidance from independent consultant actuaries, or

2. A scheme contracted with a life assurance office either as:

(*a*) A group contract for the entire staff or individual contracts for individual members, or

(*b*) A deposit administration on which a virtually independent contributory funded scheme is, for an expenses charge, husbanded by the Life Office with its advantage of wider experience in and much larger participation in the investment of funds.

In the 1950s the amount of pension business of one kind or another written by Life Offices rose phenomenally and it has continued to grow.

The figures in table XV.9 have been taken from periodical sample surveys conducted by the Government Actuary. The total number of pensions in payment has increased from 0.2 million in 1936 to 3.7 million in 1979.[8] Not all schemes are funded. For those that are funded the total size of funds increased from £2.25 billion in 1955 to £1.2 billion in 1975.[9]

Permanent health insurance

Another feature of improvement in mortality and the accompanying growth of interest in other risks surrounding survival has been the growth of participation in so-called "permanent health insurance". Permanent health insurance (PHI) contracts are issued as ordinary policies on individual lives or under group policies arranged with the employer of lives insured. Benefits may be in the form of income during qualifying disability (after an optional period of deferment), lump sums on permanent disablement and waiver of premiums under life policies during disablement.

The first United Kingdom insurance company to provide sickness and accident cover commenced to issue policies in 1885, and two Life Offices have been transacting this type of business for nearly 100 years. But it was possible to obtain this type of cover well over a hundred years before the Life Offices first began to offer it. It was the principal type of benefit offered by the Friendly Societies which were then growing in membership. The State entered the business in partnership with the Friendly Society movement but the partnership ended in 1946 with the passing of the National Insurance Act of that year. This Act inaugurated compulsory sickness insurance for all employed persons but the weekly benefit was not immediately earnings-related and not above subsistence level. For those in higher-paid occupations, and especially the self-employed in professions who sought in the event of long term sickness to maintain, at least partially, their incomes, there was a need for supplementary insurance and this is what PHI provides. About this time, therefore, the market for PHI was expanding and many offices, in addition to the original two, entered it.

Tables of sickness claim rates are compiled regularly by the Continuous Mortality Investigation (CMI), a bureau maintained jointly by the Institute of Actuaries (of England and Wales) and the Faculty of Actuaries (of Scotland). These rates are based on the pooled experiences of those offices that conduct PHI. In 1947 the scale on which this business was being conducted was relatively small and not such as to produce a demand for standard tables. In 1972, however, when the CMI first began to produce tables, the number of policy-holders covered in the pooled experiences of 10 offices numbered about 160,000 and the market has

TABLE XV.9. EMPLOYEES IN PENSION SCHEMES, 1936-1979

(Millions)

	Private sector		*Public sector*		
Year	*Men*	*Women*	*Men*	*Women*	*Total*
1936	1.3	0.3	0.8	0.2	2.6
1953	2.5	0.6	2.4	0.7	6.2
1956	3.5	0.8	2.9	0.8	8.0
1963	6.4	0.8	3.0	0.9	11.1
1969	6.8	1.3	3.1	1.0	12.2
1971	5.5	1.3	3.2	1.1	11.1
1975	4.9	1.1	3.7	1.7	11.4
1979	4.7	1.5	3.8	1.8	11.8

continued to expand. It is likely that this form of insurance will continue to expand. As has already been remarked the decline in mortality has not hitherto been accompanied by a similar decline in morbidity.

The figures in table XV.10 are indicative. These figures indicate a reduction in shorter-term sickness and an increase in longer-term sickness. It is difficult to interpret these figures since claim rates (and we are looking at *claims,* not actual sickness) are certain to be affected by the very high unemployment of recent years. In the case of illnesses of lesser severity, fear of losing a job would encourage an earlier return; for longer term sickness it is probable that retirement from the existing employment would be involved and in present circumstances it would be difficult to find another job—so there would be a tendency to prolong the claim if possible.

TABLE XV.10. SICKNESS AND INVALIDITY RATES IN YEARS ENDING MAY 1975 AND MAY 1980: MALES

(Weeks of sickness or invalidity[a] benefit paid per person exposed to risk)

Age (years)	Sickness rate 1975	Sickness rate 1980	Invalidity rate 1975	Invalidity rate 1980
20-24	0.91	0.89	0.08	0.15
25-29	0.87	0.81	0.19	0.29
30-34	0.91	0.83	0.34	0.45
35-39	1.07	0.89	0.46	0.69
40-44	1.15	0.98	0.68	1.05
45-49	1.24	1.12	0.95	1.36
50-54	1.47	1.34	1.38	1.82
55-59	1.76	1.61	2.30	3.33
60-64	2.33	2.12	5.00	7.25

Source: Report by Government Actuary on first quinquennial review of operation of Social Security Act 1975.
[a] Sickness of more than 3 months' duration.

Similar trends are shown by the combined offices' experience of PHI as recorded by the CMI as table XV.11 shows.

TABLE XV.11. CMI COLLECTED PHI EXPERIENCE, ALL OFFICES, INDIVIDUAL POLICIES, 1974 AND 1980: MALES

(Weeks of sickness claims per policy)

Age	Under 3-month period 1974	Under 3-month period 1980	3 months or longer 1974	3 months or longer 1980
40-44	.383	.214	.179	.168
45-49	.479	.284	.387	.336
50-54	.506	.322	.578	.566
55-59	.585	.519	1.071	1.455
60-64	.920	.600	2.383	3.041

So far as sickness unrelated to insurance claims is concerned, the available data are scanty. The General Household Survey (a regular interview survey in Great Britain of a representative sample of households) Report for 1980 showed that between 1972 and 1979 there was, in all age groups and for both sexes, a rising trend in the proportion of persons who reported acute sickness (defined as restricted activity in the 14 days before interview) but the proportions appeared not to have changed further in 1980. The proportions with long-standing illness also rose, for all age groups and both sexes, between 1972 and 1979 and continued to rise in 1980. The proportions of persons who had consulted their general practitioner in the 14 days before interview also rose for all age groups and both sexes, as did also the proportions attending hospital outpatient departments. Probably the most that can be said is that there is no evidence of significant decline in morbidity.

THE PRESENT EXTENT OF CHANGE

To summarize the present extent of adaptation to falling mortality we may say, broadly, that there has been a partial transfer of interest from dying to surviving; from protection against economic stress resulting from death to economic stress encountered in the lifetime—protection and enhancement of savings (for major spending periods in lifetime), loss of income from sickness during working life and loss of income in retirement.

THE FUTURE

If present mortality trends persist, then these shifts of emphasis will continue. If the more extreme assumptions of mortality projection No. 3 prove to be justified then the shifts will become stronger, much stronger.

There will be a further serious problem in relation to all pension schemes, including those arranged through life assurance offices. Rapid advances in technology in all countries of advanced economic development have made it possible for the goods and services required by the total population to be produced by a much smaller number of workers than hitherto. This has caused very high levels of unemployment which are likely to persist for decades to come, certainly until adjustments in population structure have taken place. The adjustment necessary will involve a sharing of the available work and this is likely to be achieved by shortening the length of the working life, i.e. postponing the age at entry (delaying the age of leaving full-time education) and advancing the age of retirement. On the other hand greatly improved longevity will, combined with earlier retirement, greatly extend the expected number of years during which a pension will be received. This will increase the cost of pensions, while on the other hand the period of time during which the pension will be paid for will be reduced. Either rates of contribution will have to be increased or pensions benefits will have to be reduced.

Since rates of contribution are already high, it seems more likely that the pension norm will have to be reduced perhaps from half final salary to one third final salary or even lower. The adjustment will be less painful and less opposed if a beginning is made now by educating the public about the difficulties that lie ahead. In the United Kingdom and in some other countries this process has begun. For example in the United Kingdom the two actuarial bodies recently conducted a public seminar at which the problems to be faced were carefully explained to politicians, financial organizations and the press.[10] In this discussion, which is concerned not only with the survival of pensioners but also with the relationship between those who currently receive pensions and those who currently work and contribute to the cost it is not realistic to isolate the factor of mortality improvement; it is a matter of looking at the age structure of the population and all the factors which influence it.

In the opening presentation to the seminar referred to above, the author showed that in England and Wales the proportion of the population aged 65 and over rose from 5.2 per cent in 1911 to 10.9 per cent in 1951. Roughly four fifths of this increase was due to the higher fertility prior to 1911 which had rendered the proportion of aged abnormally low (compared with a stationary population), i.e. a low starting point, and to the subsequent fall in fertility; only one fifth was attributable to the decline in mortality. From 1951 to 1981 the proportion aged 65 and over rose further to 15.1 per cent.

Of this latter change about two thirds was due to declining fertility and one third to mortality improvement. So while mortality improvement has not been an insignificant factor in the change of age structure, the decline in fertility has been the major factor.

As to the social security effects of the "aging" of the population structure, the figures are displayed in table XV.12.

The numbers in column 3 are the numbers of children aged 0-14 at different dates; they provide an approximate measure of child dependants, though there are many children above the age of 15 who are still dependent on their parents or the State. The numbers in column 4 are of married women who, though active in the home, are not gainfully employed and in that sense and that sense only are dependent. Column 5 shows the numbers in the pensionable age groups; there are some in that age group who are still gainfully employed and some of younger ages who have retired early, but column 5 is an approximate measure of pensioner dependants, i.e. dependent on others for the production of their current consumption of goods and services notwithstanding the liabilities they have built up by the income transfers (pension fund contribution or social security taxes) which they, the pensioners, suffered during their working life. Column 6 shows the remainder of the total population (column 2) who, by elimination, represent the supporting population.

The ratios of columns 3, 4 and 5 to column 6 provide indices (not true measures) of the three forms of dependency—child, married woman, pensioner. Column 10 is the addition of columns 7, 8 and 9 and is an index of total dependency. The three types of dependency are different in quality. Children, for example, are lighter consumers than adults, although it has to be borne in mind that they require many health, welfare and education services. A weighted addition of the indexes might be thought more appropriate but the choice of weights would be difficult, and since it is the time *trend* in the index that is important and *not* the absolute values, the refinement is not important. (Column 10 however understates total dependency for the simple reason that not all those in column 6 are at present able to work; they are themselves dependants. Column 11 has therefore been added to indicate this extra dependency.)

Most of the sets of figures relate to census enumerations, but the last three lines are based on population projections. Projection A represents a combination of a moderate recovery in fertility and the medium assumptions of mortality projection No. 2: not surprisingly the figures are close to those of the third line, i.e. the official population projection by the Government Actuary. Projection D represents a combination of a very small recovery in fertility (to barely replacement level) and the extreme mortality assumptions of mortality projection No. 3.

Looking first of all at column 9 it can be seen that pensioner dependency has risen steadily since the beginning of the century, but that the projected rise to the year 2021 on moderate mortality assumptions will not be large (from 0.38 to 0.44). The projected rise on the extreme assumptions of mortality projection No. 3 and continuing low fertility will, of course, be much larger, to 0.58. But it has to be stressed that these are extreme assumptions which not all observers are prepared to support. However, it will be seen from column 10 that because of the offsetting effect of reduction in the dependency of children (from declining fertility) and of married women (from their increasing entry into paid employment) the total index of dependency declined steadily up to 1981 and on moderate assumptions will increase only by a small amount over the next 40 years. Even on the extreme assumptions this total index will be no greater than in 1921. Furthermore, if it were thought, nevertheless, that the supporting population was too low, the index of column 11 shows that there is a reserve army of labour that can be drawn upon. More than 3 million unemployed are desperately anxious to be given work. It is indeed important here to stress that the dependency ratios for 1981 and in the future are *not* actually comparable with earlier values for the reason that technological improvements have greatly reduced

TABLE XV.12. ECONOMIC PRESSURE OF DEPENDENT POPULATION IN THE UNITED KINGDOM

(In thousands)

Projection	*Year (1)*	*Home population, all ages (2)*	*Children under 15 (3)*	*Non-gainfully occupied females, 15-59 (4)*	*Pensionable class Males 65+ Females 60+ (5)*	*Remainder (6)*	*Ratio to remainder of* Col. (3) (7)	Col. (4) (8)	Col. (5) (9)	Cols. (3+4+5) (10)	*Proportion of economically active population unemployed*[a] *(11)*
	1901	38 237	12 421	7 717	2 386	15 713	0.79	0.49	0.15	1.43	N.A.
	1921	44 027	12 304	9 560	3 501	18 662	0.66	0.51	0.19	1.36	0.093
	1931	46 038	11 174	9 819	4 421	20 624	0.54	0.48	0.21	1.23	0.110
	1951	50 225	11 325	9 211	6 827	22 862	0.50	0.40	0.30	1.20	0.009
	1961	52 709	12 336	8 629	7 733	24 011	0.51	0.36	0.32	1.19	0.012
	1971	55 515	13 387	7 325[b]	9 015	25 788	0.52	0.28	0.35	1.15	0.035
	1981	56 252	11 560	8 272[b]	10 064	26 356	0.44	0.31	0.38	1.13	0.114
A	2021	59 693	11 717	8 539[b]	11 964	27 473	0.43	0.31	0.44	1.18	
D	2021	63 274	11 118	8 507[b]	16 094	27 555	0.40	0.31	0.58	1.29	
Official ..	2021	59 307	11 608	8 484[b]	11 979	27 236	0.43	0.31	0.44	1.18	

[a] Census figures.

[b] Estimated as 50 per cent of age group.

the number of workers needed to produce the goods and services required by dependants—if this were not so we should not be seeing such a serious rise in unemployment.

It remains only to say that these demographic changes are not peculiar to the United Kingdom but apply fairly generally among the countries of advanced economic development.

To the insurance offices handling pension schemes the commercial aspect of this problem will not be palatable; they are going to have to offer less attractive benefits in order to keep the costs down.

There are a number of other problems connected with pension funds—protecting the rights of the early leaver (in order to ensure no loss of rights when a worker moves from one employer to another), equality of treatment between sexes, methods of funding (the increase in the total size of funds must have an impact on the national economy)—which have little or nothing to do with declining mortality and will not be discussed here.

THE DEVELOPING COUNTRIES

For the less developed countries of the world, economic development, notwithstanding all too limited aid from the already developed countries, is largely a matter of creating and using their own internal capital.

Life insurance

Life insurance as a form of saving (apart from the main object, in countries of higher mortality, of protection for the family) would be a desirable contribution to this internal capital. But saving implies belt-tightening, and in countries where the great majority of the population live on a subsistence level belt-tightening is already a way of life and the possibilities for further constraint are very limited.

El Mansoury[11] looked at this problem generally, but with particular reference to Egypt, and concluded that the low per capita incomes of developing countries do not permit more than the provision of so-called "industrial life assurance", i.e. the granting of life policies for small amounts, the premiums for which are collected by means of collectors calling regularly at the homes of the policy-holders.

The general characteristics of industrial life assurance are:

(*a*) Premiums paid frequently, weekly or monthly;

(*b*) Limitation on the amount of insurance per policy or per life;

(*c*) Collection of premiums by company's representative at policy-holder's home or place of business;

(*d*) Insurance normally sold in premium units, rather than units of insurance;

(*e*) Insurance generally written on all members of the family from birth to 65 or 70 years of age;

(*f*) The general omission of medical examinations.

In Egypt industrial assurance really did not become very active until 1965. Expansion has hitherto been somewhat slow because of the low incomes of the masses and the relatively high cost of insurance. There is moreover competition from the national social security system and some resistance to the idea of insurance arising from the Islamic religion. El Mansoury adds also as factors, the lack of understanding of insurance among the working class (there is still much illiteracy) and wrong methods of marketing. El Mansoury, taking a broad view of other possible savings channels, makes suggestions for improving the situation and offers a blue-print for the ideal insurance policy. The sum assured per policy should be little more than one year's per capita income and the rate of interest used in the premium should be near or equal to the highest rate in the market (to make this feasible he proposes that the Egyptian companies should be permitted to invest their premiums more freely than hitherto). Steps should be taken (he makes recommendations) to minimize the expense loadings on the premiums.

Social security

As distinct from life insurance as such (i.e. on an individual purchase basis) social security schemes embracing all members of the population must be considered. The developing countries (except for a few, most of which may not be regarded as in a relatively late stage of development, e.g. Brazil, China, Costa Rica, Egypt) are not able to support social security schemes (old age pensions and death benefits) covering the whole population.

Most Governments of those countries provide pension schemes for persons in the public service only. At least one Government (Malaysia) provides pensions on permanent disability, employers and employees contributing specifically for this benefit. For the employee the contribution in Malaysia is approximately 0.4 per cent of earnings, and for the employer the contribution is approximately 0.4 per cent of the payroll (for both employees and employers there is some variation according to wage class). A number of developing countries (Fiji, Ghana, India, Kenya, Lebanon, Malaysia, Nepal, Singapore, Sri Lanka, Swaziland, Uganda, United Republic of Tanzania, Zambia—the list may not be complete) have managed to provide provident fund systems, to use the terminology of the International Labour Organisation. These schemes provide for lump sum old-age grants based on the accumulation of contributions from both employee and employer (usually about 5 per cent of pay), with interest added at a rate which varies from country to country according to the differing economic conditions of the countries and the capacity of the Governments to pay. For the same reason the rate of interest may vary from year to year within a country. Clearly a provident fund, when sufficiently funded by higher contributions, can be converted to an annuity purchase scheme and thence to full social insurance. It is understood that a move towards annuity purchase has already been under consideration, for example in Malaysia, though the change has not yet been implemented.

THE MORTALITY-LED FERTILITY DECLINE

There remains the possibility that more money might be available for saving in developing countries if essential family expenditure were to be reduced by a reduction in family size, notwithstanding that this would also reduce the potential earning power of the family. Most developed countries have experienced a sharp decline in fertility following a major reduction in child mortality.

Parents no longer have to compensate for the expected failure of a significant number of births to survive. In England and Wales as a result of public health measures, such as ante-natal and post-natal care, improved nutrition, raised obstetric standards and medical supervision, and education of mothers, infant mortality (deaths in the first year of age per 1,000 live births) fell from 156 in the period 1896-1900 to 90 for the period 1916-1920 and to 55 for 1936-40. The average completed family size (the number of live-born children) fell from 4.7 for marriages of 1890-99 to 2.1 for the marriages of 1935 and after a very slight rise for marriages between 1950 and 1965 it appears likely to have fallen below replacement level for more recent marriages. The period total fertility rate for 1981 (the sum of the age-specific fertility rates) was 1.82. This rate, by mixing marriage cohorts, is much affected by changes in the timing of family building within the reproductive age period, but it has been persistently below 2.0 for several years. Not all of this reduction in family size is attributable to the improved prospects of survival of children and the removal of the need to replace those expected to die. Some part of it is due, initially, to the determination of married couples to avoid the economic burden of large families and, more recently, to other anxieties—poor employment prospects for school-leavers, international tension and concerns about excessive nuclear stock-piling (and in some, concern about any nuclear risk). But clearly, in the early part of the century any reduction in family size was regarded as a benefit to the economic strength of the family, and since for several decades child labour had been outlawed, it was a net gain.

However, in the agrarian sectors of developing countries, child labour is regarded as very important, and a reduction in family size would be regarded as net economic loss even if it could be seen to be desirable on grounds of the care of the health of the mothers and their children and of contributing to the retardation of population growth, so vital for national economic development. In this situation the contribution of mortality improvement to the reduction of family size would not be great, but it would be real.

Other demographic considerations

Although not part of the main focus of this chapter, which is concerned with mortality, the fall in fertility that is likely to accompany economic development and industrialization can make difficulties for developing countries, as it has done for developed countries in producing an aging of the population structure. Larger generations of earlier years are replaced, as they grow up, by smaller generations. The goods and services consumed by the elderly are provided by a diminishing work force; or to put it another way, the cash transfers from current workers to provide pensions become an increasing proportion of the overall wage bill. However, in the developing countries there will be at the same time an increase in the wage bill as workers move from rural subsistence industry to urban factory production.

If the changes are gradual there will initially be compensatory effects and difficulties may be minimized. But of course an increase in the urban industrial work-force must also mean a later increase in occupational pension scheme benefits (if these are introduced). So the relief may be only temporary.

It will be more difficult if the fall in fertility is rapid, as in China with the introduction of the one-child family. China has had to face a choice between economic disaster by the end of the century from sheer overcrowding or economic strain now from an aging population structure. The authorities are well aware of the emerging difficulties, and great efforts are being made to speed up industrialization at the highest possible technological level. Given the strength of the national will which is evident in Chinese society there is no reason to doubt that these efforts will succeed.

Notes

[1] B. Benjamin, "The significance of demographic factors in the design of retirement and other benefits", *Proc. Inst. Act. Congress*, Sydney (October 1984).

[2] A. H. Pollard, "Interaction between morbidity and mortality", *J. Inst. Act.*, No. 107 (1980), pp. 233-313.

[3] A. Comfort, "The prolongation of vigorous life", *Impact of Science on Society*, vol. XX, 307.

[4] B. Benjamin and E. Overton, "Prospects for mortality decline in England and Wales", *Population Trends* 23 (London, H. M. Stationery Office, 1981), pp. 22-28.

[5] B. Benjamin, "The aging population", annual Woodhead Lecture, 1979. Unpublished document.

[6] B. Benjamin, *Smoking and mortality* (Liège, International Union for the Scientfic Study of Population, 1981).

[7] This also affected salary incremental scales. Young men were no longer content, as were their forebears, to accept a slow rise up a long salary scale. They demanded that economic rewards for service should be earlier in their careers.

[8] Government Actuary, "Occupational pension schemes 1979", *Sixth Survey by the Government Actuary* (London, H. M. Stationery Office, 1981).

[9] Wilson Committee, "Projection of occupational pension schemes to the end of the Century", appendix V to report of the Committee appointed to review the functioning of financial institutions (The Wilson Committee), Cmnd, 7937, (London, H. M. Stationery Office, 1980).

[10] Institute of Actuaries, "Report of a seminar on pension growth", (November 1983). Unpublished document. Copies available from Institute of Actuaries, Staple Inn, High Holborn, London.

[11] M. T. A. El Mansoury, "A theoretical basis for life assurances in developing countries with particular reference to Egypt". (Unpublished doctoral thesis, City University, London (1978)).

XVI. CONSEQUENCES OF MORTALITY CHANGE ON AGING

*Naohiro Ogawa**

Compared with individual aging, population aging is a relatively recent subject of inquiry. Broadly speaking, population aging is a phenomenon of age compositional changes in which the elderly population increases its proportion of the total population, and the young population decreases its relative share in the numbers of persons. In Japan, this demographic process has been increasingly pronounced in the recent past, and is expected to accelerate towards the early part of the next century. Although Japan's current level of population aging is not yet as advanced as in many of the Western industrialized countries, within the next few decades it is likely to be even higher than the current levels of those countries.

The age compositional shifts have already generated a wide range of disturbances in the Japanese socio-economic system. For example, the aging of the labour force has been contributing to a rapid dissolution of the traditional seniority-oriented wage system and other employment practices.[1] Some of the businesses have been gradually changing their product planning in response to shifts in demand patterns induced by the changing age distribution of consumers. The government sector has been seriously concerned about possible financial insolvency in the operation of a variety of social security programmes, particularly in the realm of old-age pension schemes and medical plans.

The present chapter deals with some of the major effects of age-structural transformations caused by mortality changes upon Japanese society. Section A, below, discusses the trends and patterns of demographic changes, particularly mortality, and their effects on the age structure of the Japanese population, covering both pre-war and post-war periods. In section B, the aging mechanism of the Japanese population is analysed with tools of formal demography, in order to clarify the role of mortality improvements in the process of aging. Section C examines the impact of alternative mortality paths upon Japan's future economic performance and social needs. Finally, section D considers some of the policy implications.

The scope of this chapter is confined largely to the Japanese context, but because population aging is one of the unavoidable consequences of demographic transition, Japan's experiences of population aging may provide a useful base for formulating appropriate long-run development policies in a number of developing countries currently undergoing rapid fertility and mortality changes.

A. Trends and patterns of demographic changes and their effects on age structure

Although an individual always ages with the passage of time, human populations can either age or rejuvenate over time, depending upon changes in fertility, mortality and migration. In a closed population such as the Japanese one, however, age-structural shifts are caused solely by changes in fertility and mortality.

Since the beginning of this century demographic indicators for Japan have been dramatically changing, and at present both fertility and mortality are extremely low by international standards. Indeed, Japan's current mortality level is the world's lowest; in 1982, the life expectancy at birth for males was 74.2 years, and that for females, 79.7 years. The infant mortality rate was 6.6 per 1,000 births. We will briefly discuss long-term fertility changes, then present a detailed analysis of the trends and patterns of mortality changes from 1920 to the present.

As presented in table XVI.1, the fertility level showed a gradual but steady downward trend prior to the Second World War. The crude birth rate (CBR) dropped from 36.2 in 1920 (the year of Japan's first

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Table XVI.1. Changes in the crude birth rate (CBR) and the total fertility rate (TFR): Japan, 1920-1982

Year	*CBR*	*TFR*	*Year*	*CBR*	*TFR*
1920	36.2	—	1955	19.4	2.38
1925	34.9	5.10	1960	17.2	2.02
1930	32.4	4.71	1965[b]	18.6	2.15
1935	31.6	4.36[a]	1970	18.8	2.10
1940	29.4	4.11	1975	17.1	1.94
1947	34.3	4.54	1980	13.6	1.75
1950	28.1	3.66	1982	12.9	1.77

Source: Ministry of Health and Welfare, Statistics and Information Department, *Vital Statistics*, various issues.

[a] TFR for 1937.

[b] Although not shown in this table, CBR for 1965 and 1967 was fairly high to avoid births in the year of the "Fire House" in 1966. This long-standing Japanese superstition says that a female born in this particular year is destined to an unhappy married life in which she will kill her husband.

population census) to 29.4 in 1940. Immediately after the Second World War, the fertility level rose back to the level of the mid-1930s, thus contributing to the baby boom (1947-1949). Subsequent to the baby boom, however, Japan underwent an unprecedented decline in fertility. The CBR fell by approximately 50 per cent in one decade, namely, from 34.4 in 1947 to 17.2 in 1957. Following this rapid reduction, it remained at a relatively stable level up to the first oil crisis of 1973. Since then, the CBR has been continuously declining, reaching a level of 12.9 in 1982. The total fertility rate (TFR) also shows trends in patterns quite comparable to those for the CBR.

The mortality level improved considerably in pre-war years, with the crude death rate (CDR) falling from 25.4 in 1920 to 16.5 in 1940 (see table XVI.2). This downward trend in mortality continued in post-war years, and its rate of decline became even more pronounced. For instance, the CDR was halved in about 10 years, from 14.6 in 1947 to 7.4 in 1958. Since the second half of the 1960s, the CDR has been below a level of 7.0, gradually approaching a level of 6.0.

Similar improvements can be observed in life expectancy at birth (e_0). As shown in table XVI.2, e_0 for males was only 42.1 years over the period 1921-1925, but it increased to 50.1 years in 1947. In other words, it took roughly 25 years to gain eight years in the value of e_0. In the next 25 years, however, the level of e_0 rose by about 20 years. Therefore, the tempo of improvements in male life expectancy accelerated in the post-war period. It should be further noted that the speed of improvement for females was also rapid.[2]

In order to identify sources of these mortality changes in both pre-war and post-war periods, we shall examine age patterns of mortality reduction on the basis of two graphical presentations. Figure XVI.1 illustrates the pattern of male survivorship for three selected years in the pre-war period and another four years in the post-war period. Figure XVI.2 presents the annual rate of these improvements in survivorship at six selected ages. From figures XVI.1 and XVI.2, one can observe that the decline in infant mortality was the principal factor accounting for the extension of life. In the early 1920s, 16.2 per cent of all males born died before reaching their first birthday. Approximately 60 years later, only 0.8 per cent failed to reach their first birthday.

It should be noted, however, that infant mortality has already reached a very low level, and its rate of improvement has slowed down in the last intercensal period. In contrast, survivorship in older age groups has improved remarkably in recent years. For example, at age 60, the annual rate of improvement increased continuously from 1.29 per cent in the 1950s to 3.44 per cent in the 1970s, as shown in figure XVI.2. Survivorship for those aged 75 recorded a very small negative growth rate in the 1950s, but substantial positive growth in the subsequent decades.

From the above analyses, one can conclude that Japan's mortality has been on a secular downward trend since 1920, and that the major source of such mortality improvements was infant mortality reduction, although better survivorship at older ages has also been contributing substantially to the protraction of life expectancy. Let us now examine to what extent these changes in vital rates have affected the age composition of the Japanese population over the period 1920-1980. Table XVI.3 lists four indices representing age compositional changes.

First, one can note that the proportion of the aged population to the productive-age population decreased from 1920 to 1935, after which it has been steadily increasing. The proportion of the young population has shown a generally downward trend, although there are several minor fluctuations. These demographic changes have been directly reflected in changes in the index of aging, shown in the last column of the table. This index, after reaching its lowest value of 12.62 in 1935, shows a continuous rise. More importantly, it took about 28 years for this index to increase by 10 percentage points from its trough in 1935, but it required only 7 years to increase by another 10 percentage points. These results imply that the population of Japan started its aging process around 1935, and that the speed of this process accelerated in recent years.

Second, the substantial shrinkage of the young population contributed to lowering total dependency (third column) up to 1970. During the period 1970-1980, however, the increase in the relative size of the aged population started to play a dominant role in the determination of the level of total dependency. These changes in the relative proportion of the two age groups, old and young, have shifted the emphasis from the quantitative question of "how many dependants" to the qualitative one of "what kind of dependants" the working population has to support.

This section has discussed changes in vital rates, with stress on mortality, and their effects on age compositional variations in both pre-war and post-war periods. The ensuing section will present a demographic analysis of the mechanism of Japan's population aging.

TABLE XVI.2. CHANGES IN THE CRUDE DEATH RATE (CDR), MALE LIFE EXPECTANCY AT BIRTH (e_0) AND THE INFANT MORTALITY RATE (IMR): JAPAN, 1920-1982

Year	*CDR*	e_0	*IMR*	*Year*	*CDR*	e_0	*IMR*
1920	25.4	42.06[a]	165.7	1955	7.8	63.60	39.8
1925	20.3	44.82[b]	142.4	1960	7.6	65.32	30.7
1930	18.2		124.1	1965	7.1	67.74	18.5
1935	16.8	46.92[c]	106.7	1970	6.9	69.31	13.1
1940	16.5	. .	90.0	1975	6.3	71.73	10.0
1947	14.6	50.06	76.7	1980	6.2	73.35	7.5
1950	10.9	59.57[d]	60.1	1982	6.1	74.22	6.6

Source: Ministry of Health and Welfare, Statistics and Information Department, *Vital Statistics*, various issues; and *Life Tables*, various issues.

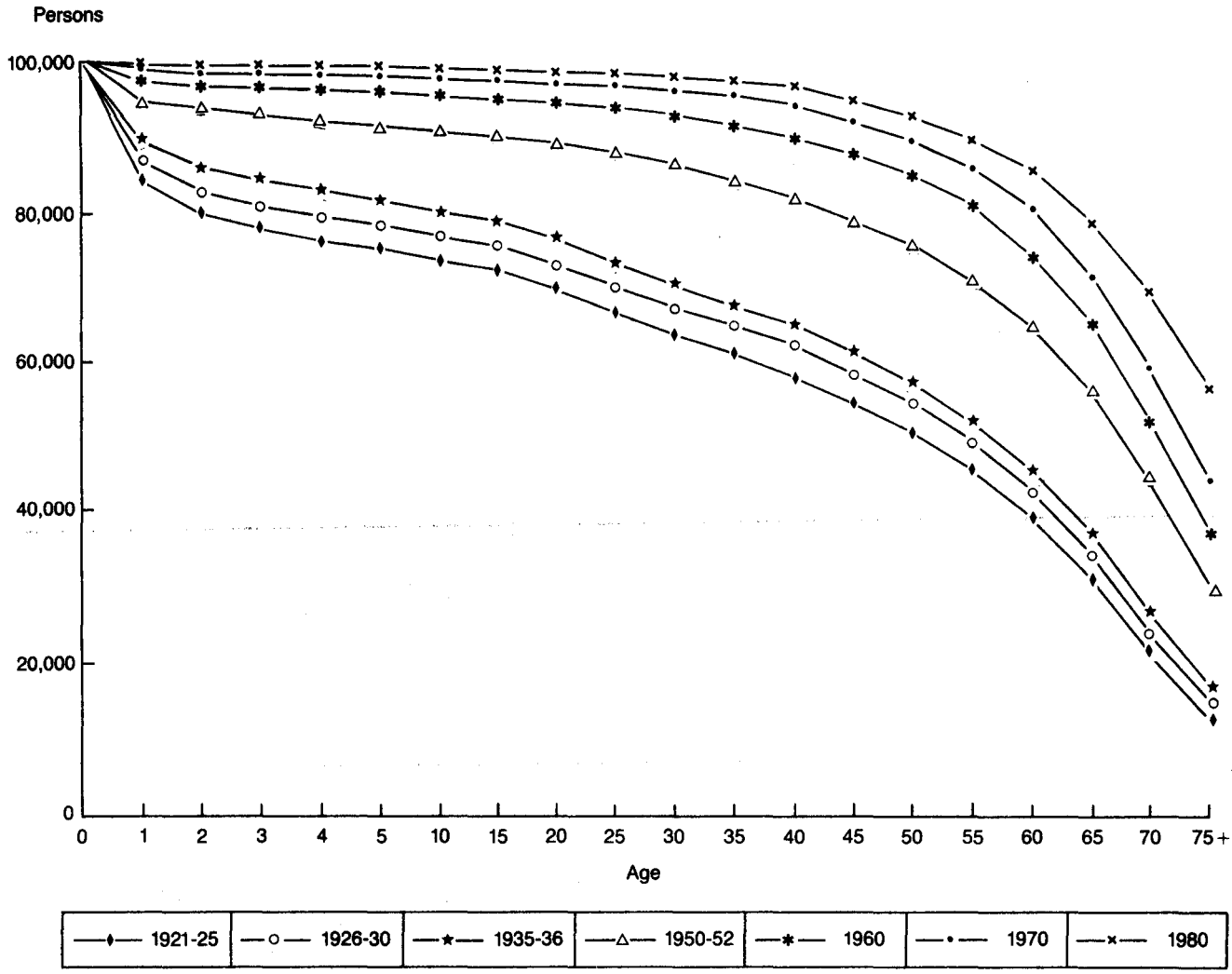
[a] e_0 for 1921-1925.

[b] e_0 for 1926-1930.

[c] e_0 for 1935-1936.

[d] e_0 for 1950-1952.

Figure XVI.1. Pattern of male survivorship in selected years: Japan



Source: Ministry of Health and Welfare, Statistics and Information Department, *Life Tables, 1983.*

TABLE XVI.3. SELECTED AGE-STRUCTURAL INDICES, 1920-1980
(Percentages)

Year	*Aged dependency*[a]	*Young dependency*[b]	*Total dependency*[c]	*Aging index*[d]
1920	9.02	62.62	71.64	14.41
1925	8.68	63.01	71.69	13.78
1930	8.10	62.37	70.47	12.99
1935	7.97	63.10	71.07	12.62
1940	7.99	60.97	68.96	13.10
1947	8.01	58.94	66.95	13.58
1950	8.27	59.26	67.54	13.96
1955	8.67	54.45	63.12	15.93
1960	8.92	46.78	55.69	19.06
1965	9.25	37.85	47.10	24.43
1970	10.24	34.69	44.93	29.53
1975	11.69	35.91	47.60	32.23
1980	13.49	34.89	48.35	38.71

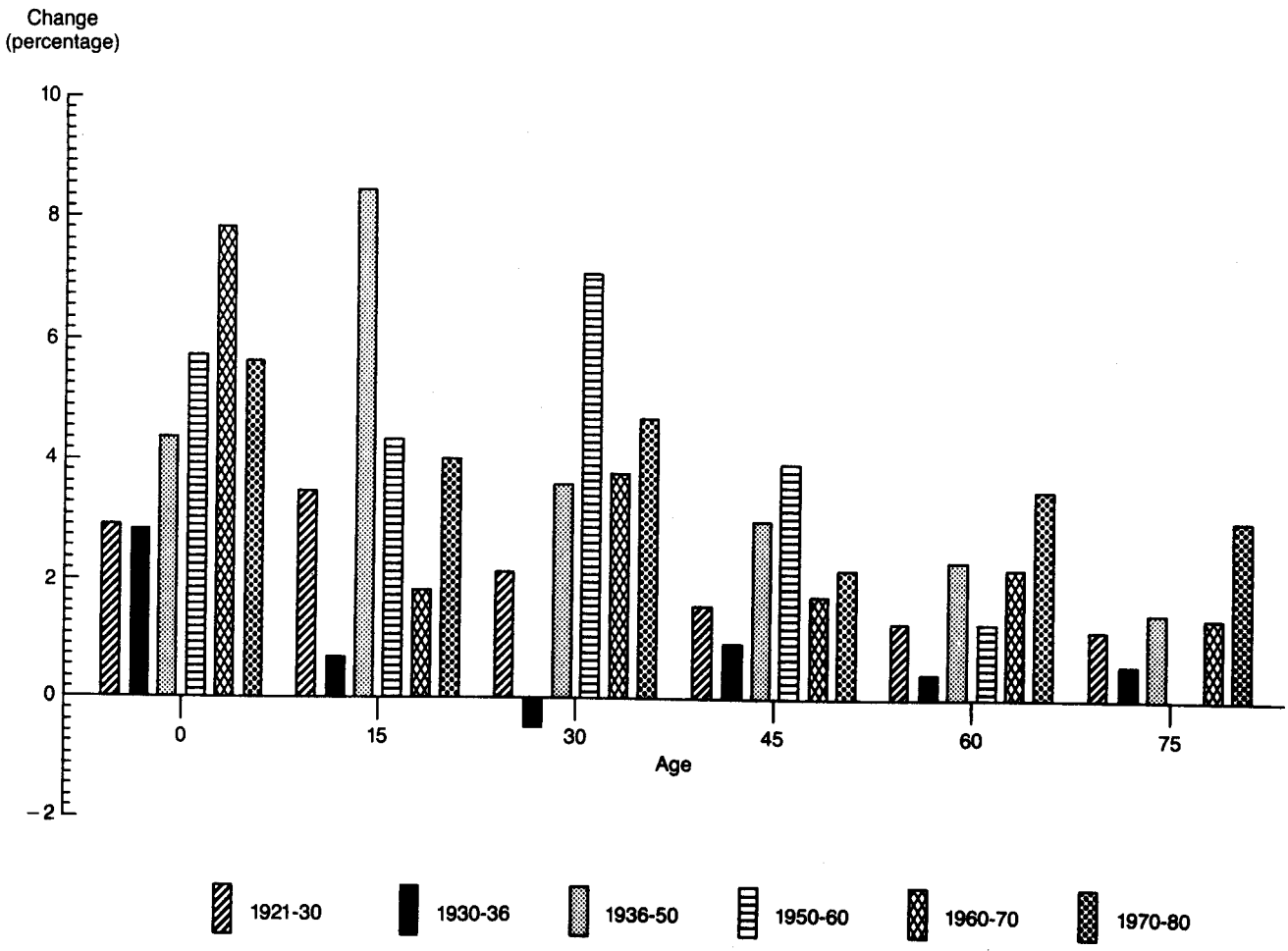
Source: Japan, Prime Minister's Office, Bureau of Statistics, *Population Census,* various issues.
[a] Those aged 65+ to those aged 15-64.
[b] Those aged 0-14 to those aged 15-64.
[c] Those aged 0-14 and 65+ to those aged 15-64.
[d] Those aged 65+ to those aged 0-14.

B. SOURCES OF POPULATION AGING: A FORMAL DEMOGRAPHIC ANALYSIS

Fertility reduction induces a relative decrease in the number of young persons, thus accounting for "aging from the base". On the other hand, depending upon its pattern of improvement, mortality affects different segments of the population differently. Improvements in infant mortality contribute to population rejuvenation, while those in older age groups contribute to population aging. To disentangle the effects of mortality and fertility upon the aging of the Japanese population, which started from 1935, the following population projections have been undertaken for pre-war (1935-1940) and post-war (1950-1980) periods, respectively:

(*a*) The projection of the base population (the 1935 census population for the pre-war case and the 1950 census population for the post-war case) up to the terminal year of the projection period (1940 for the pre-war case and 1980 for the post-war case) by applying the fertility rate as observed, but keeping

Figure XVI.2. Annual rate of survivorship improvements for males at selected ages: Japan, 1921-1980



Source: Ministry of Health and Welfare, Statistics and Information Department, *Life Tables, 1983.*

mortality constant at the level of the initial year (1935 for the pre-war case and 1950 for the post-war case);

(*b*) Projection of the same base population up to the terminal year by applying the declining rate of mortality, holding fertility constant at the initial level;

(*c*) Projection of the base population up to the final year of each projection period with fertility and mortality constant at their levels of the initial year.

Table XVI.4 compares the index of aging derived from these population projections. First, let us focus on its changes for the pre-war period. The index had a value of 12.62 in 1935 and 13.10 in 1940. It would have increased to 13.09 in 1940 under projection (*a*), to 12.89 under (*b*) and to 12.88 under (*c*). The total change in the index from 1935 to 1940 can be decomposed as follows:

total change = fertility component + mortality component + residual.

Substituting the values of the components from tables XVI.3 and XVI.4, we find

$$(13.10 - 12.88) = (13.09 - 12.88) + (12.89 - 12.88) + \text{residual}$$

or

$$0.22 = 0.21 + 0.01 + \text{residual}$$

where the residual is zero in this case. This decomposition shows that both fertility and mortality contributed to population aging, but the fertility component was 21 times more dominant than the mortality component in the process of aging over the pre-war period 1935-1940.

The same analysis can be applied to the post-war period (1950-1980). By utilizing the results presented on the right-hand side of table XVI.4, we can find that the fertility component (30.67 − 16.24) is approximately 4.2 times more dominant than the mortality component (19.69 − 16.24). Although both fertility and mortality components contributed to population aging, the relative impact of the latter on the aging process increased considerably in the post-war years, as compared with the case of the pre-war years.

These comparative analyses indicate, first, that declines in fertility were the principal propellant for Japan's aging starting from 1935, and, second, that although improved mortality affected the aging of the population to a lesser extent, the magnitude of its effect has been increasing in recent decades.

TABLE XVI.4. CHANGES IN THE AGING INDEX: PROJECTED POPULATION IN PRE-WAR AND POST-WAR PERIODS

Pre-war period (1935-1940)		Post-war period (1950-1980)	
Year	*Aging index*	*Year*	*Aging index*
Projection (a) (Constant mortality and actual fertility)			
1940	13.09	1960	18.08
		1970	26.73
		1980	30.67
Projection (b) (Actual mortality and constant fertility)			
1940	12.89	1960	15.05
		1970	16.94
		1980	19.69
Projection (c) (Constant mortality and constant fertility)			
1940	12.88	1960	14.48
		1970	15.44
		1980	16.24

C. EFFECTS OF DIFFERENT MORTALITY PATHS ON JAPAN'S AGING PROCESS

1. *A model*

In 1982, a long-term comprehensive macro-economic model was developed by the Nihon University Population Research Institute (NUPRI). This NUPRI model consists of the three submodels, namely, the population submodel, the economic submodel and the social security submodel. One of the principal features of the model is that both fertility and mortality were endogenously incorporated, thus allowing for various interactions among demographic and socio-economic factors. These three submodels are mutually interdependent via 61 major behavioural equations estimated over the period 1962-1979. Because a detailed framework of this model, which contains numerous neoclassical and supply-oriented considerations, has been described elsewhere,[3] no further explanation of the mechanism of the model seems to be in order.

In so far as the mortality function is concerned, the equations of life expectancy at birth for both males and females are positively linked to the one-year lagged per capita medical expenditure.[4] To keep predicted values within a realistic range, each of these equations was estimated on the basis of a logistic curve with its ceiling imposed. The ceiling values for both males and females were utilized directly from one of the hypothetical life tables compiled by synthesizing the best age-sex-specific mortality rate in the contemporary world.[5] The ceiling value for males was 77.4 years, and for females, 81.7 years. The predicted value for each year was then translated to the number of person-years lived between two ages for each sex.

2. *Standard case*

For the sake of convenience, let us call the simulation exercise based on the above-mentioned model "the Standard Case". Table XVI.5 presents a summary of such simulation results over the period 1980-2025. Total population size continues to increase from 117.1 million in 1980 to 131.3 million persons in 2007. After reaching this peak, Japan's future population is projected to shrink, thus becoming as small as 124.9 million persons in 2025. As regards fertility, after oscillating noticeably until the end of this century, TFR continues to fall, subsequently approaching a level of 1.70 in the 2020s. As for mortality, the male life expectancy at birth will asymptotically approach a level of 77.4 years in 1998, and the female life expectancy at birth, a level of 81.7 years in 2000. Moreover, the mortality differential by sex decreases considerably over time. From 1980 to 2000, it shrinks from 5.2 years to 4.3 years.

In terms of age compositional changes, the following few observations are worth making. First, throughout the entire projection period, the proportion of the population aged 0-14 decreases continuously, but the proportion aged 65 and over rises. By the early part of the next century, the latter exceeds the former. These changes are directly reflected by the pattern of changes in the index of aging.

Second, the proportion of those aged 65 and over is only 9.1 per cent in 1980, but it is expected to grow to 23.9 per cent in 2020 and 23.8 per cent in 2025. These projected results indicate that although the Japanese population is at present still considerably younger than most of the populations in the Western world, it is very likely to become the world's most aged population around the year 2025.[6] More importantly, the length of time which the Japanese population will require to increase its proportion of those 65 and over from 10 per cent to 20 per cent is only 25 years. No other country in the world will undergo the same demographic transformation at this speed.[7]

TABLE XVI.5. FUTURE DEMOGRAPHIC CHANGES UNDER STANDARD CASE PROJECTIONS[a]

Year	*Total population (millions)*	*Total fertility rate*	*Male life expectancy at birth (years)*	*Female life expectancy at birth (years)*	*Population at ages* 0-14	15-64 (percentages)	65+	75+/65+ (percentage)	*Aging index*
1980	117.06	1.740	73.47	78.69	23.51	67.39	9.10	34.37	38.71
1985	120.76	1.744	75.26	80.24	21.47	68.26	10.27	37.53	47.84
1990	123.75	1.733	76.63	81.27	18.44	69.71	11.84	39.73	64.22
1995	126.69	1.739	77.31	81.66	17.08	68.87	14.05	38.84	82.29
2000	129.48	1.723	77.40	81.70	17.06	66.70	16.25	39.12	95.26
2005	131.11	1.713	77.40	81.70	17.25	64.67	18.08	42.40	104.85
2010	131.01	1.708	77.40	81.70	16.70	63.22	20.08	44.71	120.23
2015	129.51	1.707	77.40	81.70	15.46	61.77	22.76	43.79	147.21
2020	127.32	1.705	77.40	81.70	14.52	61.63	23.86	46.37	164.34
2025	124.90	1.704	77.40	81.70	14.46	61.75	23.79	53.46	164.47

[a] See text for description of projection model.

Third, it is also essential to note that the proportion of those aged 75 and over in the aged (65 and over) population rises from 34.4 per cent in 1980 to 39.1 per cent in 2000, and even to 53.5 per cent in 2025. Thus, the aging of the aged population will accelerate substantially, particularly in the early part of the next century.

These demographic changes are expected to affect adversely numerous aspects of Japan's future socio-economic system. As indicated in table XVI.6, real GNP (measured in terms of 1975 constant prices) increases by 3.9 times, from 193.7 trillion yen in 1980 to 755.2 trillion yen in 2025. Its annual growth rate, however, falls gradually from 5.3 per cent in the 1980s to 1.6 per cent in the 2010s. On the other hand, nominal GNP continues to grow at a relatively fast rate. For instance, its average annual growth rate is 8.2 per cent in the 1980s and 6.3 per cent in the 2010s. These numerical results imply that the rate of inflation accelerates substantially in the next few decades.

One of the principal sources of such a dreary economic prospect is a decline in the amount of effective labour supply due to a decrease in the number of workers and shortened work hours.[8] Another source is the decrease in saving rates (particularly government savings)[9] and slower capital formation, as a result of increased expenditures for social security programmes.

An increase in the elderly population leads, *ceteris paribus,* to an increase in the cost of the social security programmes. The ratio of social security benefit payments to national income corresponds to 12.5 per cent in 1980, 24.8 per cent in 2000 and 48.7 per cent in 2025. Although Japan's current level of the relative burden of social security benefit payments is considerably lower than that for most of the industrialized countries, these computed results indicate that Japan would surpass the current level of the Federal Republic of Germany around the end of this century and that of Sweden in the early part of the next century.[10] Moreover, because the tempo of Japan's population aging is much faster than that of those countries, the relative financial burden of Japan's social security programmes is likely to become the highest in the world within the next few decades.

The nucleus of the Japanese social security system consists of both public pension schemes and public health plans. With regard to public pension schemes, the amount of benefits paid out increases in nominal terms by 142 times over the period 1980-2025, as shown in table XVI.6. In accordance with such enormous growth of pension benefit payments, the contribution rate in each of the pension schemes is required to increase. For instance, the contribution rate for the Employee's Pension Scheme (EPS), which is one of the main programmes in operation, rises from 10.6 per cent of average wage to 18.6 per cent in 2000, and to as high as 40.2 per cent in 2025. Similar trends are applicable to other public pension schemes. These rapidly growing contribution rates reflect both the aging of the population and the maturity of these pension schemes.

As discussed earlier, Japan is expected to undergo accelerated aging not only of the population in general but also of the aged population. In these aging processes, the average cost of health benefits increases substantially and the probability of health care needs rises pronouncedly. As presented in table XVI.6, the total medical expenditure expands in nominal terms by 79 times over the entire simulation period. It corresponds to only 4.5 per cent of nominal GNP in 1980, but it rises to 9.1 per cent in 2000, and to 16.4 per cent in 2025.

Table XVI.7 compares age-specific daily demand for medical and dental services for 1980 and 2025.[11] Over this time period, the estimated number of patients increases by about 40 per cent. As regards age-specific demand, those at ages 65 and over show an approximately 200 per cent growth, while those aged 0-14 undergo a considerable reduction of 34 per cent. As opposed to these two age groups, the productive-age population shows only a modest increase of 6.8 per cent.

TABLE XVI.6. SELECTED SOCIO-ECONOMIC INDICATORS FOR THE STANDARD CASE

Year	*Real GNP*[a] *(billion yen)*	*Nominal GNP (billion yen)*	*Social security benefit (percentage of national income)*	*Pension benefit paid out (billion yen)*	*Contribution rate for employee's pension scheme (percentage)*	*Total medical expenditure (billion yen)*
1980	193 695	237 194	12.46	7 530	10.6	10 749
1985	255 011	352 785	14.09	14 431	12.6	17 691
1990	325 045	521 078	16.31	27 587	14.6	29 345
1995	399 492	751 578	20.00	51 488	16.6	53 499
2000	473 386	1 075 678	24.73	95 104	18.6	97 416
2005	542 502	1 544 222	30.23	173 196	20.6	166 989
2010	602 657	2 280 128	36.31	341 054	28.6	282 392
2015	655 321	3 266 145	43.21	595 974	35.2	483 249
2020	704 023	4 194 798	46.99	835 820	38.5	672 718
2025	755 193	5 131 688	48.70	1 067 047	40.2	844 109

[a] 1975 constant price.

TABLE XVI.7. ESTIMATED NUMBER OF ALL PATIENTS AND IN-PATIENTS, BY AGE PER DAY, 1980 AND 2025: STANDARD CASE

	1980		*2025*	
Age group	*All patients*	*In-patients*	*All patients*	*In-patients*
0-14	1 657 277	61 742	1 087 640	41 523
15-64	4 898 377	756 602	5 229 033	820 982
65 and over	1 865 650	387 310	5 423 735	1 186 661
TOTAL	8 421 304	1 205 654	11 740 408	2 049 166

It is also interesting to note in table XVI.7 that the effect of population aging upon demand for medical services makes its presence felt more pronouncedly in terms of in-patients. The total number of in-patients increases by about 70 per cent in 45 years, but most of this rapid growth is due to the fast growth in size of the oldest age group. This result implies that the aging of in-patients tends to make the average duration of hospitalization longer and the average cost per medical case higher, thus contributing to heavier medical expenditures.

If the demand for medical services rises at the rate discussed above, and if the current demand-supply equilibrium condition is satisfied throughout the projected period, the future needs for hospitals, clinics and dentists increase as presented in table XVI.8. The number of hospitals required rises by 52 per cent, and the number of hospital beds, by 68 per cent. The number of clinics is required to rise by 43 per cent, and the number of clinic beds by 83 per cent. Although the demand for hospital and clinical services continues to grow over the period 1980-2025, the peak of the demand for dentists is around 2005. This difference in the timing of the demand peak is explained by the fact that the age-specific demand pattern for medical services differs considerably from that for dental services.

3. *Alternative cases*

The above discussions have been based upon the assumption that the ceiling value of life expectancy at birth for males is 77.4 years and that for females, 81.7 years. Let us now assume the following two alternative mortality paths for analytical purposes. In Alternative I, it is assumed that the mortality level remains unchanged for both males and females at the 1980 level throughout the entire simulation period. The life expectancy at birth is 73.5 years for males and 78.7 years for females. In Alternative II, the ceiling value of life expectancy at birth for males is assumed to be 77.5 years, and that for females, 82.9 years. These new ceiling values have been adopted from a hypothetical life table allowing for greater mortality improvements than those used for the Standard Case.

TABLE XVI.8. CHANGES IN MEDICAL AND DENTAL SERVICES REQUIRED PER DAY, 1980-2025: STANDARD CASE

Year	*Hospitals*	*Hospital beds*	*Clinics*	*Clinic beds*	*Dentists*
1980	8 670	1 282 554	77 253	291 615	38 061
1985	9 380	1 410 851	81 882	320 548	39 176
1990	10 139	1 546 877	86 813	354 335	40 027
1995	10 998	1 695 740	93 180	392 113	40 807
2000	11 803	1 838 702	99 928	430 522	41 411
2005	12 438	1 960 691	105 422	465 151	41 753
2010	12 813	2 045 525	108 351	488 052	41 369
2015	13 057	2 107 816	109 922	507 537	40 369
2020	13 228	2 153 540	111 097	528 594	39 379
2025	13 149	2 155 062	110 671	534 507	38 500

The simulated results are shown in tables XVI.9 to XVI.11. Table XVI.9 presents the effect of the alternative mortality paths upon a few selected demographic indicators. In the case of Alternative I, the size of the projected population is considerably smaller compared to the Standard Case. For example, it is 2.1 per cent smaller in the year 2000, and 4.7 per cent smaller in 2025. As reflected by changes in the index of aging, the level and speed of aging are substantially less pronounced than those for the Standard Case. In 2025, it is 140 for the case of Alternative I, as opposed to 164 for the Standard Case.[12]

In the case of Alternative II, the results are quite the opposite of those for Alternative I. By raising the ceiling values by 0.05 years for males and 1.24 years for females, total population size is 0.6 per cent larger in the year 2000, and 1.1 per cent larger in 2025, as compared with that for the Standard Case. The level of aging is expected to become slightly higher than that for the Standard Case.

As opposed to faster aging cases such as the Standard Case and Alternative II, Alternative I leads to slower economic growth in the beginning, but it eventually yields faster economic growth, as indicated in table XVI.10. In terms of real GNP, Alternative I is marginally smaller in the first two decades, as compared with the Standard Case or Alternative II. In the terminal year of simulation, however, real GNP in Alternative I

TABLE XVI.9. FUTURE DEMOGRAPHIC CHANGES BASED ON ALTERNATIVE MORTALITY CONDITIONS

Year	*Total population (millions)*	*65+ (percentage)*	*Aging index*
	Alternative I (Constant mortality case)		
1980	117.06	9.10	38.71
1985	120.54	10.18	47.35
1990	122.88	11.50	61.93
1995	124.90	13.35	77.17
2000	126.74	15.16	87.26
2005	127.49	16.63	94.14
2010	126.59	18.30	106.31
2015	124.50	20.66	129.00
2020	121.79	21.45	142.11
2025	118.96	21.15	140.13
	Alternative II (Rapid mortality decline case)		
1980	117.06	9.10	38.71
1985	120.80	10.30	47.97
1990	123.94	11.95	64.84
1995	127.13	14.30	83.90
2000	130.19	16.65	97.98
2005	132.09	18.62	108.55
2010	132.21	20.72	124.89
2015	130.84	23.46	152.79
2020	128.69	24.57	170.44
2025	126.27	24.48	170.38

TABLE XVI.10. SELECTED SOCIO-ECONOMIC INDICATORS FOR ALTERNATIVE CASES

Year	Real GNP[a] (billion yen)	Nominal GNP (billion yen)	Social security benefit (percentage of national income)	Total medical expenditure (billion yen)
		Alternative I (Constant mortality case)		
1980	193 695	237 194	12.46	10 749
1985	254 870	352 862	14.02	17 418
1990	324 349	523 376	16.03	27 823
1995	398 360	761 609	19.38	48 709
2000	472 983	1 103 862	23.65	85 719
2005	545 023	1 626 251	28.59	143 579
2010	610 119	2 462 052	34.23	238 897
2015	670 450	3 628 293	40.49	405 738
2020	730 524	4 827 000	43.59	558 980
2025	796 220	6 149 081	44.80	695 094
		Alternative II (Rapid mortality decline case)		
1980	193 695	237 194	12.46	10 749
1985	255 024	352 834	14.12	17 769
1990	325 064	521 249	16.41	29 842
1995	399 325	751 815	20.26	55 368
2000	472 479	1 074 882	25.23	102 411
2005	539 842	1 536 676	31.01	177 346
2010	596 996	2 247 698	37.39	300 827
2015	645 645	3 182 382	44.62	512 739
2020	688 985	4 030 858	48.68	710 167
2025	733 687	4 858 352	50.59	884 752

[a] 1975 constant price.

is 5.4 per cent greater than in the Standard Case, and 8.5 per cent greater than in Alternative II. In addition, Alternative I shows a lesser financial burden imposed by the social security programmes, including pension schemes and medical plans, than the Standard Case or Alternative II. As presented in table XVI.10, the ratio of social security benefits to national income under Alternative I is 44.8 per cent in 2025, which is 3.9 percentage points lower than that for the Standard Case and 5.8 percentage points lower than that for Alternative II. These numerical results imply that although lower mortality is advantageous in terms of the size of human resources in the first few decades, such advantages are more than offset in the long run by the disadvantages of slower formation of capital stock owing to higher social security expenditures.

A brief examination of table XVI.10 also reveals that these different mortality paths yield enormous differences in the total medical expenditure. In the case of Alternative I, the total medical expenditure amounts to 11.3 per cent of nominal GNP in 2025, while it is 18.2 per cent in the case of Alternative II. These differences are directly reflected by the number of patients and in-patients, as indicated in table XVI.11. In Alternative I, the number of patients increases by 30 per cent over the period 1980-2025, but in Alternative II, it shows a 42 per cent increase over the corresponding period. A major source of this difference lies in the difference in size of the age group 65 and over between these two opposing cases.

These differentials in the demand for medical services lead to considerable differences in the number of hospitals, clinics and dentists required to provide the same level of per capita medical services as the current one. With regard to the required number of hospitals, Alternative I needs approximately 10 per cent fewer hospitals than the lower mortality case in the year 2025. Similar observations are applicable to clinics and dentists.

From the above discussions, one may conclude that the aging of the Japanese population is likely to accelerate in the next few decades, and that future changes in mortality affect considerably not only the level and speed of aging but also Japan's future economic performance and the pattern of social needs. In the ensuing section, various policy implications of the different mortality paths will be discussed.

TABLE XVI.11. ESTIMATED NUMBER OF ALL PATIENTS AND IN-PATIENTS, BY AGE PER DAY: ALTERNATIVE MORTALITY PATHS FOR 2025

(Unit: 1,000 persons)

Age group	Alternative I (Constant mortality case)		Alternative II (Rapid mortality decline case)	
	All patients	In-patients	All patients	In-patients
0-14	1 081 061	41 273	1 092 382	41 695
15-64	5 120 302	802 707	5 233 701	820 786
65 and over	4 568 966	987 142	5 653 579	1 236 642
TOTAL	10 770 329	1 831 122	11 979 662	2 099 123

D. Policy implications and concluding remarks

The simulated results indicate that the Japanese population will age rapidly in the next few decades, and this in turn will lead to economic slow-down, rapid inflation and rising social security costs. Due to their rising costs, government medical plans and pension schemes seem likely to encounter serious financial difficulties either towards the end of this century or at the beginning of the next century. Such possible financial insolvency in the operation of these social security programmes suggests urgent needs for basic reformulation of these programmes.

One of the policy measures being considered by policy makers is to lower social security benefit levels. Lower benefits contribute to higher saving rates and promote faster capital formation. Reduced social security benefits lead to a lessening of social security contributions, thus alleviating cost-induced inflationary pressures. Lower pension benefits also discourage aged workers from early retirement. Moreover, reduced benefits and coverage in medical plans contribute to mitigating government deficits, thus keeping aggregate savings at a relatively high level.

Lower social security benefit levels would need to be implemented jointly with a set of compensatory policy measures.[13] These compensatory measures include the provision of greater employment opportunities for the elderly, the development of vocational training programmes for re-employment, and accessibility to housing facilities for retirees. To formulate these compensatory policy measures effectively, basic needs for the elderly should be carefully re-evaluated from the viewpoint of intersectoral planning.

Among these compensatory policy measures, the provision of employment opportunities for aged persons requires special attention. Japan's institutional employment structure differs from that of other countries in that it is the tradition for a worker to remain with the same enterprise and enjoy guaranteed lifetime employment until he reaches a predetermined retirement age, normally 55 years. It should be noted that this retirement system was instituted when Japan's life expectancy at birth was still around 50 years. Although life expectancy has improved to a remarkable extent, the retirement age has been extended by only a few years in the past several decades. One of the primary reasons for such a slow change in retirement age is the prevalence of the seniority wage system where the wage of each worker is determined on the basis of his duration of service. For this reason, management tends to prefer not to keep an old worker on the payroll. Extension of the retirement age, therefore, requires basic changes in the Japanese remuneration system.

The feasibility of the above-mentioned policy measures is directly dependent upon the future pattern of mortality change. Faster improvements in mortality tend to underline the need for faster institutional responses in various socio-economic dimensions. It should be noted that the more drastic these institutional changes are, the more complicated the adjustment problems. For instance, if pension benefits are lowered, it is very likely to result in the worsening of intergenerational equity. Reduced medical benefits would also lead to similar difficulties.

The other problem arising from mortality changes is intra-generational inequity. Owing to differences in mortality in favour of females, females tend to enjoy higher returns on their investments in social security programmes, as compared with males.[14] As demonstrated by the numerical experiments discussed above, there is a difference of 4.33 years in life expectancy at birth for the Standard Case, 5.22 years for Alternative I and 5.49 years for Alternative II. The seriousness of the intra-generational issue, therefore, depends heavily on the future pattern of mortality differentials by sex.

Such mortality differentials by sex lead to another problem. In the age group 65 and over, women outnumber men to a considerable degree. In 1980, for instance, the population aged 65 and over totals 10.7 million, out of which 6.2 million persons are females and 4.5 million persons are males; the net sex differential is only 1.7 million persons. In the year 2025, however, there is an excess of 2.99 million women for the Standard Case. Alternatives I and II have 3.5 million and 3.7 million too many women, respectively. These numerical results suggest that in a universal-marriage society like Japan, the number of widows will increase in the next several decades. The incidence of widowhood, however, differs considerably with the age-sex-specific pattern of mortality improvements. These sex compositional changes in the old age group are likely to create a wide range of disturbances in the Japanese family structure and housing arrangements.

From the above discussions, it is clear that further mortality improvements will directly affect the nature and magnitude of problems related to population aging. Further research on likely limits to the prolongation of life expectancy is therefore urgently needed to facilitate effective long-range planning at government, community, business, familial and personal levels.

Notes

[1] Naohiro Ogawa and Daniel B. Suits, "Retirement policy and Japanese workers: some results of an opinion survey", *International Labour Review*, vol. 122, No. 6 (1983), pp. 733-746; Naohiro Ogawa and Linda G. Martin, "The impact of age structural changes upon employment and relative wages in post-war Japan", paper presented at the Seventh World Congress of the International Economic Association, 5-9 September 1983, Madrid, Spain.

[2] The differential by sex in life expectancy at birth, however, has been gradually expanding over time in favour of women.

[3] Naohiro Ogawa and others, "Demographic-economic model building for Japan", *Modelling Economic and Demographic Development*, Asian Population Studies Series No. 54 (Economic and Social Commission for Asia and the Pacific (ESCAP), 1983), part 3, pp. 117-223.

[4] Although these equations were also estimated with one-year lagged per capita real GNP, their fitness was not as satisfactory as the one adopted.

[5] Shigekazu Hishinuma, *Jimyo no genkai o saguru (An exploration of a limit to human longevity)* (Toyo Keizai Shimposha, 1978).

[6] Naohiro Ogawa, "Japan's limits to growth and welfare", *Population Aging in Japan: Problems and Policy Issues in 21st Century*, pp. 7-9.

[7] *Ibid.*, p. 8.

[8] As a consequence of lowered fertility, the absolute size of the labour force starts to shrink from 1998, and its composition of ages over time. Also, the hours worked decrease almost continuously owing to a gradual rise in real wages.

[9] Government savings become negative from the year 2004.

[10] Naohiro Ogawa, "Ageing of the population", *Population of Japan,* Economic and Social Commission for Asia and the Pacific (ESCAP) Country Monograph Series, 1984 (forthcoming).

[11] Such demand has been computed under the assumption that those aged 70 and over would continue to receive free medical services. Starting from February 1983, however, the free medical plans for the aged have been replaced by fee-charging medical plans. Due to the recency of this institutional change, there have been no data to measure its effect on the medical demand. For this reason, the simulation runs have been undertaken on the basis of the old institutional set-up. Moreover, the impact of income growth on the demand for medical services has been incorporated in the simulated experiments.

[12] Shigekazu Hishinuma, "Mortality trends in Japan and their possible causes", *Medical Aspects of Mortality Statistics,* Kandia International Symposia, 1980, pp. 121-140.

[13] Naohiro Ogawa, "Economic implications of Japan's ageing population: a macro-economic demographic modelling approach", *International Labour Review,* vol. 121, No. 1 (January-February 1982), pp. 17-32.

[14] Naohiro Ogawa, "The impact of population aging on public pension schemes: the Japanese case", paper presented at the first meeting of National Study Directors for Economic Demographic Modelling for Three Selected Countries of the ESCAP Region, November 1979.

XVII. WORK ABILITY OF THE AGED UNDER CONDITIONS OF IMPROVING MORTALITY*

*Jacob J. Feldman***

The designation of a normal retirement age has been linked to the age at which people are no longer "sufficiently healthy to function in their jobs". This linkage was accepted by both the proponents and the opponents of raising the retirement age in the March 1981 report of the National Commission on Social Security. The majority position was: "The Commission anticipates that increased longevity will be accompanied by a corresponding increase in active life. . . . Expert opinion in the field of research on aging holds that the period of 'diminished vigor' associated with aging will decrease so that 'chronic disease will occupy a smaller proportion of the typical life span'."[1] On the other hand, a minority of the commission contended that "the evidence does not support any claims that longer life is equivalent to longer years of good health. . . . The evidence certainly does not support speculation that the incidence of *good* health is increasing."[2] Unfortunately, the current state of knowledge does not permit a definitive resolution of this controversy. I shall attempt, however, to clarify some of the issues.

We shall focus on the populations in the age groups between 50 and 69 years of age because the experiences of these groups are most relevant to the issue of retirement age. As can be seen from figure XVII.1, the death rates for women in this age range have been declining rather steadily since 1950. In fact, death rates for women of this age began to decline rapidly and steadily in about 1935, so this trend has been operative for nearly 50 years.[3] We can see from figure XVII.2, on the other hand, that the rapid downward trend in death rates for men between 50 and 69 years of age has been in effect only for the past 15 years. We should also note that at each age in this range, the death rate for men is twice as high as the death rate for women.

It has been suggested that the decline of death rates for this age segment is tantamount to improved health or to a reduction in the prevalence of ill health and work incapacity.[4] What light do the data shed as to the validity of this supposition? While definitive long-term trend data bearing on health status are not available, figure XVII.3 permits us to examine short-term trends. We see there that the proportion of men in the 50 to 69 age segment reported as being unable to work because of illness increased between 1970 and 1980. Remember, this was the period of the rapid decline in death rates for men of that age. Furthermore, the fragments of available evidence regarding work-disability rates during earlier periods suggest even somewhat lower levels in the more distant past. For instance, for men aged 55 to 64, the rate of reported work disability in 1949 was about 10 per cent.[5] (Approximately 12 per cent of men aged 55 to 64 were reported as having been kept from working because of illness on the day of the interview. Since the data presented here for the recent period pertain to relatively long-term disability, the 1949 statistics must be adjusted. About three fourths of those reported as disabled had been, by the day of the interview, disabled for three months or longer. This means that approximately 9 per cent of all men in the age group had been disabled for three months or longer. The estimate of 10 per cent in the text includes an additional correction for men with a disabling *chronic* condition that had its onset within three months prior to the interview.) The rate was apparently even lower in 1935.[6] Thus, rather than the predicted decline in the prevalence of work disability, we appear to have been experiencing an increase.

Some definitions are in order at this point. We are here defining a disabled person as one who is reported as not being able to work at all because of one or more chronic conditions. Examples of such chronic conditions would be coronary heart disease, arthritis, a musculoskeletal impairment due to an accidental injury or a stroke, and blindness. We are not restricting our definition to the totally and permanently disabled. We are counting cases here, however, only if they are relatively long-standing. Total recovery or rehabilitation for the disabled in the relevant age groups tends to be relatively rare, although partial recovery does occur rather frequently.[7]

Some of the individuals who are here being counted as work disabled would probably, under the proper circumstances, be able to earn money at some type of employment; not all of them are totally disabled. However, these are individuals who are unable to perform the duties of a regular job of a type for which they appear suited.

Returning to the question at hand, how do we account for the increase in the prevalence of reported work disability that has been taking place concomitantly with the decline in mortality rates? While there are obviously a number of different factors at work,[8] figure XVII.4 can help us to appreciate that a decline in mortality does not necessarily signify a decline in work disability. The schematic represents what happens to a population cohort over a 10-year period, from age 55 to age 65. As one might expect, death rates among the disabled have generally been extremely high.[9] Thus, at earlier times, a substantial proportion of those disabled at age 55 would

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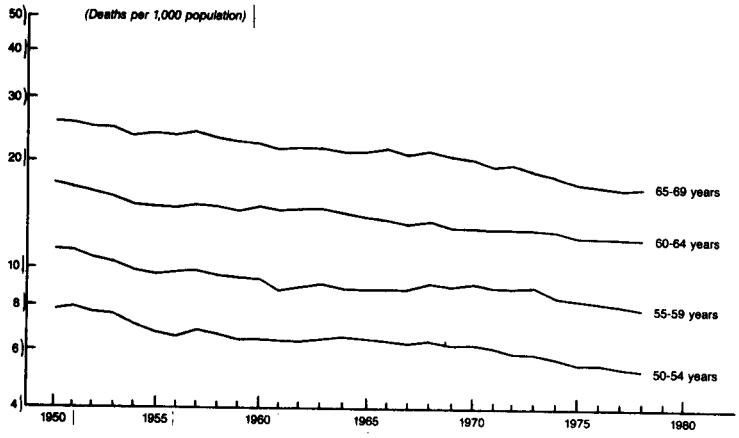
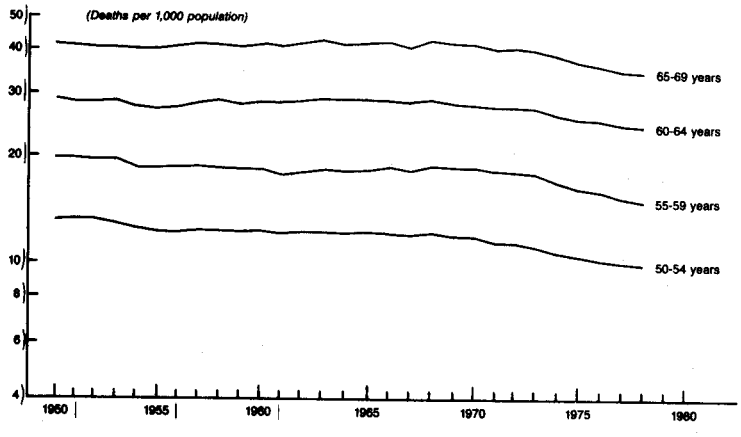
Figure XVII.1. Decline in death rates for women: United States, 1950-1978



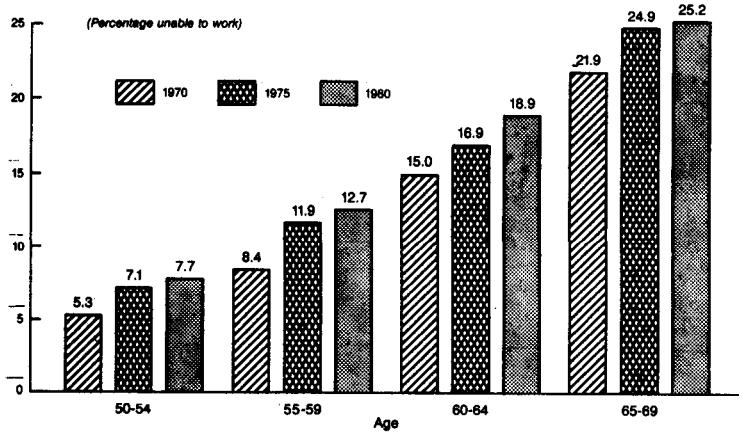
Source: Division of Vital Statistics, National Center for Health Statistics.

Figure XVII.2. Decline in death rates for men since the late 1960s: United States, 1950-1978



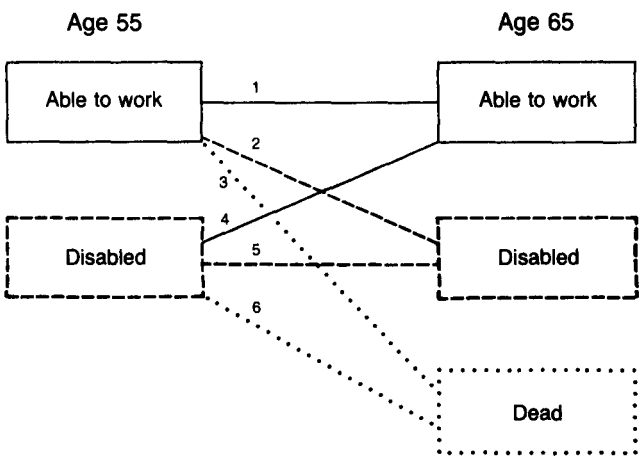
Source: Division of Vital Statistics, National Center for Health Statistics.

Figure XVII.3. Increase in work disability rates for men during 1970-1980: United States



Source: National Health Interview Survey, National Center for Health Statistics.

Figure XVII.4. Transition schematic

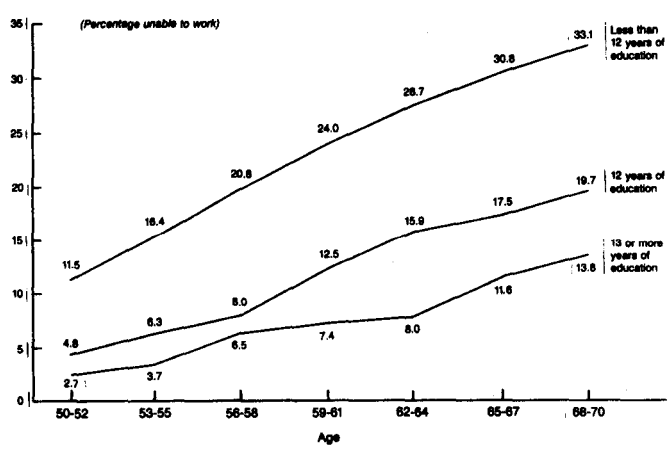


have died before reaching age 65. The pool of disabled at age 65 was limited in size because it was, in the main, composed only of individuals who had become disabled in the fairly recent past. This situation may very well have been changing since the late 1960s. The death rate from myocardial infarction (heart attacks) has been declining rapidly for both men and women in their fifties and sixties.[10] Myocardial infarctions are frequently the proximate cause of death, the coup de grâce, for individuals with other infirmities.[11] (On the basis of multiple cause-of-death tabulations, it is clear that most individuals who die of a myocardial infarction also have been suffering from other health impairments.) Reduced incidence and improved survival for myocardial infarction among the disabled would result in a major increase in the size of the pool of disabled at age 65, for instance. In terms of figure XVII.4, it appears that what may have been happening is that the rate represented by stream 6 has been appreciably decreasing in size while the rate represented by stream 5 has been expanding, resulting in the marked accumulation of disabled individuals at older ages.[12] (Fries and Crapo predict that a period of "increase in the number of years of impaired health per person" will precede the anticipated "compression of infirmity".)

I should now like to turn to the current situation as represented by figure XVII.5. The steady rise of the prevalence of work disability with age is striking if not surprising. The rates in this chart can, of course, be viewed two ways. Combining the three educational groups, we might observe that, for instance, 24 per cent of all men aged 65 through 67 are too disabled to engage in any gainful employment. Alternately, we might observe that 76 per cent of men of that age are still able to work to some extent. It should also be noted, however, that in addition to the 24 per cent of the men aged 65 to 67 reported as not being able to work at all, another 13 per cent are limited in the kind or amount of work they can perform; this leaves 63 per cent being reported as fully able-bodied with respect to work.

The other striking fact conveyed by this figure is the wide differential in work-disability rates according to educational attainment. At ages 62 to 64, 29 per cent of the men who had not been graduated from high school were unable to work because of a health problem; among men completing one or more years of college, only 8 per cent had such a limitation due to health. Those with less education are likely to be in more physically demanding jobs than are those with more education. The less educated may also not have the skills necessary to be employed in a physically less demanding alternative job. There are a number of other explanations for these observed differences but they need not concern us here.[13] The central question facing this commission in this regard is whether the prevalence of work disability of people in their sixties will decline in the future as successively more highly educated generations pass through that age range. I know of no way to answer this question with any certainty. It would seem, however, that trends in the occupational and industrial structure of the economy would be as important as trends in educational attainment. It appears likely that there will remain in the future a substantial number of jobs that are physically or emotionally demanding. While service industries are projected to be the fastest growing employment sector, it should be kept in mind that strenuous work such as automobile repair and hospital nursing is expected to be a rapidly growing component of the service sector. Similarly, rapid growth in employment opportunities is expected in eating and

Figure XVII.5. Sharp increase in work disability rates for men with age (the less educated experience the highest work disability rates): United States, 1976-1980



Source: National Health Interview Survey, National Center for Health Statistics.

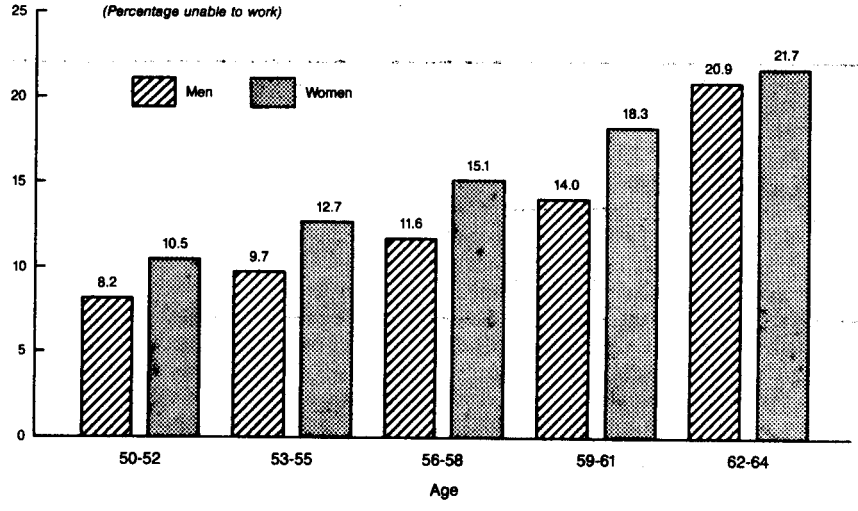
drinking establishments, jobs that also require considerable stamina.[14]

Differences in work-disability rates between men and women can be examined in figure XVII.6. At each age, women are reported as having a higher prevalence of work disability than are men. As was pointed out in connection with figures XVII.1 and XVII.2, the death rates for men in this age range are twice as high as those for women. The discrepancy between the mortality and disability differentials confirms our contention that mortality rates are very poor indicators of work-disability prevalence rates across population groups or over time.

In figure XVII.7, we observe the rapid increase with age in the prevalence of certain functional impairments. For instance, about 22 per cent of all women between 35 and 44 years of age experience some trouble standing for long periods; this prevalence nearly doubles by ages 55 to 64. Only four typical functional capacities are shown in the chart but the age patterning in prevalence is nearly identical for a wide variety of physical activities that are commonly required for jobs.

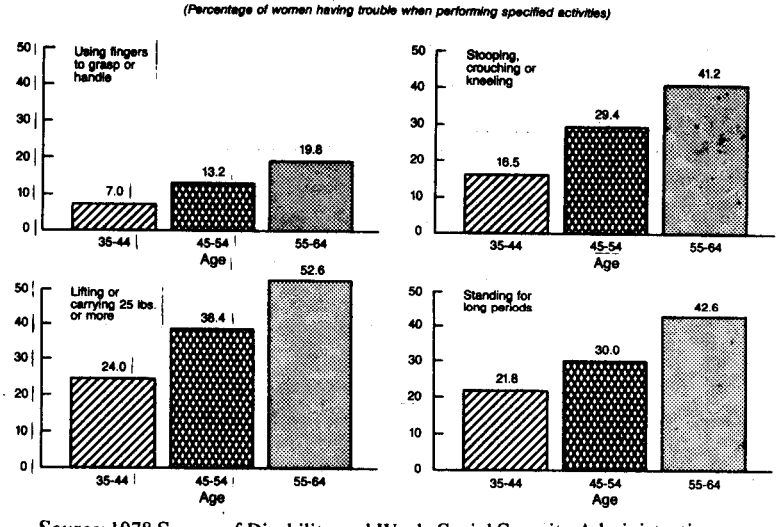
We can see from figure XVII.8 that the age pattern for men is quite similar to that for women, although the reported prevalence rate at each age for each particular impairment is generally somewhat lower for men. It should be understood that these physical limitation counts are based on a low threshold of limitation. We note, for instance, that 28 per cent of men aged 55 to 64 report themselves as having some trouble lifting or carrying 25 pounds. Only a small minority of the men with the limitation are completely unable ever to lift or

Figure XVII.6. Work disability rates higher for women than for men: United States, 1976



Source: Survey of Income and Education, Bureau of the Census.

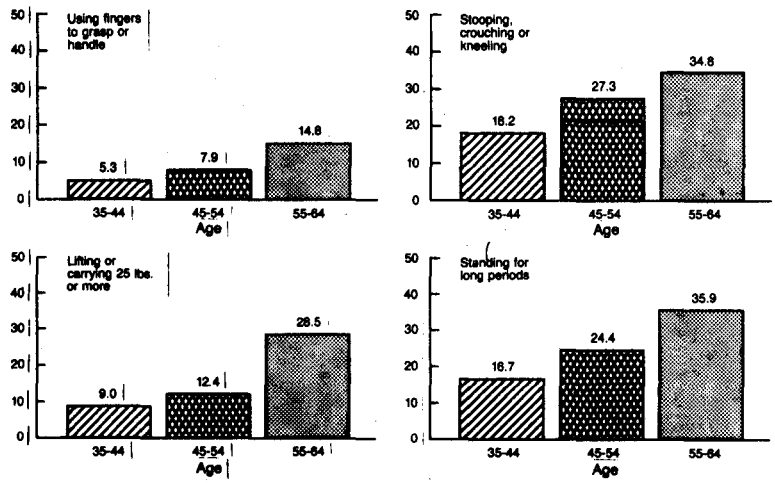
Figure XVII.7. Difficulty in performing routine acts as one grows older: women, United States, 1978



Source: 1978 Survey of Disability and Work, Social Security Administration.

Figure XVII.8. Difficulty in performing routine acts as one grows older: men, United States, 1978

(Percentage of men having trouble when performing specified activities)



Source: 1978 Survey of Disability and Work, Social Security Administration.

carry that much weight. Most of these men can handle 25 pounds during certain periods of time, for instance, while their bursitis or back conditions are in remission. There are other periods, however, when these same men find it quite painful or difficult to lift or carry 25 pounds. Some of the men can perform such a task occasionally with practically no difficulty, but would have trouble doing it repeatedly and frequently. For some individuals, the pain and discomfort of such exertion is noticeable but relatively mild; for others, it may be more severe but still bearable. Although the limitation categories presented here are extremely heterogeneous with regard to severity, we do need to recognize how rapidly the prevalence of functional limitations increases with age.

It is clear that some individuals could continue working despite a physical limitation if they could find a job that would permit them to work intermittently, i.e., during periods of remission of their symptoms. Others could work part-time but not full-time. Still others could work at a physically less demanding job but not at their regular jobs. Such employment changes would, of course, generally result in an appreciable diminution of earnings. Before the advent of current social insurance and income maintenance programmes, such employment shifts occurred with some frequency. Older workers left more physically demanding occupations and became night watchmen, guards, doormen, elevator operators, bootblacks, gardeners in private households, and real estate agents.[15] In addition, the substantial proportion of older workers who were self-employed as farmers, shopkeepers and craftsmen were able to adapt to their physical limitations by working intermittently or part-time or by selectively performing those of their former array of tasks that their impaired health permitted. Because of such changes in work activity, earnings declined appreciably for a segment of the aging population as they passed through what is now viewed as the retirement period. Present-day workers suffering physical impairments might not be as successful in obtaining suitable alternative employment as were their counterparts half a century ago. There are probably fewer "old folks" jobs in the economy now and there may be greater institutional barriers to sporadic, occasional or part-time employment.[16] (In a section of his monograph entitled "Contracting Field for Employment of Older Workers", Durand indicates that the institutional barriers to employment were already a serious problem in the period immediately following the Second World War.) The state of health and the requirements of the job for a majority of workers reaching their mid-sixties would permit them to continue in their regular line of work with only minimal, if any, job redesign. It is the sizable minority with a rather wide discrepancy between the demands of their regular jobs and their remaining functional capacity for whom there is a problem.

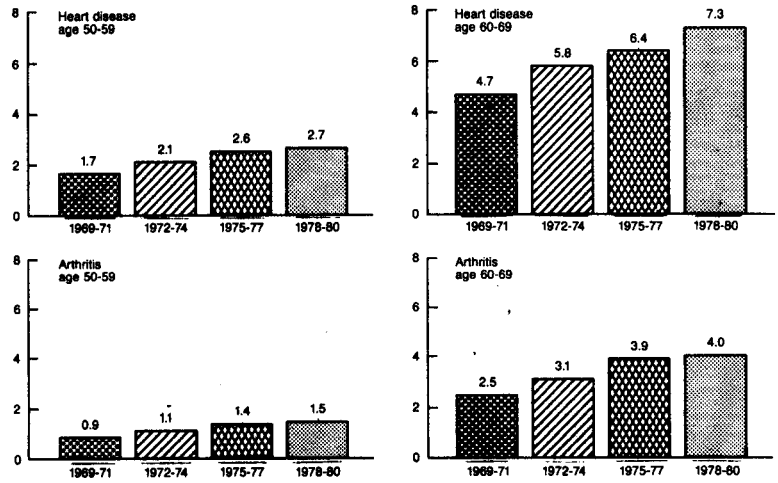
The concern of this commission is with future trends in work disability, a question I have addressed only tangentially. The problem is illustrated by the discussion in a recent Social Security Administration Actuarial Note[17] that projects equivalent retirement ages to the year 2050. Permit me to quote briefly from the note:

> "The measures of equivalence considered in this note take into account mortality, but do not take into account morbidity. That is, they adjust for the expected length of life spent in retirement, but they ignore the question of whether that life is spent in a more or less healthy condition. One reason for ignoring that question in this note is that morbidity is much more difficult to quantify than is mortality. . . . Another reason for ignoring morbidity is that we believe that mortality and morbidity are correlated. That is, when mortality improves, morbidity also tends to improve."

I suggested earlier that a decline in mortality rates can be connected with an increase in morbidity rates. As can be seen in the top panel of figure XVII.9, the prevalence rate of disabling heart disease has been increasing throughout the recent period of rapidly

Figure XVII.9. Increase in disability rates due to heart disease and arthritis over the past decade: United States, 1969-1980

(Percentage of men unable to work because of specified conditions)



Source: National Health Interview Survey, National Center for Health Statistics.

declining heart disease mortality rates. People with disabling heart disease may be surviving longer.[18] (The observed improvement in long-term survival for patients with angina pectoris is suggestive.) This could result in an increase in the size of the disabled population.

A second point of confusion involves the equating of life-threatening conditions with disabling conditions. While there is obviously some overlap between the two sets of conditions, a great deal of disability is caused by conditions that are not lethal. Musculoskeletal conditions are the cause of a large proportion of work disability. Arthritis, for instance, does not appear to shorten one's life to any great extent. Figure XVII.9 shows the upward trend in the prevalence of disabling arthritis during the past decade or so. While it is not clear why this prevalence has been increasing, there is no particular reason why reductions in mortality rates should result in a reduction in the prevalence of arthritis or of any of a number of other disabling conditions that are generally not lethal.

It has been suggested that the future trend will be markedly different from that depicted here. The concept of the "compression of infirmity" has been receiving wide currency.[19] It is held by some that the age at which chronic diseases manifest themselves is largely under our control as individuals and as a society. The age of onset of disability could be delayed by attention to such personal health habits as exercise, cigarette smoking, alcohol abuse, obesity and dietary intake as well as the management of high blood pressure and control over environmental pollution. Under this scenario, a widespread reform in personal health habits is taking place and will eventually result in the postponement of the age of onset of disability. The prevalence of work disability would certainly then be lowered in the age span of concern to us here. In terms of figure XVII.4, the stock of disabled at age 55 would be much smaller and the flow of stream 2 would be much slower, thereby reducing the proportion of disabled at age 65 and, of course, at all intervening ages.

What the future holds in this regard is very much a matter of conjecture. The long-term impact of further mortality reductions on the health of the surviving population is difficult to gauge. What has been happening with regard to diabetes is instructive. Diabetes is a condition of which we do not as yet know how to retard the onset but for which the duration of survival subsequent to onset has improved tremendously. Before the use of insulin in the management of diabetes, very few patients lived more than three or four years after diagnosis. Diabetic comas caused very early deaths. Subsequent to the use of insulin and other advances in the management of diabetes, patients began to survive for far longer periods of time. Medicine became aware of a wide variety of late complications of the disease that arise only after an individual has lived with the disease for many years. When almost all patients died soon after onset, there was no way of knowing what the late complications would be. The greatly improved survival of diabetic patients has resulted in an extremely large increase in the prevalence of the condition and such disabling complications as vision loss and cardiovascular problems.[20] The lesson to be learned from this is that we forecast the future course of disability prevalence at our own peril.[21]

The "compression of infirmity" is based on the anticipation of an imminent widespread reform of personal health habits. Certainly a lower proportion of the population smokes cigarettes now than was the case a decade or two ago. Some other health practices have also shown improvement, but there is no assurance that these trends will continue. Furthermore, it is not clear that the recent trends for alcohol and drug abuse have been particularly favorable. It is difficult to place a great deal of confidence in a forecast of future disability rates that is contingent on a widespread and permanent change in behavior.

I have attempted in these remarks to inject a note of caution regarding the forecasts of a rapid decline, perhaps by the turn of the century, in the prevalence of

work disability. On the other hand, we cannot extrapolate the recent increases in work-disability prevalence very far into the future; advances in the prevention, treatment or rehabilitation of musculoskeletal conditions could be countervailing factors. In addition, jobs could be redesigned to accommodate the handicapped. Given the many intangibles, the commission's recommendations concerning the retirement age will undoubtedly have to be formulated in the face of considerable uncertainty regarding the future course of disability prevalence rates. "Increases in longevity in the past have generally been somewhat larger than the best-informed estimators had predicted."[22] Disability prevalence may well be more difficult to predict than is longevity. Our relatively poor record in predicting the future course of mortality rates does not bode well for our prediction of disability prevalence trends.

NOTES

[1] National Commission on Social Security, *Social Security in America's Future*, final report of the National Commission on Social Security (Washington, D.C., 1981), p. 126.

[2] *Ibid.*, p. 331.

[3] I. M. Moriyama, *The Change in Mortality Trend in the United States*, Vital and Health Statistics, Series 3, No. 1 (Washington, D.C., United States Public Health Service, 1964), pp. 8-10.

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[5] T. D. Woolsey, "Estimates of disabling illness prevalence in the United States", *Public Health Reports*, No. 65 (10) (February 1950), pp. 170, 178.

[6] *Ibid.*, p. 183.

[7] E. S. Schecter, *Work Experience of Disabled and Nondisabled Adults*, 1974 Follow-up of Disabled and Nondisabled Adults, No. 2, Social Security Administration, publication No. 13-11725 (Washington, D.C., 1979), p. 11; R. Treitel, "Disability beneficiary recovery", ORS Working Paper No. 2 (February), (Washington, D.C., Social Security Administration, 1979), p. 7, tables 2-4.

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[9] R. Treitel, *op. cit.*; J. C. Hennessey, *An Age Dependent, Absorbing, Semi-Markov Model of Post-Entitlement Work Histories of the Disabled Beneficiaries*, Social Security Administration Staff Paper No. 38, publication No. 13-11868 (June 1980), pp. 11-14; C. M. Croner and L. D. Haber, "Declining mortality among disabled-worker beneficiaries", Social Security Administration Research and Statistics Note No. 13, publication No. 74-11701 (1974), p. 4; H. Orcutt, "Differential mortality by income and education: economic and demographic statistics," paper given at the November 1980 meeting of the American Statistical Association (Social Security Administration, 1980), pp. 201-206.

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[11] R. A. Israel, "Analytic potential for multiple cause-of-death data" (Washington, D.C., National Center for Health Statistics, 1981), table 3.

[12] J. F. Fries and L. M. Crapo, *Vitality and Aging* (San Francisco, W. H. Freeman, 1981), pp. 85-93.

[13] J. J. Feldman, "Health of the disadvantaged: an epidemiological overview", in *Behavior, Health Risks, and Social Disadvantage*, D. L. Parron, F. Solomon and C. D. Jenkins, eds. (Washington, D.C., National Academy Press, 1982). p. 16.

[14] V. A. Personick, "The outlook for industry output and employment through 1990", *Monthly Labor Review*, No. 104 (August 1981), pp. 28-41.

[15] D. J. Bogue, *The Population of the United States* (Glencoe, Illinois, Free Press, 1959), pp. 499-502.

[16] J. D. Durand, *The Labor Force in the United States, 1890-1960* (New York, Social Science Research Council, 1948), pp. 110-116.

[17] F. R. Bayo and J. F. Faber, *Equivalent Retirement Ages: 1940-2050*, Social Security Administration Actuarial Note No. 105 (June), (Washington, D.C., 1981), pp. 5-6.

[18] L. R. Elveback, D. C. Connolly and L. T. Kurland, "Coronary heart disease in residents of Rochester, Minnesota"; "Mortality incidence and survivorship, 1950-1975", *Mayo Clinic Proceedings*, No. 56 (November 1981), pp. 665-672.

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[21] R. Dubos, *Mirage of Health* (New York, Harper and Row, 1959).

[22] R. J. Myers, Memorandum No. 22 to the National Commission on Social Security Reform (1982), p. 1, footnote.

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