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PREFACE

The purpose of the *Population Bulletin of the United Nations*, as stipulated by the Population Commission, is to publish population studies carried out by the United Nations, its specialized agencies and other organizations with a view to promoting scientific understanding of population questions. The studies are expected to provide a global perspective of demographic issues and to weigh the direct and indirect implications of population policy. The *Bulletin* is intended to be useful to Governments, international organizations, research and training institutions and other bodies that deal with questions relating to population and development.

The *Bulletin* is prepared by the Population Division of the Department for Economic and Social Information and Policy Analysis* of the United Nations Secretariat and published semi-annually in three languages—English, French and Spanish. Copies are distributed widely to users in all States Members of the United Nations.

Although the primary source of the material appearing in the *Bulletin* is the research carried out by the United Nations Secretariat, officials of governmental and non-governmental organizations and individual scholars are occasionally invited to contribute articles.

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*Formerly the Department of International Economic and Social Affairs.

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Explanatory notes

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.

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

The term "billion" signifies a thousand million.

Annual rates of growth or change refer to annual compound rates, unless otherwise stated.

A hyphen between years (e.g., 1994-1995) indicates the full period involved, including the beginning and end years; a slash (e.g., 1994/95) indicates a financial year, school year or crop year.

A point (.) is used to indicate decimals.

The following symbols have been used in the tables:

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 minus sign (–) before a number indicates a deficit or decrease, except as indicated.

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

Population Bulletin of the United Nations, No. 39—1995

THE ENVIRONMENT AND REFUGEES: THEORETICAL AND POLICY ISSUES

*Anthony H. Richmond**

Summary

The concept of "environmental refugee" is not included in the definition of refugee as established by the 1951 Convention relating to the Status of Refugees and its 1967 Protocol, which are the most widely used instruments providing the basis for granting asylum to persons in need of protection. Yet, it is increasingly being recognized that environmental factors interact with political, economic, social and bio-psychological factors to generate mass movements of people which may require a humanitarian response by the international community. In order to improve our understanding of the role that environmental factors play in triggering migration, it is necessary to recognize the multivariate nature of the phenomenon under consideration, where the difference between internal and international migration is often accidental and there is a continuum between *proactive* and *reactive* migration.

Introduction

According to the 1951 Convention relating to the Status of Refugees and its 1967 Protocol, a person must meet the following criteria in order to be granted refugee status: (*a*) be outside his or her country of nationality; and (*b*) demonstrate a well founded fear of persecution for reasons of race, religion, nationality, membership in a particular social group or political opinion. People in need of humanitarian assistance are not refugees if they are still in their own country, even if they have

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been displaced by war or other violent upheaval. When they flee their country, it is not enough to be a victim of war, disaster or generalized violence; there must be evidence of persecution, which must be directed against the individual asylum claimant.[1] Economic or environmental conditions in the country of origin are not deemed adequate grounds to grant asylum.

Nevertheless, the term "environmental refugee" has gained currency in recent years, following reports by the United Nations Environment Programme (UNEP) and the Worldwatch Institute (El-Hinnawi, 1985; Jacobsen, 1988). The former defined the term very broadly to include anyone forced to leave his or her traditional habitat because of marked environmental disruption. Other, more or less synonymous, terms have been used to describe the plight of those fleeing long-term environmental degradation or short-term disaster. They include "ecological refugees" and "resource refugees". None of these terms or the concepts that underlie them has any standing in international law. However, the reality of international and internal migration induced mainly, or partly, by environmental factors cannot be denied. Furthermore, migration resulting from political upheavals may have environmental consequences for those areas receiving sudden population influxes (Lassailly-Jacob and Zmolek, 1992).

The scale of environmentally induced migration, whether defined as a movement of refugees or not, is difficult to estimate.[2] Much depends upon whether past, present or possible future movements are considered; whether worldwide migration or only that occurring in developing countries is considered; whether internal as well as international migration is taken into account; and whether environmental degradation is considered in isolation or in conjunction with other political, economic and social determinants of population movement.

Demographic aspects

The distinction between internal and international migration has long been recognized in demographic studies, despite the artificiality of State boundaries. Although persons displaced within their own countries because of civil war, political persecution or other types of serious disturbance to the public order do not meet the Convention definition of refugees, there is a growing recognition of their need for humanitarian assistance. Recent developments in Eastern Europe and the legacy of colonialism in Africa and Asia are evidence of the lack of correspondence between State boundaries and the ethnic ties that cut across them. Nationalist and irredentist movements have led to the definition of new boundaries and claims to self-determination. India (after partition), the Soviet Union, Yugoslavia and Somalia are examples of States that have disintegrated in the aftermath of colonialism or as a result of the collapse of a totalitarian regime, giving rise to forced population movements. Population movements that would once have been regarded as internal become international. The reverse can occur when neighbouring territories are annexed. Although States are reluctant to interfere in the internal affairs of other sovereign States, there is a growing recognition that civil wars and environmental catastrophes have consequences for the global system. In the future, multinational intervention, probably under the aegis of the United Nations, is likely to occur more often for peacekeeping purposes, for the prevention of ecological disasters or to facilitate rehabilitation after such disasters. In these circumstances the distinction between international and internal population displacement is a political one, without demographic or sociological foundation.

Sociologists and demographers usually make a distinction between movers and migrants. Besides involving some consideration of distance and boundaries—whether those between countries or between administrative subdivisions within a country—the difference between the two groups depends on the duration of the move. Temporary movements are generally not regarded as migration. Somewhat arbitrarily, demographic convention regards changes of residence of a year or more as migration and those of a lesser duration as temporary movements.[3] However, with respect to both internal and international migration, special types of movements of short duration are sometimes considered "migration". Thus, seasonal and other short-term movers may still be considered international or internal migrants if they have certain residence or work permits or if they establish certain lasting economic or social ties in the areas of destination.

In considering the question of environmental disasters, the distinction between temporary and long-term movements or changes of residence is important. Life-threatening situations may call for the temporary evacuation of a population from an area that is overcome by a natural disaster or by some technological catastrophe such as a chemical spill, gas leak or nuclear fallout. However, if the people in question are able to return to the area of origin within a period of days, weeks or even months, it would not be appropriate to consider them as "environmental migrants" and even less as "environmental refugees", even if they are in need of assistance because they have lost their livelihood or their homes have been destroyed.

Given the limitations of the definition of refugee as contained in the 1951 Convention, it has been suggested that alternative terms, such as "environmental migration" or "environmentally induced internal displacement", used to refer to persons who have not crossed an international border, might be more appropriate. It is generally assumed that, if a new category of "environmental refugees" were to be recognized in international law, it would supplement the existing definition. Those favouring the recognition of an additional category emphasize that "environmental refugees" would have to be persons who cross international borders and are forced to flee their areas of origin because of environmental factors (Suhrke and Visentin, 1991; Trolldalen, 1992).

There is ample precedent for the distinction between "voluntary" and "involuntary" migration in social demography (Petersen, 1958). However, there are sociological grounds for questioning the validity of a simple dichotomy. It is more appropriate to think in terms of a continuum between proactive and reactive migration (Richmond, 1988 and 1993). Proactive migrants have a greater freedom of choice with regard to the decision to move, the timing of that move and the choice of destination. Reactive migrants are constrained to a greater degree by the physical and social situation in which they find themselves. Faced with a life-threatening situation, their degree of freedom is limited, and flight may be their only rational choice. However, in practice, many international and internal migrants find themselves somewhere between the two extremes of maximum proactivity and maximum reactivity. Furthermore, the factors compelling them to migrate or inducing their migration are unlikely to be unidimensional and are far more likely to involve some combination of economic, political, social, bio-psychological and environmental processes (Richmond, 1993).

Proactive migration induced by purely environmental considerations includes movements of people in response to climatic conditions, when these are not directly linked to economic needs and livelihood. Examples include the migration to "summer homes" of wealthier families retreating from the heat or the winter movements of retirees and others from northern climates to warmer southern locations. Reactive migrations, exclusively in response to environmental factors, include the flight from earthquakes, volcanoes, floods and other "natural" disasters that cannot be predicted with certainty. As our understanding of the factors likely to cause such geophysical catastrophes increases, it is impossible to separate purely environmental causes from economic and political issues. By anticipating natural disasters and taking appropriate precautions, it is possible to save lives and reduce the need for reactive migration. The building of dykes and dams, the application of strict building standards and the introduction of emergency procedures, including temporary evacuation, may reduce the necessity for long-term migration induced by environmental crises.

Many of the environmental influences associated with both proactive and reactive movements are inseparable from political causes. What Kunz (1973) calls "anticipatory refugee movements" may result from a recognition of the potential environmental disasters induced by war or terrorist activity (such as bombing dams or setting fire to oil wells). It is hard to separate such proactive movements from the reactive migration that occurs after such events have taken place and which are of the "acute" type. The use of defoliants and "scorched earth" tactics by armed forces may have devastating and long-lasting consequences for the environment. Political and economic considerations may also determine whether adequate precautionary measures are taken in anticipation of earthquakes and other natural disasters. Failure to do so may generate environmental migration of the reactive type. Although the direct cause of migration may be famine or drought, civil war or some other type of political upheaval may contribute to the crisis by preventing the planting of crops, the transport of water or the supply of emergency aid. As Suhrke (1992, p. 28) notes, when environmental degradation leads to migration, it is generally a proximate cause linked to questions of economic growth, poverty, population pressure and political conflict.

When environmental factors are combined with economic considerations and the necessity to earn a livelihood, proactive migration includes the hunting and trapping lifestyles of aboriginal populations in various parts of the world, including the Arctic and some tropical regions in Africa and South America. Proactive migration is also typical of pastoral and "slash and burn" subsistence economies. Seasonal factors play an important role in determining such migration in conjunction with the need to follow the trail of migrating animals and fish. Reactive migration under these circumstances occurs when the supply of such natural resources diminishes to the point of threatening the livelihood of the populations concerned. Such resource depletion may occur under natural conditions, but today it is more often induced by the effects of environmental pollution or by the incursion of commercial and industrial practices that damage the traditional resources upon which aboriginal populations have relied, thus giving rise to environmental movements of the reactive type.

Another example of proactive migration related to both environmental and economic factors is that of gypsies, peddlers and trading communities which travel carrying with them supplies of raw materials or artefacts for trade in remote destinations. Classical examples are the caravans that carried silk, spices and other oriental goods from Asia to Europe in return for gold or manufactured goods. Modern methods of transportation have made such migrations anachronistic. The jet-flying traders and executives of the twentieth century are proactive movers who may spend more time in airports and hotels than at home, but they are generally not considered migrants. The reactive equivalent would be gypsies who are refused permission to stay in a particular location or country and are expelled. Reactive migrants also include persons escaping natural disasters who are refused admission to other countries on the grounds that they are not individually persecuted for the reasons established by the 1951 Convention.

Social factors interact with environmental ones to facilitate proactive as well as reactive migration. Examples of the former include migration to reunite families or to maintain communities with strong linguistic or religious ties. The desire to preserve a particular lifestyle or to begin a new life in communes, cooperative ventures or the like may result in proactive migration. The environmental influence may be present as either a "push" or a "pull" factor or some combination of both. Gradual environmental deterioration or soil erosion may lead initially to proactive migration which may eventually become reactive as the process of degradation accelerates. Reactive migration in response to both environmental and social factors occurs when whole communities are forced to move as a consequence of environmental degradation or disaster and are then re-established in a new location.

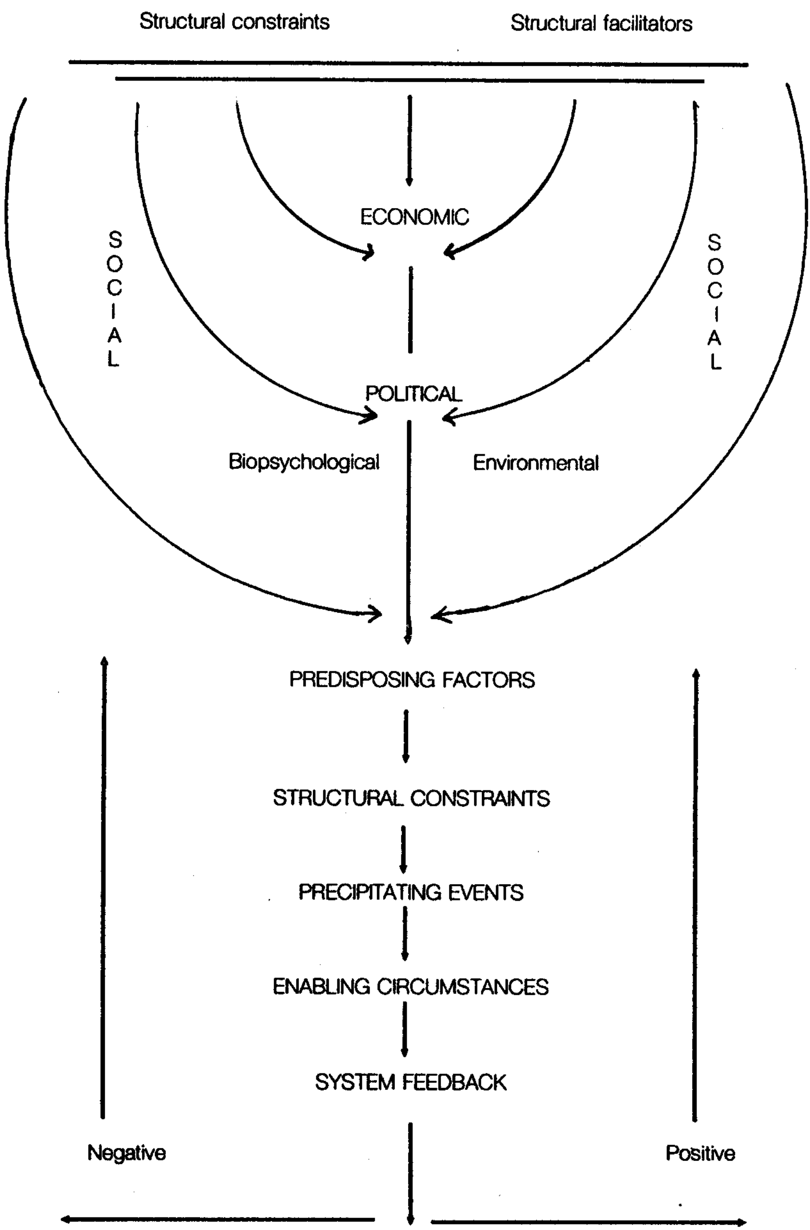
Environmental factors may also interact with bio-psychological factors to induce migration. Proactive examples include migration to health spas or movements of people who deliberately wish to relocate in rural communities or in small towns to avoid noisy or stressful situations likely to affect their physical or mental health. Reactive migration under these conditions includes escape from plagues, epidemics, pollution and other health hazards. Environmental disasters giving rise to radiation hazards or to the chemical contamination of air or soil would result in environmentally related migration of the refugee type.

SYSTEMS MODEL

It is necessary to go beyond a descriptive typology of environmental reactive migration (whether or not defined as a movement of "refugees") in order to understand the dynamic interaction of multiple causal factors which are likely to generate such population movements. Therefore, a clearer definition of predisposing conditions, structural constraints, facilitating factors and precipitating events is needed (figure I), together with a closer examination of the "feedback" effects of environmental reactive migration on both national and global systems. Positive effects—that is, those that exacerbate and accelerate reactive migration—include conflicts related to the environment and access to resources. Negative or mitigating feedback that reduces the damaging effects of acute reactive migration includes measures such as emergency aid and humanitarian intervention by governmental and non-governmental agencies. Immediate and longer-term policy responses must be considered, including preventive measures.

Predisposing factors include geophysical conditions over which there is no control, although scientific advances may make some contingency planning possible. Thus, research on geological fault lines or volcanic conditions and atmospheric, oceanic and meteorological studies may eventually lead to better predictions of possible catastrophic

Figure I. Reactive migration: multivariate factor analysis



events. Forecasts of their probable strength can provide a basis for early warning systems and the implementation of adequate prevention. However, scientific knowledge in these fields is far from reaching a point where a total elimination of all potential hazards is possible. Unfortunately, technological developments may themselves create predisposing conditions that have potentially disastrous consequences. Obvious examples include the long-term consequences of global warming or damage to the ozone layer. In addition, industrial pollution, waste disposal and deforestation contribute to ecological damage, placing the planet under stress and setting up the conditions for reactive migration (Mungall and McLaren, 1990).

The predisposing factors that increase the probability of reactive migration notwithstanding, the environment itself may also constrain and limit the possibility of flight under some circumstances, while facilitating it in others. People living in an earthquake zone, in the vicinity of a volcano or in the path of a flood may have little opportunity to escape if they are surrounded by mountains or the sea. The very suddenness of the disaster may preclude effective evacuation or rescue operations. In other cases, environmental conditions may render relocation more feasible and survival more likely. The availability of natural shelter (as in caves) or the use of trees or other natural objects to cling to or shelter under may facilitate flight and rescue. When environmental degradation occurs gradually, it may be recognized ahead of time and contribute to proactive rather than reactive migration.

Environmentally induced reactive migration generally occurs as a result of a precipitating event which may or may not have been preceded by some warning of the impending disaster. Figure II identifies some of the principal factors likely to precipitate reactive migration and having direct or indirect environmental implications. They may be categorized as natural, technological, economic, social and political. It is important to stress that they are not independent of each other but may interact and be mutually aggravating. The political precipitants are akin to those singled out by the 1951 Convention, but they may interact with environmental factors to produce the type of reactive migration of interest. Thus, war almost invariably has deleterious environmental effects, destroying food supplies, contributing to crop failure, resource depletion and pollution. In the course of battle, dykes, dams and bridges are likely to be damaged or destroyed, and the technological controls used to restrain environmental hazards are likely to weaken or collapse. Ironically, overzealous action by those wishing to protect the environment, save species or proclaim animal rights may induce reactive migration when the livelihoods of those who depend on the exploitation of certain resources are threatened by such campaigns. Thus, combating seal hunting, whaling, fishing or fur-trapping is likely to lead to the displacement of persons working in those occupations, as markets for

Figure II. Typology of environmentally related disasters

Naturally induced disasters (NIDs)		
Hurricanes	Tornadoes	Whirlwinds
Earthquakes	Volcanic eruptions	Avalanches
Floods (freshwater)	Floods (salt water)	Hail and snow storms
Fires	Electric storms	Lightning
Droughts	Famines	Plagues
Technologically induced disasters (TIDs)		
Chemical	Nuclear	Oil spills
Pollution (air)	Pollution (water)	Pollution (soil)
Explosions	Building collapse	Rail or airplane crash
Dams (floods etc.)	Mining accidents	Power cuts
Factory accidents	Soil exhaustion	Urban dereliction
Economically induced disasters (EIDs)		
Deforestation	Crop failure	Fishery exhaustion
Mineral exhaustion	Species extinction	Human redundancy
Population clearances	Relocation	Structural adjustment
Politically induced disasters (PIDs)		
War (external)	War (internal)	Terrorism
Apartheid	Ethnic cleansing	Holocaust
Exile	Persecution	Rights violations
Totalitarianism	Anarchy	Extremism/intolerance
Socially induced disasters (SIDs)		
Ecological extremism	Animal rights activism	Green crusaders
Fanaticism	Excommunication	Jihad
Class war	Shunning	Boycott

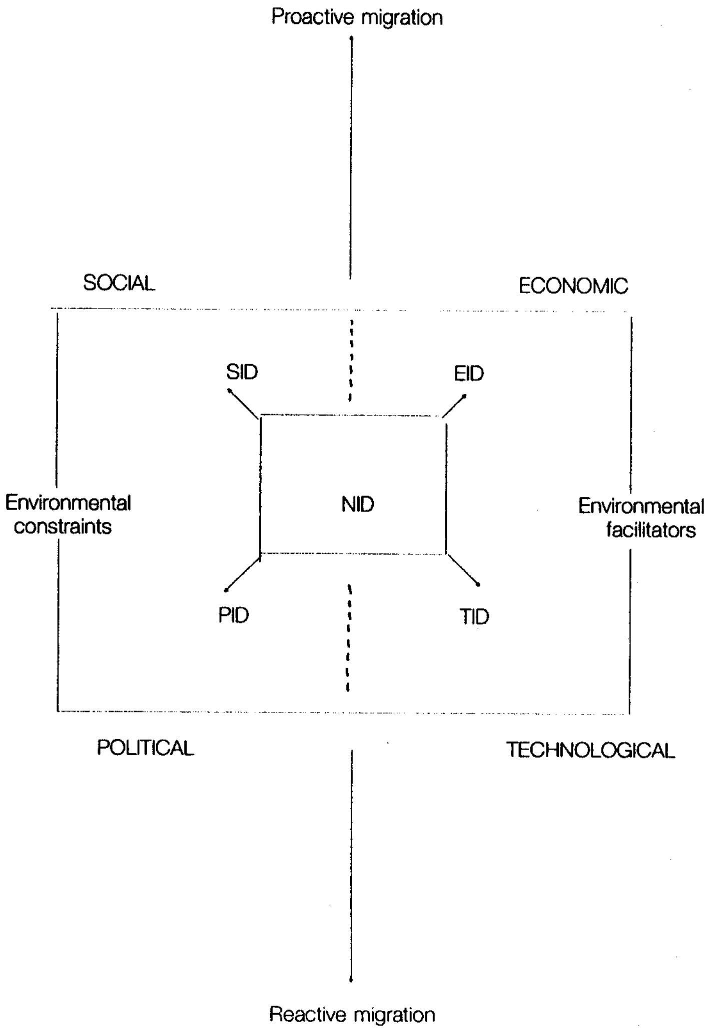
their products collapse, or laws forbidding or limiting their activity are passed. In some types of population movements, the environmental connection may be indirect, being linked to political factors, technological change and economic pressures. That is the case of the conflicts associated with access to oil in the Middle East or the closing of coal mines in Great Britain. Although these examples cannot be completely isolated from powerful ideologies, they are related to the consumption or depletion of natural resources.

Figure II identifies some of the more obvious natural disasters likely to precipitate reactive migration over which human intervention can have little influence, except to provide contingency planning and emergency response capability. More direct human responsibility is involved in technologically and economically induced disasters. These may sometimes appear to be "natural" when, in reality, they are the result of previous actions such as the building of dams, the diversion of rivers or the destruction of forests. Calculated risks are taken and cost-benefit analyses made when major projects are undertaken, such as the building of nuclear power plants, hydroelectric plants, irrigation schemes or the development of mines. There is growing recognition of the need to assess the environmental impact of those projects before they are undertaken, whether they are publicly funded or not. Population displacement, relocation and compensation may be among the economic and social costs that must be considered. Past experience suggests that the human trauma resulting from relocation is often underestimated.

The interaction of economic determinants and environmental factors in producing migration is evidenced in phenomena such as resource depletion and species extinction and in the human redundancy which comes with changing market conditions and technological change. At the United Nations Conference on Environment and Development, held in 1992, it was recognized that rapid population growth, poverty and environmental degradation are closely related and may be exacerbated by the structural adjustment programmes imposed on developing countries by banks and international agencies concerned with the control of inflation or loan repayments (George, 1992). The export of raw materials and the exploitation of mineral or forestry resources may be the only way for developing countries to deal with balance-of-payments crises and to meet interest payments. The resulting environmental devastation may make reactive migration inevitable, often increasing the rate of urbanization and thus contributing to greater ecological stress in urban areas (United Nations Association of Canada, 1991; Homer-Dixon, Boutwell and Rathjens, 1993).

The complex interactive and multivariate nature of proactive and reactive migration related to environmental factors is illustrated in figure III. Social and economic determinants tend to be more relevant in the case of proactive migration, whereas political and technological factors are more likely to play key roles in leading to reactive migration. However, the proactive/reactive dimension represents a continuum rather than a simple dichotomy, and many large-scale migration flows are likely to fall between the two extremes. Thus, environmental factors may predispose, enable or precipitate migration but may also impose restrictions and constraints on population movements, thus affecting both their scale and direction.

Figure III. Environmentally related population movements: multivariate model



Key: NID Naturally induced disaster
TID Technologically induced disaster
EID Economically induced disaster
PID Politically induced disaster
SID Socially induced disaster

SYSTEM FEEDBACK

Proactive and reactive migration may be induced by the preventive measures designed to reduce the effects of environmental degradation or catastrophe as well as by the measures needed to clean up after disasters. Policies aimed at reducing environmental damage may affect the livelihoods of those who have depended on resource exploitation for employment. Certain measures force people to move, including reductions in the exploitation of coal, oil or forest products; moratoria on fishing or on the slaughter of animals for fur or ivory; and the banning of trade in exotic birds and animals in danger of extinction. Because of the nature of such measures, there is likely to be little sympathy or humanitarian aid for the persons compelled to migrate as a result, although some compensation may be demanded by corporations if their economic interests and contractual obligations have been adversely affected. Clean-up operations after environmental disasters are likely to induce the temporary inflow of skilled personnel to aid in the process, and there may be long delays before the original inhabitants can return to the area affected by the disaster in question.

Among the more serious "feedback" effects of environmental change is the possibility of violent conflict when population growth and movement results in competition for scarce resources. Further conflicts are generated when hitherto separate and potentially antagonistic ethnic groups are brought into close proximity as a result of environmentally induced migration. When resource scarcity and competition combine with nationalistic, racial, linguistic or religious differences, the probability of overt conflict is enhanced. Ironically, attempts to deal with refugee movements by the establishment of camps or by resettlement programmes in already overpopulated or arid locations may themselves contribute to environmental damage. Some Mozambican refugee camps in Malawi are a case in point (Smith, 1993).

ENVIRONMENTAL ISSUES AS A SOURCE OF VIOLENCE

Researchers studying environmental change and acute conflict have identified various ways in which ecosystem vulnerability may interact with the scarcity of renewable resources and with political factors to generate acute conflict which can become violent (Homer-Dixon, Boutwell and Rathjens, 1993). In some contexts, internal or international migration may lead to ethnic conflict, urban unrest and the weakening of Governments. These processes may, in turn, exacerbate pressure on the environment by interrupting planting, causing crop failure, or destroying food or fuel supplies. Political, economic and environmental forms of reactive migration may all increase as a result. The history of China provides several examples in which reactive migration resulted from the interaction of population growth, industrialization, political conflict and environmental change (Smil and Gladstone, 1992). Other Asian and African countries experiencing growing population pressure on the environment are facing a rapid transformation of their political and economic systems. These countries could pose a serious threat to global security if they are not given constructive aid. Somalia is a case where civil war exacerbates famine and poses important internal and external security problems. Despite the lip-service paid to environmental issues at the Earth Summit in 1992, Canada, the United States and other developed countries are diverting foreign aid from developing countries to Eastern Europe for economic, political and strategic reasons, including the perceived need to stem the flow of reactive migrants from former Eastern bloc countries to the West. As a result, migration pressures in developing countries are likely to increase.

The most critical conflicts arising from environmental factors are likely to be those related to land, water and energy, including fossil fuels. Disputes over land rights have traditionally given rise to war and colonial conquest. As previously subjugated peoples seek their independence, issues of self-determination and sovereignty are major underlying, intervening and precipitating causes of reactive migration. Attempts to gain control over territory lead not only to "ethnic cleansing" and civil war but also to attacks on neighbouring countries. Indigenous peoples seek redress for past deprivation and the right to control their own land and its resources, a development that could lead to the expulsion of those deemed not to belong to the ancestral community. Although violence is always a possible consequence of acute conflict situations, comparative studies of environmental degradation in Africa, India, Thailand and elsewhere lead to the conclusion that "environmental degradation, in so far as it causes displacement of people, is more likely to generate exploitation than acute conflict" (Suhrke, 1992, p. 31), mostly because the populations concerned are likely to be weak and small in number relative to the surrounding communities. However, in the case of Bangladesh, the combined effects of population growth, the movement of political refugees, pressure on land, and the trauma of flooding have exacerbated existing ethnic conflicts and contributed to violence (Hazarika, 1993, pp. 45-63).

In many parts of the world, water has become a major source of conflict. Once-abundant sources of potable water are rendered scarce by pollution, dam-building and the diversion of rivers. When combined with hydroelectric power plants or projects that divert water supplies from one area to flood another, water becomes a major source of conflict. Examples include the James Bay region of northern Quebec, the Hungarian/Slovakian region of the Danube, the Jordan river basin, and mega-projects in Africa, Asia and Latin America. Nearly all have resulted in significant population displacement and subsequent disputes (Zmolek, 1992; Gleick and Lowi, 1992).

Access to fossil fuels continues to be a source of acute conflict. The universal dependency of advanced industrial countries on cheap oil has created an arena in which superpower interests are directly affected by any threat to the supply of oil. Oil exploration, extraction and transportation pose serious environmental hazards. Supply management and control over oil markets is a potent source of economic and political conflict which has already led to war in the Middle East and elsewhere. Developing countries rely heavily on the exploitation of forest products for export, while advanced industrial countries are faced with the necessity of finding alternatives to coal. All these situations increase the probability of environmentally induced reactive migration.

POLICY IMPLICATIONS

The above analysis suggests a number of policy initiatives and programmes that are needed at the international and national levels. From an ecological perspective, better planning, irrigation, soil conservation and reafforestation are clearly essential. Collaborative efforts are also needed to deal with air and water pollution, ozone depletion and global warming. A conference on migration and development, held in 1992, identified a number of areas for policy development (International Organization for Migration, 1992), placing emphasis on organizational roles, relationships and responsibilities, including the need to coordinate the efforts of the various United Nations agencies, other intergovernmental organizations, national and non-governmental organizations. It was recognized that such groups might have competing or even conflicting interests (International Organization for Migration, 1992, pp. 25-28). It was considered important to define State responsibility and to develop a legal regime to deal with people forced to move because of environmental factors. The identification of resources and mechanisms to respond to the needs of such migrants was called for, especially in the context of long-range planning for sustainable environmental change. The human rights aspects of environmentally triggered international migration were stressed, and the need to devise strategies to prevent such migration and to assist migrants was underscored (International Organization for Migration, 1992, pp. 225-228; World Council of Churches, 1992, pp. 6-7).

Certain additional questions arise. First, it is clear that the 1951 Convention relating to the Status of Refugees does not deal with the needs of all reactive migrants, particularly those whose international or internal displacement is directly or indirectly induced by environmental factors. Although there may be financial and politically expedient reasons for not attempting to amend the existing Convention and its Protocol at this time, a new instrument may be necessary to address the humanitarian needs of people who are displaced from their homes by circumstances beyond their control, whether or not they cross an international border. Environmental factors should be one concern, although they may be linked to other economic, political and social influences promoting reactive migration. Secondly, given that development aid and humanitarian assistance are inevitably scarce, it may be necessary to develop a system of priorities in which weight is given to certain critical factors in order to measure the severity of a given threat. Early warning systems need to combine indicators of impending environmental disaster with concomitant political, economic, social and biopsychological variables to determine the degree of urgency and scale of the preventive or ameliorative measures required. Thirdly, there is need for more effective coordination of the efforts of the various United Nations agencies and other intergovernmental and non-governmental organizations and of a more efficient targeting of assistance to the areas suffering from the most acute conflict or deprivation. Fourthly, the Governments of developed and developing countries alike need to take a long-term view of resource utilization. The concept of sustainable development requires greater elaboration and specification, taking into account the needs of sedentary and mobile populations in the context of a post-industrial global society in which proactive migration will probably increase. Reactive migration should be rendered anachronistic, as people are enabled to exercise greater freedom of choice and are not constrained to move by environmental or other conditions beyond their control.

As the Norwegian delegate to the Conference on Security and Cooperation in Europe (Helsinki, 1992) proposed, we should transplant the concept of "confidence- and security-building measures", usually understood in strictly political and military terms, to the environment (Brett, 1992, p. 38). Consequently, security would involve not only arms reduction and an end to the dumping of nuclear and chemical wastes but also an active promotion of peace and mutual cooperation. We worry about the toxic wastes that we dump in our rivers and landfills. We should also recognize the threatening consequences of arms proliferation. Trickle-down economics may not have worked well, but trickle-down munitions sales have turned the world into a huge bazaar for weapons deemed by the manufacturing countries to be surplus or technologically redundant. Arms production and sales are seen as the politicians' answer to economic recession. We have created a global garbage dump full of explosives ready to ignite at the slightest increase of political heat or ethnic conflict, anywhere in the world. The weapons available range from handguns through high-velocity rifles and AK 47s, to weapons of mass destruction immensely more powerful than those used in the bombing of Hiroshima and Nagasaki. Delivery of short- and long-range missiles is possible by sea, land or air, increasing the vulnerability of remote destinations. Such weapons are now controlled by some relatively small and politically unstable States. They could eventually get into the hands of unscrupulous politicians or terrorists, determined to hold the world at ransom. The global refugee problem will never be solved as long as the militarization of the global economy continues. Any attempt to deal with "root causes" must address the issue of multilateral disarmament and all the other factors contributing to reactive migration, including those related to the environment.

NOTES

[1]The Organization of African States and the Governments of some Central American countries have adopted a broader definition of refugee which includes persons compelled to move as a result of "events seriously disturbing public order". In principle, such a definition might be interpreted to include those escaping environmental crises but, in practice, it is unlikely that the Governments concerned would recognize such persons as genuine refugees ("Conference report: migration and the environment", *International Migration* (Geneva), vol. XXX, No. 2 (June 1992), p. 23.

[2]Using a very broad definition of "environmental refugee" to include any persons forced to move, temporarily or permanently, as a result of environmental disruption or degradation, the Worldwatch Institute estimates that the number of environmental refugees stood at about 10 million in 1988 (Jacobsen, 1988). Extrapolating from that figure, an IOM/Refugee Policy Group report suggested that as many as 1 billion persons may be displaced by the end of the century ("Conference report: migration and the environment", *International Migration* (Geneva), vol. XXX, No. 2 (June 1992), p. 9. These estimates fail to recognize the complexity of the concept of reactive migration, its relation to determinants other than environmental ones, and the non-recognition of "environmental refugees" in international law.

[3]The officially recommended definition of an international migrant is a person who enters or leaves a country with the intention of remaining a year or more inside or outside that country, respectively (*Recommendations on Statistics of International Migration*, United Nations publication, Sales No. E.79.XVII.18). However, most countries do not use this definition in gathering international migration statistics and, consequently, comparisons among countries are difficult.

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SEX DIFFERENTIALS IN OLD-AGE MORTALITY

*Thomas Buettner**

SUMMARY

This article examines levels and trends of sex differentials in life expectancy at older ages for 29 developed countries. Significant sex differentials in life expectancy among the elderly have been found—but no common trend among countries. Sex differentials in life expectancy for the elderly continued to widen for less than half of the countries studied; most of them experienced a declining trend. Due to the existing sex differentials in mortality among the elderly, their sex ratio is expected to change dramatically as they age. According to hypothetical life-table populations, differential mortality would change an almost balanced sex composition at age 60 into a population with femininity ratios ranging from 140 to almost 250 women per 100 men. Eastern European countries show, for most of the measures employed, a picture different from that for the advanced Western societies. They have the lowest life expectancies above age 60, and the contributions of age group 60-85 to sex differentials in mortality at birth are the lowest.

The article concludes that it is necessary to draw more attention to old-age mortality, and to sex differentials in particular, since the size and relative weight of the elderly segment of the population continues to grow. Also, it seems to be necessary to include specific goals for old-age mortality in national health strategies aimed at reducing overall mortality and narrowing inequalities between social groups.

INTRODUCTION

A remarkable reduction in overall mortality took place in developed countries during recent decades, especially at the early and late stages of life (United Nations, 1990a). However, marked differentials between the sexes, between countries and within countries continue to

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exist. Consequently, much attention has been given to the widening gap between male and female life expectancy at birth, to persistent socio-economic mortality differentials and to mortality differentials within countries.

Theories and explanations regarding mortality differentials are still developing, and expectations about future developments vary considerably. It has often been thought, for example, that mortality differentials between Western European countries will diminish as health and survivorship prospects improve. Yet the opposite expectations have also been put forward—namely, that mortality differentials may increase, as declining economic growth and "cut-off" approaches to welfare provision are instituted (Dean, 1992).

The World Health Organization (WHO) strategy for the attainment of health for all in the European region devotes considerable attention to equity in the provision of health services, both between and within countries. "The great difference in socio-economic development, political systems and administrative traditions among the member States of the region has resulted in widely varied patterns of distribution and organization of institutions and personnel for health care. . . . Urban areas are generally better served than rural ones. There are also inequities within cities, where poor areas often bear the brunt of the shortages".[1] According to that strategy, differences in health status should, by the year 2000, be reduced by at least 25 per cent. With respect to differentials in life expectancy, the European goal of an overall average life expectancy at birth of 75 years by the year 2000 could be achieved by reducing differences between geographical areas, socio-economic groups and the sexes by at least 25 per cent (target 6). Since most European countries already have very low mortality levels, existing differentials in overall mortality stem mostly from mortality differentials in adulthood and at older ages (Lopez, 1983). Yet differentials in old-age mortality have attracted limited attention, and none of the WHO targets deal explicitly with them.[2]

There is no universally accepted practice on how to define the elderly. Many studies use age 65 as a cut-off point between active adulthood and old age; others use age 60, and sometimes even age 55. These definitions are often justified in terms of the prevailing retirement age (usually established by pension regulations), actual mean ages of retirement, early retirement schemes etc. In this article, the elderly are defined as people aged 60 and over. This definition is consistent with prevailing United Nations practice and reflects the age at which the transition from economically active life into retirement tends to take place. It must be borne in mind, however, that any age limit selected to distinguish the elderly from the rest of the population has some degree of arbitrariness.

SEX DIFFERENTIALS IN LIFE EXPECTANCY AMONG THE ELDERLY

Data and methods

Sex differentials in mortality at older ages in developed countries will be analysed mostly in terms of life expectancy and selected other life-table measures. A series of annual life-tables was calculated for developed countries, starting with 1980 and ending with the latest year available, using central death rates by five-year age group compiled by the WHO.[3] Developed countries include all countries of Europe, Australia, Canada, Japan, New Zealand and the United States. Albania and the former Soviet Union were excluded because of lack of data, Iceland, Luxembourg and Malta because of small population size. Table 1 gives the information available for each country. The software package MORTPAK-Lite was used to calculate life-tables, ensuring consistency regarding the methodology (United Nations, 1990b). Since the WHO data are compiled from those provided by national statistical offices, the completeness of death registration[4] and the accuracy of annual population estimates[5] may vary between countries and calendar years. No adjustments have been made.

Because of possible, but unknown, data distortions at very old ages, mortality data for age groups above 85 have been excluded from the analysis of sex differentials. The focus was thus on the age group 60-84. Another reason for narrowing the age span considered is associated with the usual life-table techniques for estimating the survivorship pattern for the oldest old: since detailed information for age group 85 or over is often not available and since observed trends tend to become erratic for the very old, estimates of survivorship for the last open-ended age group are based on mortality trends at younger ages. Though this technique is justifiable for estimating the overall level of life expectancy, it can distort results for the elderly.

Three measures will be used to analyse sex differentials in mortality at older ages:

(*a*) Sex differentials in life expectancy at age 60 for age group 60-85;

(*b*) The absolute and relative contribution of sex differentials in mortality in age group 60-85 to sex differentials in life expectancy at birth; and

(*c*) The impact of differential mortality on the sex ratios of (hypothetical) cohorts of survivors, expressed by the femininity ratio.

Since these three measures are derived from life-tables, they refer to exact ages, thereby making it necessary to include the upper bounds of a given age group in its notion.

The life expectancy at age 60 for age group 60-85 ($e_{60/85}$) is the number of person-years lived by a survivor to age 60 between exact age 60 and exact age 85—that is:

$$e_{60/85} = \frac{T_{60} - T_{85}}{l_{60}} = \frac{T_{60}}{l_{60}} - \frac{T_{85}}{l_{60}} = e_{60} - \frac{T_{85}}{l_{60}} \qquad (1)$$

Sex differentials in life expectancy at age 60 for age group 60-85 ($SDe_{60/85}$) have been computed simply as the difference between $e_{60/85}$ for women and that for men—that is:

$$SDe_{60/85} = e^{f}_{60/85} - e^{m}_{60/85} \qquad (2)$$

The contribution of sex differentials in mortality within the 25-year span between exact ages 60 and 85 ($\Delta SDe_{60/85}$) to sex differentials in e_0 has been calculated by decomposing the overall sex differentials in e_0 into age components. The formula applied to decompose contributions of different age groups to SDe_0 considers that the contribution of a given age group to SDe_0 is determined by the differences between male and female mortality, the location of the age group along the age continuum, and the mortality in all preceding age groups (United Nations, 1988). The following equations have been used:

For age group 0-1:

$${}_1\Delta SDe_0 = (e^{f}_{0} - e^{m}_{0}) - \left[(e^{f}_{1} - e^{m}_{0}) \times \frac{(l^{f}_{1} + l^{m}_{1} r)}{2} \right] \qquad (3)$$

For age groups between the first and the last age group:

$${}_n\Delta SDe_x = \left[(e^{f}_{x} - e^{m}_{x}) \times \frac{(l^{f}_{x} + l^{m}_{x})}{2} \right] - \left[(e^{f}_{x+n} - e^{m}_{x+n}) \times \frac{(l^{f}_{x+n} + l^{m}_{x+n})}{2} \right] \qquad (4)$$

For the last, open-ended age group (85 and over):

$${}_\infty\Delta SDe_{85} = (e^{f}_{85} - e^{m}_{85}) \times \left[\frac{(l^{f}_{85} + l^{m}_{85})}{2} \right] \qquad (5)$$

where ${}_n\Delta SD_x$ is the contribution of mortality differentials within age

TABLE 1. SEX DIFFERENTIALS IN LIFE EXPECTANCY AT AGE 60 OVER THE AGE SPAN 60-85

Country[a]	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*
Greece . . .	1.98	2.08	2.19	2.10	2.13	2.21	2.24	2.16	2.27	2.27	..	..
Romania . .	2.03	2.14	2.11	2.18	2.19	2.24	2.30	2.22	2.33	2.29	2.38	..
Yugoslavia (former) .	2.38	2.41	2.53	2.54	2.51	2.48	2.58	2.54	2.70	2.63	2.71	..
Japan	2.59	2.53	2.53	2.56	2.57	2.58	2.56	2.59	2.64	2.68	2.72	..
Bulgaria . .	2.28	2.24	2.31	2.56	2.54	2.50	2.63	2.72	2.73	2.67	2.77	..
New Zealand	3.02	3.14	3.25	3.01	3.00	3.03	3.04	2.79	3.03	2.86	..	..
United States of America .	3.26	3.22	3.16	3.15	3.01	2.97	2.87	2.82	2.75	2.65	..	..
German Democratic Republic .	2.90	2.80	2.88	2.80	2.81	2.86	2.82	2.82	2.96	2.90	..	..
Sweden . . .	3.02	3.02	3.02	3.05	3.00	3.03	2.99	2.88	2.88	2.81	..	..
Spain	2.78	2.84	2.80	2.87	2.94	2.99	2.95	2.97	3.00	..	..	..
Portugal . . .	2.91	2.93	2.86	2.91	2.99	2.99	2.95	2.97	3.03	3.04	3.14	3.27
Australia . .	3.49	3.37	3.39	3.20	3.15	3.13	2.97	3.01	2.99	..	..	..
United Kingdom	3.40	3.29	3.24	3.29	3.21	3.16	3.13	3.01	2.97	2.86	2.84	..
Ireland . . .	2.73	2.94	2.96	3.12	2.98	3.22	3.23	3.01	3.11	2.96	..	..
Canada . . .	3.27	3.21	3.24	3.15	3.15	3.11	3.06	3.03	3.09	3.01	..	..
Austria . . .	3.20	3.22	3.23	3.29	3.19	3.11	3.02	3.03	2.99	3.09	3.17	3.03
Denmark . .	3.30	3.31	3.05	3.23	3.09	3.14	2.98	3.04	2.84	2.91	2.88	..
Switzerland .	3.22	3.28	3.23	3.32	3.22	3.27	3.27	3.21	3.20	3.17	3.15	3.10
Federal Republic of Germany .	3.39	3.38	3.35	3.36	3.40	3.38	3.26	3.23	3.19	3.20	3.06	..
Italy	3.22	3.19	3.23	3.33	3.30	3.28	3.30	3.26	3.24	3.21	..	..
Norway . . .	3.28	3.30	3.25	3.42	3.36	3.36	3.44	3.36	3.22	3.24	3.10	..
Belgium . . .	3.68	3.57	3.54	3.46	3.64	..	3.44	3.45	..	..	..	..
Hungary . .	3.17	3.24	3.29	3.39	3.51	3.45	3.41	3.50	3.49	3.68	3.64	..
France	3.68	3.64	3.60	3.62	3.63	3.62	3.70	3.58	3.48	3.51	3.41	..
Netherlands .	3.67	3.66	3.73	3.75	3.66	3.67	3.71	3.59	3.60	3.52	3.43	..
Czechoslovakia (former) .	3.31	3.41	3.41	3.47	3.49	3.56	3.56	3.60	3.66	3.67	3.86	..
Poland . . .	3.47	3.42	3.38	3.41	3.39	3.55	3.61	3.64	3.68	3.62	3.75	3.84
Finland . . .	4.18	3.91	3.93	4.03	3.91	4.05	3.80	3.78	3.67	3.69	3.62	..

[a]Countries ranked according to values for 1987.

where ${}_n\Delta SD_x$ is the contribution of mortality differentials within age group $(x, x+n)$ to SDe_0 and n is the length of the age interval. The other symbols have their normal meaning in life-table notation.

The femininity ratio of survivors at age 60 (FRl_{60}) and age 85 (FRl_{85}) is the ratio of female to male survivors in a stationary (life-table) population, after adjusting for the sex ratio at birth. The femininity ratio FRl_x was therefore calculated by

$$FRl_x = \left(\frac{l_x^f}{l_x^m \times SR_0} \right) \times 100 \qquad (6)$$

where l_x is the number of survivors at exact age x among males (m) or females (f) and SR_0 is the sex ratio at birth that has been set to 1.06 (106 male per 100 female newborn).

In order to visualize trends in life expectancy and in sex differentials in life expectancy, linear regressions with time (calendar years) as the independent variable were fitted to the respective data for a number of countries.[6] The slope (the coefficient of the x-variable) of the regression equation can then be interpreted as the average annual change in life expectancy or in sex differentials in life expectancy for the observation period. Most of the countries considered showed a clear linear trend in life expectancy, which made it possible to apply the regression to the rather short period of observation. Some countries, however, either exhibited a reversal in tendency or erratic fluctuations, which resulted in weak or statistically non-significant estimates.

OVERALL TRENDS IN LIFE EXPECTANCY AND IN SEX DIFFERENTIALS IN LIFE EXPECTANCY

For most of the countries considered, the secular trend of increasing life expectancy continued throughout the 1980s (see table 2 and figure I). The highest life expectancy at birth was observed in Japan, with 76.07 years for men and 82.14 years for women in 1990. Countries with the highest levels of life expectancy at the end of the observation period also show high increases in life expectancy during the 1980s. For example, Austrian males gained 3.58 years from 1980 to 1991, and Japanese females gained 3.17 years from 1980 to 1990. France, the then Federal Republic of Germany, Italy and Portugal also exhibited relatively rapid increases in life expectancy. Assuming a continuing linear trend, these countries would gain another year in life expectancy at birth every three to four years. On the other end of the spectrum, Eastern European countries had not only low life expectancy around 1990 but experienced also only minor changes throughout the 1980s. The lowest male life expectancy was observed for Hungary, with 65.18 years in 1990, while Romania had the lowest life expectancy for females, with 73.10 years in 1990. Bulgarian, Hungarian and Romanian males re-

TABLE 2. LIFE EXPECTANCY AT BIRTH AND SEX DIFFERENTIALS

Country[a]	1980		Latest data			Average annual change[b]		Sex differential (females–males)	
	Males	Females	Males	Females	Year	Males	Females	1980	Latest year
Greece	73.07	77.57	74.54	79.65	1989	0.1393	0.2161	4.49	5.11
Ireland	69.88	75.17	71.63	77.18	1989	0.2039	0.2257	5.30	5.55
United Kingdom	70.47	76.61	72.93	78.64	1990	0.2302	0.1862	6.14	5.71
Denmark	71.25	77.24	72.24	78.03	1990	0.0939	0.0677	5.99	5.79
Sweden	72.82	78.88	74.84	80.79	1989	0.1841	0.1712	6.07	5.95
Yugoslavia (former)	67.87	73.31	69.47	75.51	1990	0.1695	0.2049	5.44	6.04
Japan	73.57	78.97	76.07	82.14	1990	0.2555	0.3165	5.40	6.07
New Zealand	69.99	75.72	71.93	78.12	1989	0.1693	0.1886	5.73	6.19
German Democratic Republic	68.75	74.69	70.14	76.40	1989	0.1315	0.1658	5.94	6.26
Netherlands	72.55	79.22	73.90	80.23	1990	0.1319	0.1004	6.68	6.33
Federal Republic of Germany	69.95	76.69	72.90	79.25	1990	0.3063	0.2756	6.74	6.36
Norway	72.39	79.20	73.48	79.91	1990	0.0826	0.0609	6.82	6.43
Australia	71.05	78.28	73.18	79.62	1988	0.2828	0.1736	7.24	6.44
Romania	66.63	71.91	66.57	73.10	1990	(–0.0436)	(0.0476)	5.28	6.53
Italy	70.97	77.46	73.60	80.14	1989	0.2834	0.2871	6.49	6.53
Austria	68.99	76.07	72.57	79.23	1991	0.3681	0.3035	7.08	6.66
Belgium	69.77	76.51	71.93	78.60	1987	..	..	6.74	6.67
Bulgaria	68.43	73.80	68.24	74.92	1990	–0.0361	0.0964	5.37	6.68
Spain	72.42	78.46	73.45	80.17	1988	0.1238	0.2153	6.04	6.72
Canada	71.48	78.79	73.67	80.45	1989	0.2312	0.1764	7.31	6.79
United States of America	70.10	77.60	71.86	78.76	1989	0.1641	0.0974	7.50	6.90
Switzerland	72.32	79.04	74.15	81.30	1991	0.1800	0.2094	6.72	7.15
Portugal	67.54	74.64	69.88	77.42	1991	0.2400	0.2667	7.10	7.54
Finland	69.21	77.89	71.01	78.91	1990	0.1520	0.0896	8.68	7.90
Czechoslovakia (former)	66.79	74.03	67.31	75.51	1990	0.0799	0.1397	7.23	8.20
France	70.74	78.91	73.34	81.55	1990	0.2624	0.2752	8.17	8.21
Hungary	65.55	72.78	65.18	73.82	1990	(0.0084)	0.1174	7.23	8.64
Poland	66.09	74.49	66.15	75.32	1991	(–0.0297)	(0.0553)	8.40	9.17

[a] Countries ranked according to sex differentials in life expectancy at birth for the latest year.

[b] Slope of a linear regression with calendar years as independent variable; slopes statistically not significant are in parentheses.

corded even slightly lower life expectancies at the end of the observation period than they had in 1980. It is noted that Denmark and Norway also showed only small progress in terms of improvements in life expectancy.

It is well known that mortality differentials by sex have widened considerably during this century. In general, sex differentials in life expectancy have increased as mortality has declined. The trend, however, was clear only between the 1930s and the 1970s, while until 1930 and after 1970 both narrowing and widening tendencies had been observed (United Nations, 1988). Sex differentials in life expectancy at birth show considerable variations between countries. For the early 1980s sex differentials in life expectancy at birth ranged from 4.6 to 9.0 years in developed countries (United Nations, 1988). Data in table 2 indicate that this range was similar around 1990, with sex differentials in life expectancy at birth varying from 5.1 to 9.2 years. The lowest sex differentials in life expectancy were observed in Greece, with 5.1 years in 1989, while they were highest in Poland, with 9.2 years in 1990. Twelve out of the 28 countries considered experienced declines in the overall sex differentials in life expectancy, with the largest reductions recorded by Australia, Finland, the United States, the United Kingdom and the then Federal Republic of Germany. The remaining 16 countries showed increasing sex differentials. The highest increases occurred in Hungary, with 1.41 years; Bulgaria, with 1.31 years; and Romania, with 1.24 years.

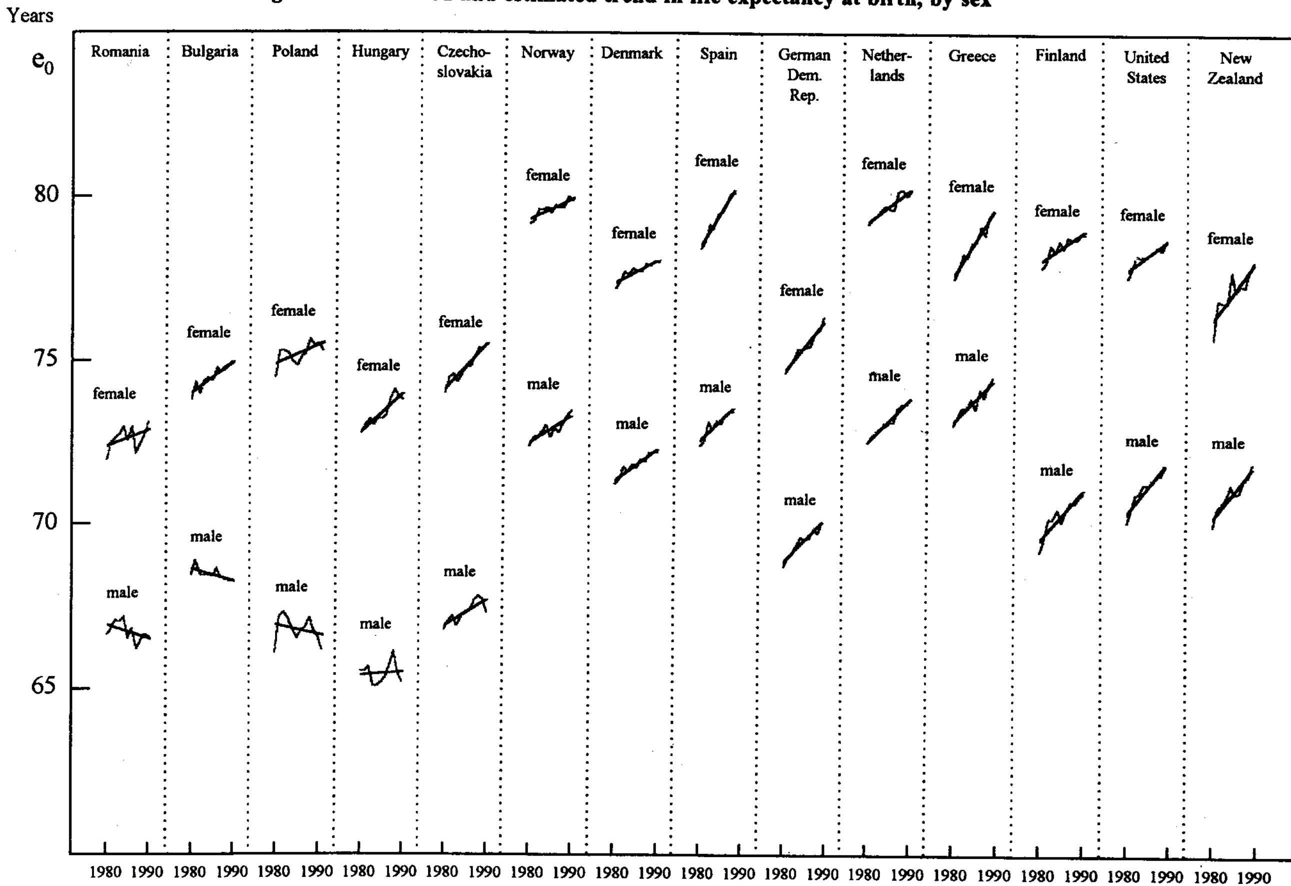
Life expectancy at age 60 over the age range 60-85 varies in a way similar to overall life expectancy (see table 3). Since female $e_{60/85}$ currently ranges from 17.9 to 21.3 years and that for males ranges from 14.2 to 20.3 years, people in developed countries aged 60 expect to live on for a substantial number of years, even if the time beyond age 85 is not considered. For most countries, $e_{60/85}$ increased during the observation period, with the exception of males in Poland and females in Denmark.

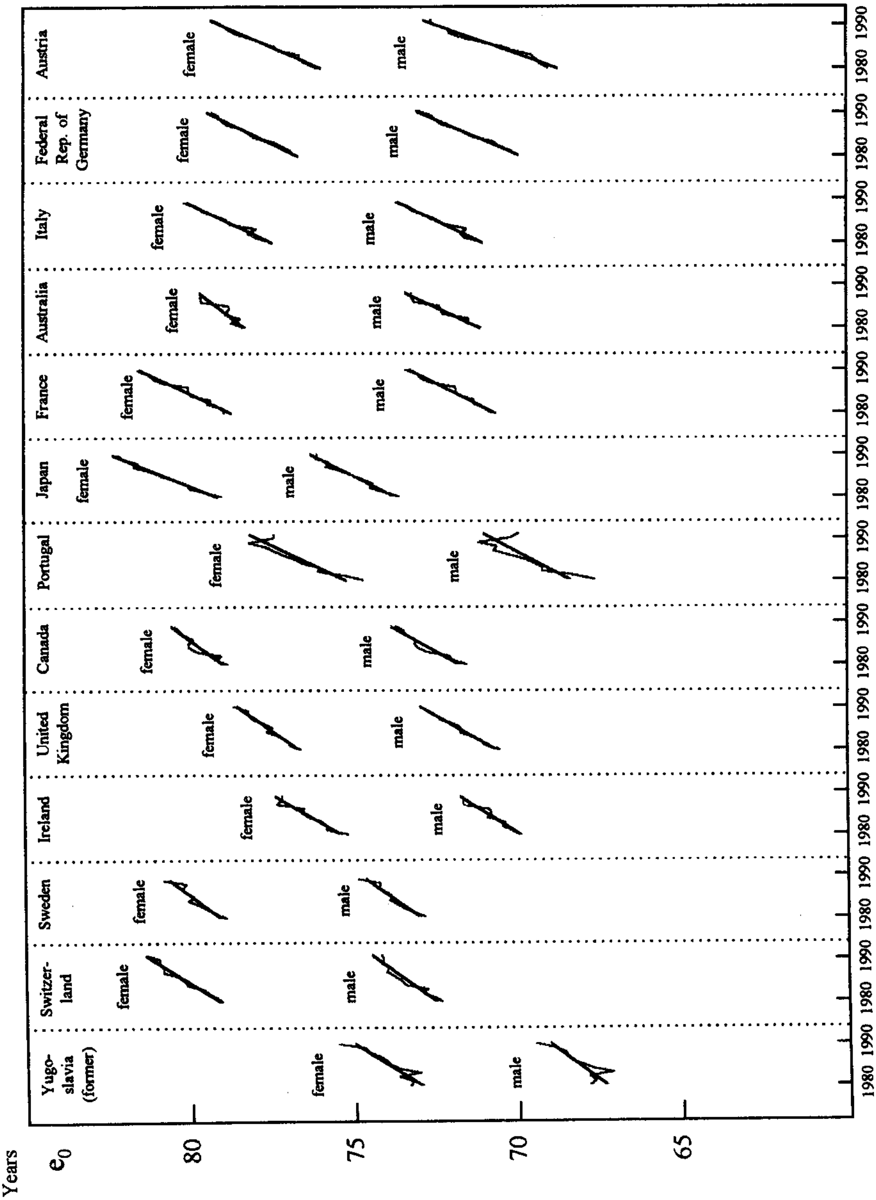
SEX DIFFERENTIALS IN LIFE EXPECTANCY AMONG THE ELDERLY

Table 1 shows sex differentials in life expectancy at age 60 over the age span 60-85 ($SDe_{60/85}$) for 28 developed countries, ranked according to the size of the differentials in 1987.[7] Throughout the 1980s, $SDe_{60/85}$ varied between 2.3 and 4.18 years. Greece, with a $SDe_{60/85}$ of 2.27 years in 1989 and Romania with 2.38 years in 1990 exhibited the smallest sex differentials in $e_{60/85}$. At the other end of the spectrum, Finland had a $SDe_{60/85}$ of 3.62 in 1990, Poland had 3.84 years in 1991, and former Czechoslovakia had 3.86 in 1990.

The absolute differences between female and male $e_{60/85}$ appear to be rather modest in terms of a complete lifetime but make a great difference for the elderly experiencing such differential patterns. The difference of 2.27 years between the $e_{60/85}$ of Greek men and women

Figure I. Observed and estimated trend in life expectancy at birth, by sex





Yugo-slavia (former)
Switzer-land
Sweden
Ireland
United Kingdom
Canada
Portugal
Japan
France
Australia
Italy
Federal Rep. of Germany
Austria
female
male
Years
e_0
80
75
70
65
1980 1990

TABLE 3. LIFE EXPECTANCY AT AGE 60 FOR AGE GROUP 60-85 ($e_{60/85}$)

Country[a]	*1980*		*Latest data*			*Increase/ decrease (–) during the period*	
	Males	*Females*	*Males*	*Females*	*Year*	*Males*	*Females*
Poland . . .	14.75	18.22	14.54	18.38	1991	–0.21	0.15
Czecho-slovakia (former) .	14.21	17.53	14.23	18.09	1990	0.01	0.57
Bulgaria . .	15.37	17.65	15.39	18.16	1990	0.02	0.51
Hungary . .	14.23	17.40	14.25	17.89	1990	0.02	0.49
Yugoslavia (former) . . .	15.61	17.99	15.82	18.53	1990	0.21	0.54
Romania . .	15.31	17.35	15.64	18.02	1990	0.32	0.67
Denmark . .	16.04	19.34	16.45	19.33	1990	0.41	–0.01
Greece . . .	17.46	19.43	17.88	20.15	1989	0.42	0.72
Norway . . .	16.68	19.96	17.12	20.22	1990	0.44	0.26
Spain	17.16	19.94	17.65	20.64	1988	0.49	0.71
Ireland . . .	15.23	17.96	15.79	18.75	1989	0.56	0.79
Netherlands .	16.38	20.05	17.01	20.44	1990	0.63	0.39
German Democratic Republic .	14.94	17.84	15.59	18.49	1989	0.65	0.65
Portugal . . .	15.64	18.54	16.34	19.61	1991	0.70	1.06
Canada . . .	16.60	19.88	17.36	20.37	1989	0.75	0.49
United States of America .	16.28	19.54	17.16	19.81	1989	0.89	0.27
Sweden . . .	16.90	19.91	17.82	20.63	1989	0.93	0.72
Italy	16.26	19.48	17.23	20.44	1989	0.97	0.96
Australia . .	16.16	19.65	17.16	20.15	1988	1.00	0.50
New Zealand	15.58	18.60	16.67	19.53	1989	1.09	0.94
Switzerland .	16.83	20.05	17.92	21.03	1991	1.10	0.98
Belgium . . .	15.37	19.06	16.47	19.92	1987	1.10	0.86
United Kingdom . .	15.41	18.81	16.52	19.36	1990	1.11	0.55
Finland . . .	15.07	19.25	16.22	19.84	1990	1.15	0.59
Japan	17.40	19.98	18.56	21.28	1990	1.16	1.30
Federal Republic of Germany .	15.71	19.10	16.94	20.01	1990	1.24	0.91
France	16.65	20.34	17.89	21.30	1990	1.24	0.96
Austria . . .	15.66	18.85	17.06	20.10	1991	1.41	1.24

[a] Countries ranked according to increase/decrease for male.

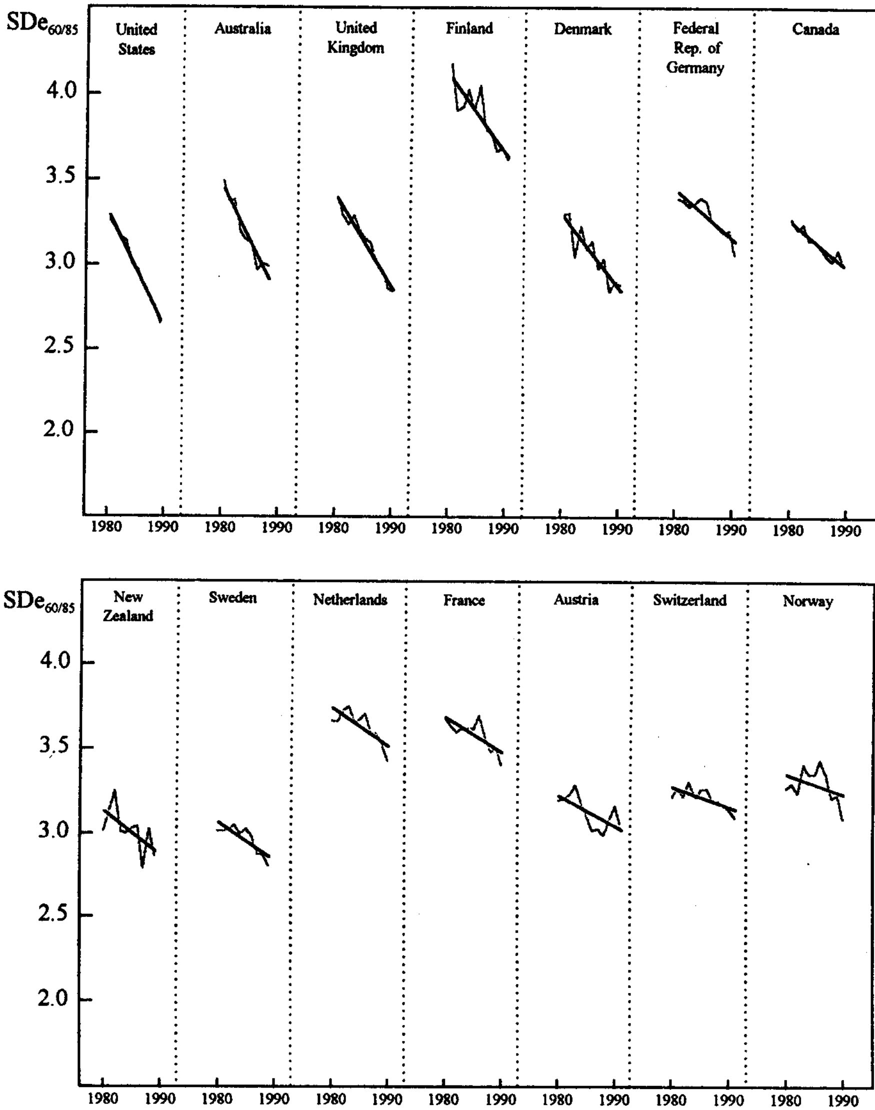
in 1989 implies, for instance, that women at age 60 expect to live 13 per cent longer than men over the same age span 60-85. Other countries show even higher relative advantages for females: 3.84 years for Poland in 1991 translates into a 26 per cent longer survivorship for aged women as compared to men, while for former Czechoslovakia, the equivalent figure is 27 per cent (a 3.86 year difference in 1991).

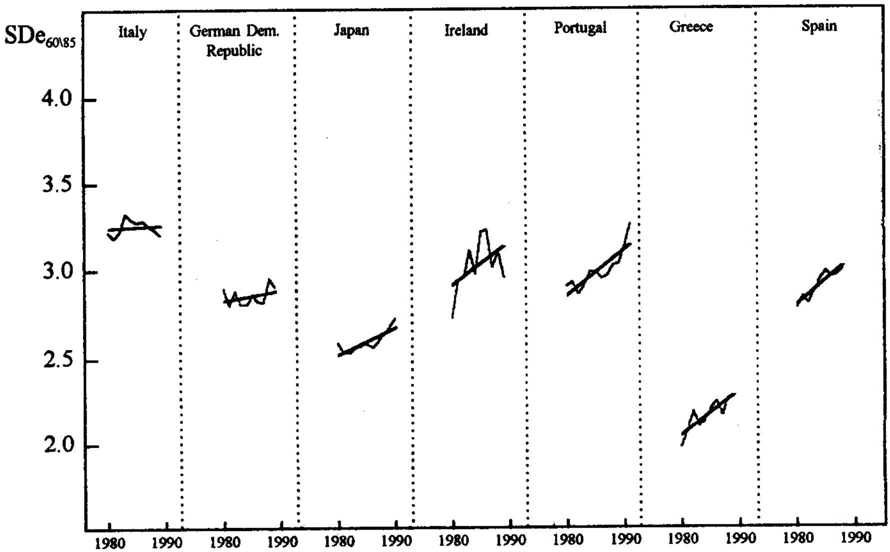
A variety of trends for $SDe_{60/85}$ were discernible at the country level for developed countries (see figure II and table 4). In general, and under conditions of higher female life expectancy, sex differentials in life expectancy will decline if annual changes in life expectancy for males are larger than for females. Thus, the average annual change in $SDe_{60/85}$ is the difference between the corresponding annual changes for males and females. The relationship between trends in male and female life expectancy with respect to trends in sex differentials can be seen in figure III. Countries above the main diagonal had higher annual changes for males—e.g., their sex differentials in $e_{60/85}$ decreased. Countries with increasing $SDe_{60/85}$ are found under the main diagonal. Parallel to the main diagonal are lines which represent the same annual changes, positive (below) or negative (above). It is easy to see that a high or low increase in sex differentials in $e_{60/85}$ can stem from a wide range of different trends for men and women, respectively. The annual change in Denmark's $SDe_{60/85}$ of –0.0436 (a decrease) results, for example, from an almost stagnant female life expectancy within the age group concerned and a rising male $e_{60/85}$. Finland's annual change of –0.0461, though similar in magnitude, is caused by increasing life expectancies for both sexes, though larger for males. The gain in Poland's $SDe_{60/85}$ during the 1980s is associated with an almost stagnant female life expectancy and a declining male life expectancy, while a similar increase in $SDe_{60/85}$ in Hungary has been the result of increasing $e_{60/85}$ for males and females.

Fourteen countries experienced a decline in sex differentials in life expectancy among the elderly, some of them rather marked. The largest declines occurred to the United States, Australia, the United Kingdom, Denmark and Finland, in order of importance, reducing $SDe_{60/85}$ by amounts ranging from 0.61 to 0.42 years during the 1980s. For the remaining 13 countries, however, the difference between female and male $e_{60/85}$ continued to increase. The increase was only minor in Italy, while the data for Ireland suggest even a reversal from increasing to decreasing sex differentials during the period covered, though such reversal is not reflected in the estimated trend. Countries in Eastern and Southern Europe experienced the greatest increases, with $SDe_{60/85}$ increasing by 0.55 years in former Czechoslovakia and 0.49 years in Bulgaria.

According to the estimated linear trend, $SDe_{60/85}$ for the United States declined by –0.069 years per annum. A similar decline was

Figure II. Observed and estimated trends in sex differentials in $e_{60/85}$




SDe60\85
Italy
German Dem. Republic
Japan
Ireland
Portugal
Greece
Spain
4.0
3.5
3.0
2.5
2.0
1980
1990

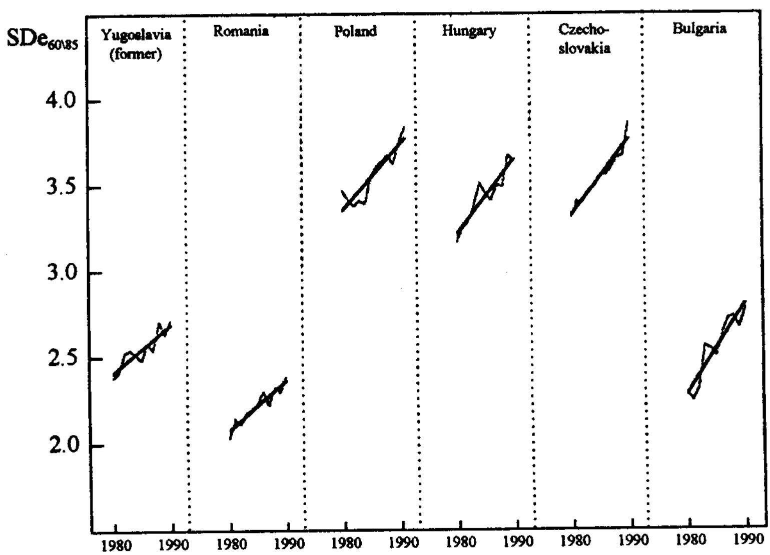
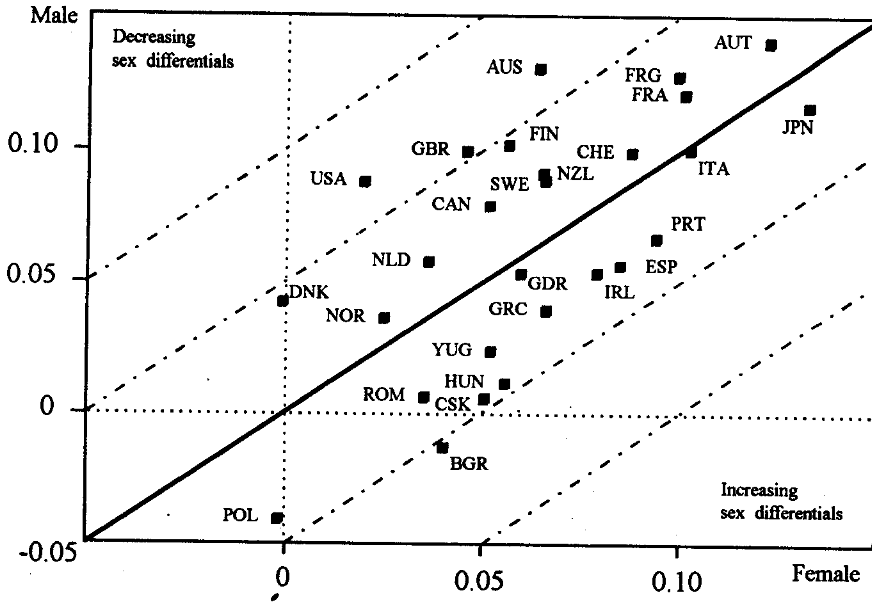

SDe60\85
Yugoslavia (former)
Romania
Poland
Hungary
Czecho-slovakia
Bulgaria
4.0
3.5
3.0
2.5
2.0
1980
1990

Figure III. Annual change in $e_{60/85}$, by sex



Key:

AUS	Austria	GRC	Greece
AUT	Australia	HUN	Hungary
BGR	Bulgaria	IRL	Ireland
CAN	Canada	ITA	Italy
CHE	Switzerland	JPN	Japan
CSK	Czechoslovakia	NLD	Netherlands
DNK	Denmark	NOR	Norway
ESP	Spain	NZL	New Zealand
FIN	Finland	POL	Poland
FRA	France	PRT	Portugal
FRG	Federal Republic of Germany	ROM	Romania
GBR	United Kingdom of Great Britain and Northern Ireland	SWE	Sweden
GDR	German Democratic Republic	USA	United States of America
		YUG	Yugoslavia

TABLE 4. AVERAGE ANNUAL CHANGES[a] IN $e_{60/85}$ AND IN SEX DIFFERENTIALS IN $e_{60/85}$

Country [b]	*Observations (N)*	$e_{60/85}$ *Males*	$e_{60/85}$ *Females*	*Sex differentials in* $e_{60/85}$
United States of America . . .	10	0.0885	0.0198	–0.0687
Australia	9	0.1309	0.0641	–0.0668
United Kingdom	11	0.1003	0.0459	–0.0544
Finland	11	0.1026	0.0565	–0.0461
Denmark	11	0.0429	–0.0007	–0.0436
Federal Republic of Germany .	11	0.1284	0.0994	–0.0290
Canada	10	0.0795	0.0517	–0.0277
New Zealand	10	0.0918	0.0653	(–0.0265)
Sweden	10	0.0890	0.0660	–0.0230
Netherlands	11	0.0585	0.0364	–0.0221
France	11	0.1215	0.1011	–0.0204
Austria	12	0.1407	0.1222	–0.0185
Switzerland	12	0.0999	0.0877	–0.0122
Norway	11	0.0369	(0.0252)	(–0.0117)
Italy	10	0.1009	0.1025	(0.0016)
German Democratic Republic .	10	0.0542	0.0599	(0.0056)
Japan	11	0.1171	0.1324	0.0154
Ireland	10	0.0544	0.0791	(0.0247)
Portugal	12	(0.0677)	0.0941	0.0264
Greece	10	0.0399	0.0663	0.0264
Spain	9	0.0573	0.0850	0.0277
Yugoslavia (former)	11	(0.0243)	0.0524	0.0281
Romania	11	(0.0067)	(0.0356)	0.0288
Poland	12	–0.0397	(–0.0016)	0.0381
Hungary	11	(0.0119)	0.0559	0.0440
Czechoslovakia (former) . . .	11	(0.0062)	0.0508	0.0446
Bulgaria	11	(–0.0124)	0.0404	0.0527

[a] Slope of a linear regression with calendar years as independent variable; slopes statistically not significant are in parentheses.
[b] Countries ranked according to average annual change in sex differentials.

recorded for Australia (–0.067), while the decline in sex differentials for the United Kingdom (–0.054 years per annum) and Finland (–0.046 years per annum) was slower. In contrast, Bulgaria experienced an annual increase of 0.053 years in the $SDe_{60/85}$; former Czechoslovakia, 0.045 years; Hungary, 0.044 years; and Poland, 0.038 years. These changes are, however, rather modest when compared with the current magnitude of differentials. If one assumes, for example, a continuation of the estimated trends, it would take the United States about 40 years to achieve equal $e_{60/85}$ for men and women and Australia about 43 years. On the other hand, the continuation of the increasing trend in $SDe_{60/85}$ in Bulgaria would translate into a sex differential of about 3.60 years in 2005, the level exhibited by Finland in 1990.

Sex differentials in life expectancy for the elderly are compared below to sex differentials in life expectancy at birth (SDe_0), so as to assess the relative weight of old-age sex differentials in overall sex differentials in mortality. Sex differentials in mortality between ages 60 and 85 are contributing significantly to sex differentials in life expectancy at birth. Table 5 shows the contribution of that age group to total differentials in e_0 (in years), and relative contributions as percentages are shown in table 6. Mortality differentials between men and women aged 60-85 contributed, for the most recent years, from 2.2 years in Romania to 4.2 years in the Netherlands to SDe_0. In terms of percentages, the range of such contributions is also wide, varying from one third in Romania to two thirds in the Netherlands. For 19 out of the 31 countries considered, the elderly's contribution to sex differentials in life expectancy at birth was 50 per cent or more. In general, the elderly made smaller relative and absolute contributions to SDe_0 in Eastern European countries than in other countries. During the observation period, most of the countries experienced only minor changes in their $\Delta SDe_{60/85}$.

Mortality differentials at older ages have an important impact on the age and sex composition of the elderly, as illustrated by comparing the femininity ratios of survivors at age 60 (FRl_{60}) and age 85 (FRl_{85}), respectively (see table 7). Femininity ratios indicate the proportion of female-to-male survivors in a stationary population (see equation 6). Since this measure is derived from a life-table, it reflects only the impact that mortality alone may have on the sex ratio of different age groups. Other factors affecting the sex ratio, such as migration or fertility, are not considered. The FRl_{60} for those surviving to age 60 range from 100 to 120 women per 100 men. This is equivalent to a proportion of 50-55 per cent female among surviving persons of both sexes. Twenty-one countries out of the 28 considered had femininity ratios equal to or lower than 106. Finland, Portugal, Bulgaria, Romania, former Czechoslovakia, Poland and Hungary, in ascending order, had higher femininity ratios. Thus, higher male mortality before age 60 compensates for the favourable sex ratios at birth for males in most of the countries considered.

In contrast, femininity ratios at age 85 are much greater, varying between 142 and 249 women per 100 men, with proportions of women among all survivors to age 85 ranging from 59 to 71 per cent. For seven countries, the expected number of women surviving to age 85 is more than twice that of men. Eastern European countries displayed especially high femininity ratios. Greece, Romania, and Japan displayed the lowest femininity ratios.

Discussion

This article examines levels and trends of sex differentials in life expectancy at older ages for 29 developed countries. Significant sex differentials in life expectancy among the elderly have been found, but no common trend among countries. Sex differentials in life expectancy for the elderly continued to widen for less than half of the countries studied, while most of them experienced a declining trend in sex differentials in $e_{60/85}$. Due to the existing sex differentials in mortality among the elderly, their sex ratio is expected to change dramatically as they age. According to hypothetical life-table populations, differential mortality would change an almost balanced sex composition at age 60 into a population with femininity ratios ranging from 140 to almost 250 women per 100 men.

For developed countries the secular trend of increasing life expectancy has led to a compression of mortality and morbidity at older ages (Fries, 1980). Around 1980, over two thirds of all male deaths and about 80 per cent of female deaths occurred beyond age 65 (Myers, 1989). The concentration of mortality at older ages and of sex differentials in mortality, in particular, though one of the major challenges to health care systems, must be considered a major achievement: for advanced Western societies, mortality during the first 50 years of life is not only low but shows only moderate differentials by sex.

Eastern European countries show, for most of the measures employed, a picture different from that for the advanced Western societies. Among all the countries considered, they have the lowest $e_{60/85}$ for both men and women, and the contributions of age group 60-85 to sex differentials in mortality at birth are the lowest. Though sex differentials in life expectancy at birth are high among Eastern European countries, they are rather small at older ages. A number of studies have found that excess mortality for male adults is one of the major factors explaining the differences between Eastern European and Western countries (see for instance, Chruscz, Pamuk, Lentzner, 1992; Compton, 1985; Holzer and Mijakowska, 1983; Meslé, 1991; Willekens, Scherbov, 1992). Relatively large sex differentials in mortality at younger ages result, therefore, in the observed smaller contributions of sex differentials in mortality among the elderly. Delayed impacts of the Second World have also been discussed as potential factors explaining excess male mortality, especially at older ages (Dinkel, 1985).

Three main hypotheses have been put forward to explain persistent sex differentials in life expectancy, assuming biomedical (genetic), behavioural (lifestyle), or environmental factors to be the main cause of those differentials (see Nathanson, 1984; Nathanson and Lopez, 1987; Verbrugge, 1985; Waldron, 1986 and 1992). However, no single factor can explain the sex differentials in mortality for every age group,

TABLE 5. CONTRIBUTION OF AGE GROUP 60-85 TO SEX DIFFERENTIALS IN LIFE EXPECTANCY AT BIRTH, IN YEARS

Country[a]	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*
Romania	1.80	1.96	1.94	1.99	2.02	2.02	2.08	1.97	2.09	2.08	2.17	..
Yugoslavia (former)	2.26	2.26	2.45	2.39	2.39	2.42	2.49	2.47	2.65	2.59	2.71	..
Greece	2.15	2.28	2.45	2.34	2.42	2.53	2.59	2.48	2.65	2.64	..	..
Bulgaria	2.15	2.17	2.21	2.45	2.46	2.36	2.49	2.60	2.60	2.54	2.64	..
German Democratic Republic	2.82	2.76	2.84	2.81	2.81	2.85	2.81	2.85	2.99	2.98	..	..
Portugal	2.79	2.90	2.94	2.96	3.10	3.12	3.10	3.16	3.25	3.32	3.29	3.41
Hungary	2.85	2.94	2.98	3.01	3.14	3.08	3.05	3.19	3.22	3.31	3.24	..
New Zealand	3.27	3.48	3.62	3.36	3.51	3.47	3.45	3.23	3.51	3.39	..	..
Austria	3.22	3.27	3.31	3.36	3.36	3.27	3.24	3.29	3.30	3.43	3.53	3.44
Japan	3.01	3.01	3.06	3.10	3.15	3.23	3.22	3.34	3.37	3.49	3.56	..
Ireland	2.76	3.06	3.07	3.20	3.16	3.42	3.44	3.34	3.42	3.25	..	..
United States of America	3.70	3.70	3.72	3.70	3.55	3.50	3.42	3.37	3.28	3.20	..	..
Czechoslovakia (former)	3.08	3.20	3.23	3.24	3.29	3.36	3.36	3.44	3.53	3.52	3.70	..
Poland	3.24	3.35	3.32	3.32	3.24	3.36	3.45	3.50	3.59	3.49	3.60	3.60
Spain	3.11	3.18	3.21	3.26	3.38	3.42	3.41	3.50	3.51	..	..	..
Denmark	3.66	3.69	3.48	3.63	3.58	3.60	3.46	3.51	3.37	3.43	3.41	..
United Kingdom	3.70	3.61	3.58	3.67	3.66	3.58	3.60	3.54	3.52	3.39	3.44	..
Sweden	3.46	3.51	3.58	3.65	3.64	3.65	3.63	3.55	3.52	3.54	..	..
Australia	3.99	3.92	3.89	3.78	3.68	3.65	3.63	3.65	3.65	..	..	..
Federal Republic of Germany	3.55	3.56	3.57	3.60	3.72	3.71	3.64	3.66	3.66	3.67	3.57	..
Italy	3.42	3.45	3.55	3.58	3.70	3.69	3.74	3.78	3.79	3.81	..	..
Canada	3.87	3.86	3.85	3.90	3.93	3.89	3.80	3.82	3.90	3.83	..	..
Belgium	3.81	3.79	3.78	3.68	3.93	..	3.79	3.90	..	..	..	..

Switzerland	3.69	3.74	3.70	3.83	3.83	3.91	3.93	3.95	3.95	3.92	3.91	3.90
Norway	3.73	3.78	3.83	3.97	3.96	3.94	4.06	3.95	3.83	3.90	3.72	..
Finland	4.31	4.08	4.21	4.30	4.22	4.28	4.12	4.11	3.99	3.99	3.96	..
France	4.08	4.04	4.08	4.07	4.16	4.16	4.23	4.27	4.21	4.26	4.17	..
Netherlands	4.26	4.31	4.37	4.46	4.37	4.36	4.39	4.40	4.37	4.30	4.22	..

[a]Countries ranked according to values for 1987.

TABLE 6. PERCENTAGE CONTRIBUTION OF AGE GROUP 60-85 TO SEX DIFFERENTIAL IN LIFE EXPECTANCY AT BIRTH

Country[a]	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*
Romania	34.1	34.7	35.2	35.0	35.2	33.8	34.1	33.3	35.1	34.2	33.3	..
Hungary	39.5	39.2	39.3	38.0	38.5	38.3	38.3	39.2	40.4	39.5	37.6	..
Bulgaria	40.1	39.9	40.0	41.4	40.8	39.5	40.6	41.4	40.5	38.6	39.6	..
Poland	38.6	41.2	41.7	40.9	39.8	40.4	41.2	41.7	42.2	40.1	40.0	39.3
Yugoslavia (former)	41.5	40.4	42.3	40.6	40.5	41.4	43.9	43.0	44.1	44.8	44.9	..
Czechoslovakia (former)	42.6	43.2	43.9	43.6	44.0	44.9	45.1	46.0	46.5	45.8	45.1	..
Portugal	39.2	41.2	42.3	43.3	43.9	44.3	45.0	46.6	45.6	47.0	45.6	45.2
German Democratic Republic	47.5	46.9	47.5	46.9	48.7	48.4	47.7	46.9	48.0	47.6	..	..
United States of America	49.3	50.0	50.6	51.4	50.5	49.6	48.2	48.2	47.5	46.4	..	..
Austria	45.5	45.8	45.5	47.5	46.6	47.0	48.0	49.9	50.1	51.0	54.2	51.7
Greece	47.8	50.3	52.1	50.0	50.8	49.2	51.8	50.0	51.2	51.7	..	..
Finland	49.7	48.0	50.5	52.8	51.4	51.3	49.6	51.2	49.6	49.8	50.1	..
France	50.0	50.2	50.0	50.4	50.9	50.8	51.6	51.8	51.5	51.7	50.7	..
Spain	51.5	52.1	52.9	53.3	53.5	52.8	53.3	52.3	52.3	..	..	..
New Zealand	57.1	55.0	58.7	56.8	54.0	56.1	54.5	54.7	56.0	54.8	..	..
Canada	52.9	53.3	55.4	55.3	56.4	56.0	55.9	56.0	57.0	56.4	..	..
Federal Republic of Germany	52.6	53.4	53.7	54.1	56.1	56.7	55.9	56.1	56.0	56.6	56.2	..
Australia	55.1	54.6	55.5	56.6	56.6	56.8	55.9	56.4	56.6	..	..	..
Japan	55.7	55.4	55.6	54.7	55.0	55.9	55.9	56.9	57.9	59.0	58.6	..
Norway	54.7	57.1	55.0	58.4	59.5	57.4	59.5	57.5	58.2	58.0	57.9	..
Switzerland	55.0	56.0	56.4	55.7	57.6	58.9	59.3	57.9	57.5	57.7	57.1	54.6
Denmark	61.0	60.8	58.4	60.2	59.7	60.0	60.4	58.0	59.0	58.8	58.9	..
Italy	52.7	53.8	54.2	55.4	56.1	56.7	57.8	58.3	58.3	58.4	..	..

Belgium	56.5	55.5	56.6	56.5	57.8	..	57.4	58.4	..	..	..	..
Ireland	52.1	54.2	56.4	56.8	57.2	59.0	60.5	58.5	61.3	58.5	..	..
Sweden	57.0	57.7	59.6	60.3	59.2	60.5	59.7	59.0	59.5	59.6	..	..
United Kingdom	60.2	60.1	60.4	61.6	61.7	61.8	61.2	61.3	60.9	61.2	60.2	..
Netherlands	63.8	64.7	65.4	67.5	65.0	66.7	67.5	66.2	66.6	67.5	66.6	..

[a]Ranked according to values for 1987.

TABLE 7. FEMININITY RATIOS[a] AT EXACT AGE 60 AND 85, STATIONARY POPULATION, 1980 AND LATEST YEAR AVAILABLE

Country[b]	Latest year	Exact age 60		Exact age 85	
		1980	Latest year	1980	Latest year
Greece	1989	101	102	136	142
Romania	1990	107	111	153	165
Japan	1990	101	100	169	165
Spain	1988	103	104	168	171
Yugoslavia (former)	1990	106	107	168	172
Sweden	1989	102	100	184	172
United States of America	1989	106	104	197	174
Austria	1991	107	104	207	178
Canada	1989	104	101	193	180
Bulgaria	1990	106	110	161	180
Italy	1989	105	102	186	181
Australia	1988	104	101	209	181
Switzerland	1991	103	102	189	182
New Zealand	1989	101	101	212	183
Norway	1990	104	102	186	185
France	1990	107	105	210	185
United Kingdom	1990	102	100	223	186
Denmark	1990	102	101	196	190
Federal Republic of Germany	1990	105	102	210	191
German Democratic Republic	1989	105	106	205	197
Portugal	1991	109	107	197	198
Belgium	1987	104	103	213	200
Netherlands	1990	102	100	201	200
Ireland	1989	103	101	195	200
Finland	1990	110	107	247	207
Hungary	1990	112	118	230	243
Poland	1991	114	117	238	247
Czechoslovakia (former)	1990	111	113	237	249

[a] Women per 100 men.
[b] Countries ranked according to femininity rates for exact age 85, latest year.

every country and all historical periods. Rather, a combination of them, with behavioural and environmental factors being subject to changes in weight and influence during the course of time, is necessary to explain observed trends. With many of the sex differentials in mortality occurring at older ages, this stage of life requires specific attention for future investigations of the causes and consequences of sex differentials.

Causes of sex differentials in old-age mortality are not easy to establish or study because behavioural and environmental factors experienced during a whole lifetime have to be considered, not just those of old age. Elo and Preston, reviewing the effects of early-life conditions on mortality at later stages of life, have found strong linkages between them (1992). Although they did not study sex differentials in particular, one may hypothesize that the causal mechanisms that link childhood conditions to mortality at older ages also contribute to sex differentials in mortality among the elderly. This is, at least partly, supported by findings that excess male mortality among adults and the elderly is linked to epidemics or catastrophic events (Anderson and Silver, 1986 and 1989; Caselli and Capocaccia, 1989; Dinkel, 1985; Horiuchi, 1983; Wilmoth, Vallin, Caselli, 1990).

Studies of sex differentials in mortality among the elderly have to consider that the transition to lower mortality is still in progress and that the people who are now elderly experienced much higher mortality levels in their early years than did the generations born after them. This may be illustrated by following Japanese and Belgian data in table 8: 81 per cent of Belgian males and 86 per cent of Japanese males would survive to age 60 under mortality conditions as of 1980, while the equivalent proportions for females are even higher (89 per cent and 92 per cent, respectively). In contrast, cohort data show that actually only 65 per cent of Belgian men born in 1920 survived to age 60 in 1980, and only 31 per cent of Japanese men from the same cohort experienced their sixtieth birthday (Veys, 1983; Nanjo and Kobayashi, 1985). Thus, almost three times more people would have survived to

TABLE 8. SURVIVORS AND FEMININITY RATIOS IN JAPAN AND BELGIUM FOR EXACT AGE 60 AND 85, COHORT AND PERIOD LIFE-TABLES

Country	Cohort	*Cohort life-tables* Survivors (lx) Males	Survivors (lx) Females	Femininity ratio (FRlx)	*Period life-tables, 1980* Survivors (lx) Males	Survivors (lx) Females	Femininity ratio (FRlx)
		Exact age 60					
Japan	1920	30 532	34 236	106	85 968	92 190	101
Belgium . .	1920	64 558	74 296	109	80 794	89 423	104
		Exact age 85					
Japan	1895	823	2 259	259	20 525	36 798	169
Belgium . .	1895	7 147	15 843	209	13 247	29 840	213

[a] *Sources*: D. Veys, *Cohort Survival in Belgium in the Past 150 Years: Data and Life Table Results*, SOI Series, vol. 15 (Louvain, Belgium, Catholic University of Louvain, Sociological Research Institute, 1983); Z. Nanjo and K. Kobayashi, *Cohort Life Tables Based on Annual Life Tables for Japanese Nationals Covering the Years 1891-1982*, NUPRI Research Paper Series, No. 23 (Tokyo, Nihon University, Population Research Institute, 1985).

the age of 60 from the 1920 cohort had they experienced current mortality levels. Large discrepancies between period and cohort survivorship are also apparent for those surviving to very old age—that is, to age 85. Whereas current mortality levels suggest that about 13 per cent of Belgian or 21 per cent of Japanese males would reach their eighty-fifth birthday, about 7 per cent of Belgian and less than 1 per cent of Japanese males actually survived to that age, according to cohort life-tables. The discrepancy between period and cohort measure is especially striking for Japanese men, with a ratio of 25:1 between period and cohort survivorship. It should also be noted that the femininity ratio for the two countries was larger for cohort than for period life-tables (except for the very old Belgian cohort).

The reduction of mortality differentials and variations seems to be a promising way to reduce overall mortality—that is, to concentrate on those groups that contribute disproportionally to the national mortality level. Many countries have implemented national health strategies in accordance with the global WHO strategy, Health for All by the Year 2000, with national targets translated into regional and even local targets. From the data analysed in this article, it seems to be necessary to include goals for mortality among the elderly and differentials in mortality, in particular, in strategies aiming at reducing overall mortality and narrowing inequalities between social groups.

NOTES

[1]World Health Organization, "Targets for health for all: targets in support of the European regional strategy for health for all" (Copenhagen, WHO Regional Office for Europe, 1985), p. 103.

[2]With respect to selected major causes of death, targets seven (infant mortality), eight (maternal mortality), nine (mortality from diseases of the circulatory system in people under 65) and 10 (mortality from cancer in people under 65) do not include old-age mortality. For targets 11 (accidents) and 12 (suicides), old-age mortality is covered only implicitly by inclusion of the old-age segment of the population.

[3]World Health Organization, Division of Epidemiological Surveillance and Health Situation and Trend Assessment, as of November 1992. For more details on data specifications, see *World Health Statistics Annual, 1991* (Geneva, World Health Organization, 1992).

[4]For evidence of systematic age misreporting in developed countries with low mortality, see G. A. Condran, C. L. Himes and S. H. Preston, "Old-age mortality patterns in low-mortality countries: an evaluation of population and death data at advanced ages, 1950 to the present", *Population Bulletin of the United Nations* (New York), No. 30 (1991), Sales No. E.91.XIII.2, pp. 23-60. According to their study, age misreporting begins to weaken data quality significantly after age 80-85.

[5]National population estimates are used for calculating the central death rates in the WHO database. For developed countries, vital registration and population estimation procedures appear fairly accurate; problems arise, however, regarding migration. Countries without a registration system for international migration

(Hungary, for example) will systematically overestimate or underestimate their population between censuses.

[6]Belgium was excluded because of incomplete data.

[7]The year 1987 was the last one for which data for all countries were available.

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EXCESS FEMALE CHILD MORTALITY IN THE DEVELOPING WORLD DURING THE 1970s AND 1980s*

*Dominique Tabutin*** and Michel Willems****

SUMMARY

In general, a decline in mortality is accompanied by changes in the differentials by sex, from a situation in which, depending on age, there is an excess in the mortality rate among males or among females to a situation in which females are at an advantage at every age. The pace of change, however, varies by age and the social context. Thus, in a very large part of the developing world, there is still an excess mortality rate among women at certain ages, particularly among girls aged 1-4 years.

How did this excess female child mortality evolve from the 1970s to the 1980s, during a period when mortality declined significantly? Is there a relationship between the intensity of the phenomenon and levels of mortality or certain social development indicators? These are some of the questions which the article discusses on the basis of reliable and comparable data taken from approximately 60 countries.

It appears that the problem is present in all regions and in a large majority of countries: after the first year of life, the risks of mortality for girls are greater than those for boys. Moreover, when detailed data are available, it can be shown that this excess mortality appears as early as the first months of life, while the child is still totally dependent on the mother. From the 1970s to the 1980s excess female child mortality declined only slightly.

For the 1970s and 1980s, no relationship between the intensity of the phenomenon and levels of mortality is observed. There is undoubtedly a general trend (on the average, the phenomenon is less frequent

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and less significant in countries with low mortality), but the disappearance of excess female child mortality occurs only at very low levels of mortality.

Furthermore, the problem does not appear to be linked to the level of social and educational development attained by countries and regions. There is no very significant statistical relationship between sex differentials in child mortality and various socio-economic development indicators, with the exception, perhaps, of education.

INTRODUCTION

Worldwide and throughout history, declines in mortality have been accompanied by changes in the differentials by sex. The situation has gradually evolved from a diverse one in which, depending on age, mortality rates could be higher among men or among women, which led to small differences in the life expectancy at birth between the sexes, to one in which women are at an advantage at every age. However, as has been shown in the case of Europe (Tabutin, 1978) or, more recently, Northern Africa (Tabutin, 1992), the pace of change varies by age and social context.

The phenomenon of excess female mortality at certain ages is clearly present—or has been present—in a very large part of the developing world. Figure I shows age-specific sex ratios of mortality at different levels of life expectancy at birth, based on the general and the Southern Asian patterns of the United Nations model life-tables for developing countries (United Nations, 1982).[1] Two points emerge from figure I: first, excess female mortality is more severe and covers broader age groups when life expectancy is low; and secondly, there is one age group which is more resistant than others to change—age group 1-4.[2]

How did sex differentials in child mortality evolve in the developing world during the 1970s and 1980s, a period when there were significant mortality declines everywhere? Are there region-specific patterns and trends? Is there a relationship between the severity of excess female child mortality and the levels of mortality, or between excess female child mortality and certain social development indicators? These are some of the questions which will be considered here.

SCOPE OF THE STUDY AND DATA

The study will focus on sex-specific mortality rates among children under age 5, distinguishing mainly between those under age 1 and those aged 1-5, but also between smaller age groups (neonatal, post-neonatal, age 1 and age group 2-4). The ratio of male-to-female mortality will be used as an indicator of higher or lower mortality among girls, compared with boys.

Figure I. Age-specific ratios of mortality

General pattern

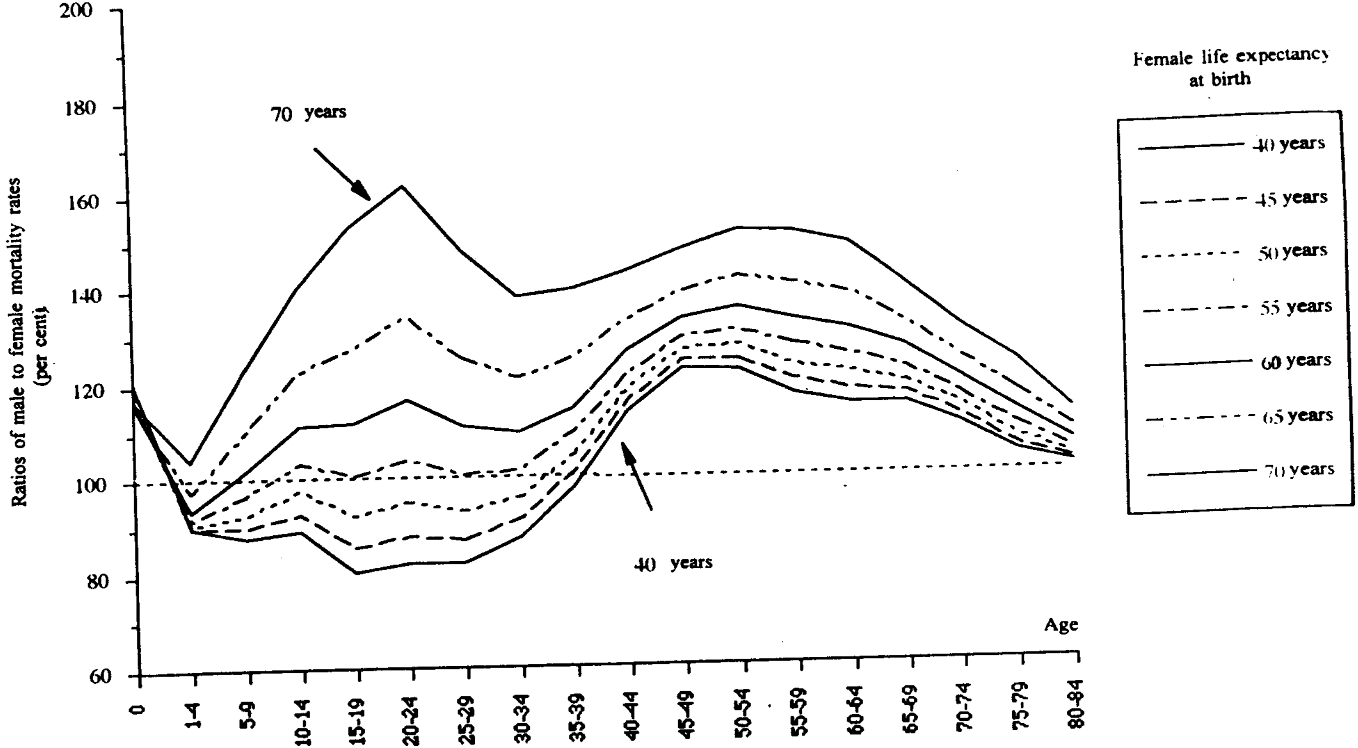
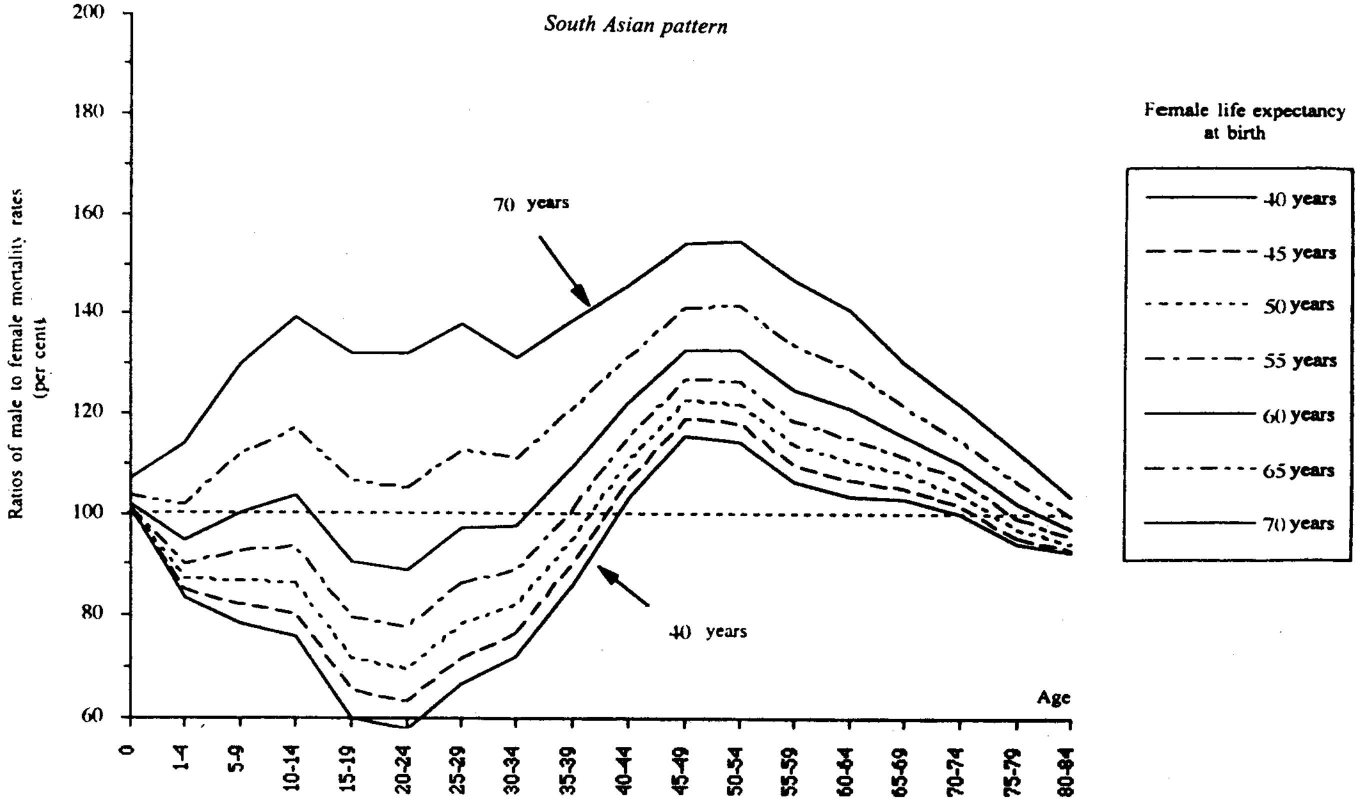


Figure I (*continued*)

South Asian pattern



To measure patterns and trends, a comparison will be made between two periods: 1970-1979 and 1980-1989. The study focuses on the national level only, distinguishing between four major regions (sub-Saharan Africa, Latin America, Eastern and Southern Asia, Northern Africa and Western Asia) and also China.

As far as possible, comparable and reliable data have been selected. For the 1970s, the data are mainly from the World Fertility Survey (WFS) and for the 1980s, from the Demographic Health Surveys (DHS) (see annex table A.1). Other reliable survey and civil registration data have also been included. Indirect estimates or other estimates based on models have not been used. In total, sex/age-specific mortality data have been gathered for 62 countries—46 countries for the 1970s and 44 countries for the 1980s. Annex table A.2 shows, by country, sources of data as well as the sex/age-specific mortality rates.

Before proceeding, a few words need to be said about possible problems with respect to data quality. In general, the WFS and DHS surveys have been of good quality, although the quality can differ among countries. However, it is also clear that the surveys can underestimate—and have frequently underestimated—mortality levels, particularly in the more distant past, before the surveys. In order to limit problems with underreporting, only recent mortality estimates—those referring to 10 years preceding the surveys—will be dealt with here. Since the purpose is to study ratios of male-to-female mortality, it has been assumed that any omissions or age misreporting affect boys and girls equally.

SEX DIFFERENTIALS IN MORTALITY AMONG CHILDREN UNDER AGE 5

First of all, what were the sex differentials in mortality for children under age 1, for those aged 1-5 and for age group 0-4 in the developing world and the various regions during the 1970s and 1980s?

Whether the median or the average of ratios of male-to-female mortality rates is considered (table 1), the results are virtually the same:

TABLE 1. AVERAGE AND MEDIAN RATIOS OF MALE-TO-FEMALE MORTALITY RATES (PERCENTAGE), BY AGE AND PERIOD

	$_{1}q_{0}$		$_{4}q_{1}$		$_{5}q_{0}$	
Ratios	*1970s*	*1980s*	*1970s*	*1980s*	*1970s*	*1980s*
Average	114	120	96	97	107	112
Median	115	117	95	95	108	110
Range	85-137	86-160	67-135	83-115	86-129	86-144
Number of countries	46	44	46	44	46	44

Source: Annex table A.2.

for all countries together, there is, on the one hand, a significant excess mortality among male infants, which increased slightly from the 1970s to the 1980s and, on the other, excess mortality among girls aged 1-4, which has barely changed. The result is a higher mortality among males in the 0-4 age group as a whole, which has increased slightly.

The averages (or medians) conceal a certain heterogeneity at the regional level and a great diversity at the national level. Excess mortality among girls aged 1-5 occurs in all regions in the 1980s (table 2). Table 2 also shows that in all regions, on average, boys had higher mortality during the first year of life. The excess male infant mortality was as high as 37 per cent in Eastern and Southern Asia in the 1980s, 19 and 23 per cent in sub-Saharan Africa and Latin America, respectively—a slight increase since the 1970s—and only 3 per cent in Northern Africa and Western Asia. There is no relationship between the level of excess male infant mortality and the levels and trends of infant mortality.

At the national level, the diversity increases significantly: the ratios of male-to-female infant mortality (table 1) range from 85 to 137 in the 1970s (46 countries) and from 86 to 160 in the 1980s (44 countries).

TABLE 2. RATIOS OF MALE-TO-FEMALE MORTALITY RATES (PERCENTAGE) AND LEVELS OF FEMALE MORTALITY (PER 1,000), BY AGE AND PERIOD

	$_1q_0$		$_4q_1$		$_5q_0$	
Region	*1970s*	*1980s*	*1970s*	*1980s*	*1970s*	*1980s*
Sub-Saharan Africa						
Ratio	116	119	101	98	110	109
Rate	94	78	84	75	170	147
Latin America						
Ratio	120	123	100	99	113	116
Rate	66	42	33	19	96	60
Eastern and Southern Asia						
Ratio	114	137	92	88	106	123
Rate	87	53	64	25	145	76
Northern Africa and Western Asia[a]						
Ratio	102	103	87	95	96	100
Rate	109	66	70	25	170	88
Total						
Ratio	114	120	96	97	107	112
Rate	86	62	59	45	141	104

[a]Excluding Kuwait, which has a very low mortality rate.
Source: Annex table A.2.

Five countries in the 1970s and three in the 1980s showed an excess female infant mortality.

Trends in the sex ratios of infant mortality between the 1970s and 1980s can be examined for 26 countries with two sets of comparable data (see figure II). In two countries, Jordan and Trinidad and Tobago, the data show excess female infant mortality in the 1980s. In nine countries, there was a slight decrease in the sex ratios of infant mortality between the two periods,[3] while in the majority of countries, the sex ratios increased significantly.

In total, for the first five years of life, there is a slight excess mortality among boys (table 2): in 45 countries the excess increased from an average of 7-12 per cent between the 1970s and 1980s, a period when mortality declined approximately 26 per cent. The increase occurred solely in the first year of life. There is still excess mortality among girls aged 1-5, which has barely changed, despite a decline of 25 per cent in the mortality rates for this age group.

EXCESS MORTALITY AMONG GIRLS AGED 1-5

Once again, whether the average or the median of ratios of male-to-female mortality is considered, the results remain much the same: after the first year of life, the risks of mortality are higher for girls than for boys in the four regions. The medians almost always accentuate the phenomenon (table 3).

With regard to the medians only, the situation changes from a heterogeneous one in the 1970s (excess female child mortality ranged from 2 to 15 per cent, depending on the region) to a relatively homogeneous one in the 1980s (excess female child mortality between 4 and 6 per cent), without any change in the overall median level. The phenomenon became less severe in Eastern and Southern Asia and in Northern

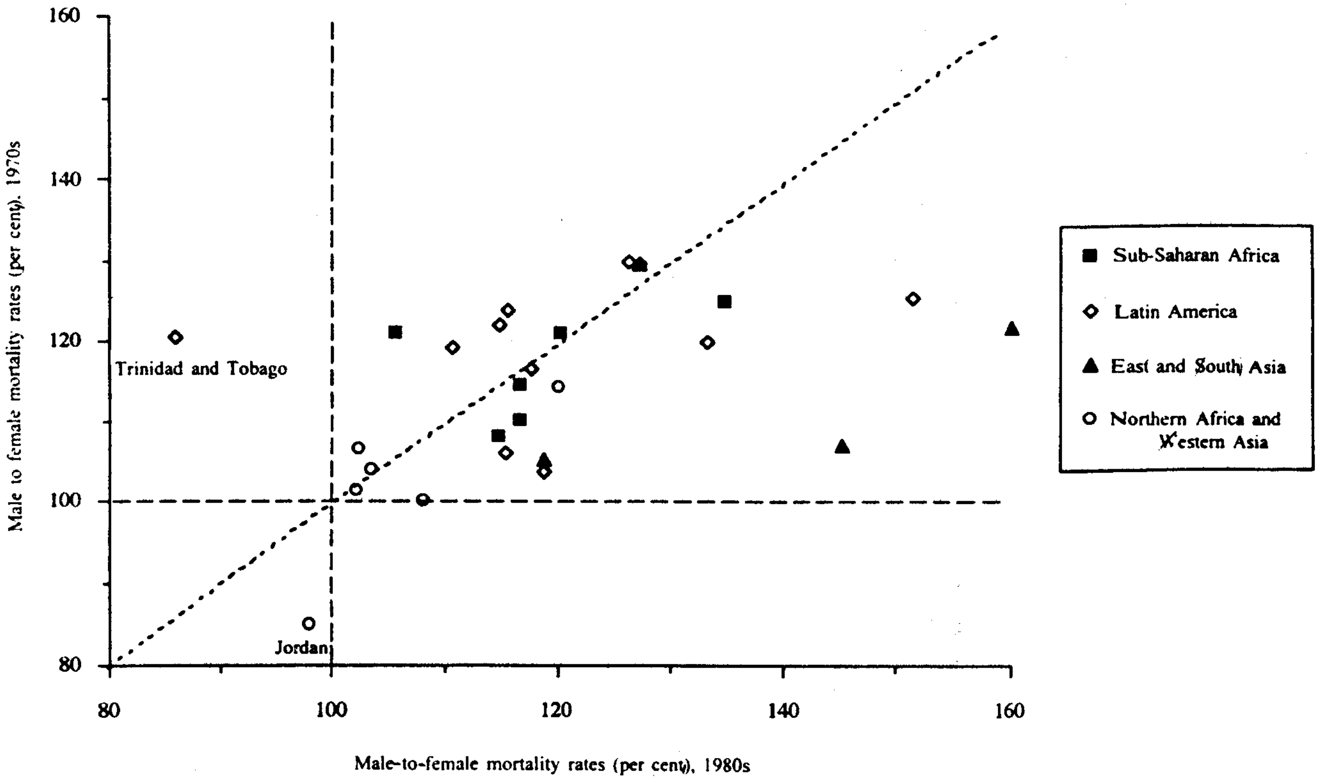
TABLE 3. AVERAGE AND MEDIAN RATIOS OF MALE-TO-FEMALE CHILD MORTALITY, ${}_4q_1$, BY REGION AND PERIOD

(Percentage)

	1970s		*1980s*	
Region	*Median*	*Average*	*Median*	*Average*
Sub-Saharan Africa	98	101	96	98
Latin America	96	100	94	99
Eastern and Southern Asia	85	92	94	88
Northern Africa and Western Asia	90	87	96	95
Total	95	96	95	97

Source: Annex table A.2.

Figure II. Sex ratios of infant mortality, 1970s and 1980s



Africa and Western Asia, while it increased slightly in sub-Saharan Africa and Latin America.

Excess female child mortality occurs in a large majority of countries (table 4). The level of the excess mortality declined only slightly between the two decades (from 11 per cent to 9 per cent). The trend varied among the major regions: an increase in sub-Saharan Africa, no change in Latin America, and a decline in Eastern and Southern Asia and in Northern Africa and Western Asia. On the whole, excess female child mortality remains high.

A comparison of all mortality rates by sex and by country for the two periods (figure III, a total of 88 estimates) clearly confirms the geographical spread of the phenomenon in both the 1970s and the 1980s, the diversity at similar levels of mortality and the absence of relationship between excess female child mortality and the level of child mortality.

The 26 countries with comparable data for the two periods (figure IV) experienced, on average, a 41 per cent decline in their mortality rates for age group 1-4, with a great diversity in the changes over time between countries:

(*a*) In the 1980s, excess female child mortality became evident in three countries (Ghana, Indonesia and Paraguay);

(*b*) It increased significantly in three countries (Cameroon, Mexico and Pakistan—the country most affected by the problem) and slightly in three others (the Dominican Republic, Morocco and Peru);

(*c*) It declined slightly in five countries (Algeria, Colombia, Egypt, Mauritius and Tunisia);

TABLE 4. NUMBER OF COUNTRIES, BY REGION, WITH EXCESS FEMALE CHILD MORTALITY BETWEEN AGES 1 AND 5 AND THE AVERAGE LEVEL OF EXCESS FEMALE MORTALITY BY PERIOD

	1970s		*1980s*	
Region	*Number of countries*	*Level of excess mortality*	*Number of countries*	*Level of excess mortality*
Sub-Saharan Africa . .	6 out of 10	+ 5	12 out of 19	+ 9
Latin America	9 out of 15	+ 9	10 out of 14	+ 9
Eastern and Southern Asia	8 out of 10	+ 16	3 out of 4	+ 13
Northern Africa and Western Asia	11 out of 11	+ 13	4 out of 6	+ 8
China	-	..	-	+ 10
Total	34 out of 46	+ 11	30 out of 44	+ 9

Source: Annex table A.2.

Figure III. Child mortality, $_4q_1$, by sex, 1970s and 1980s

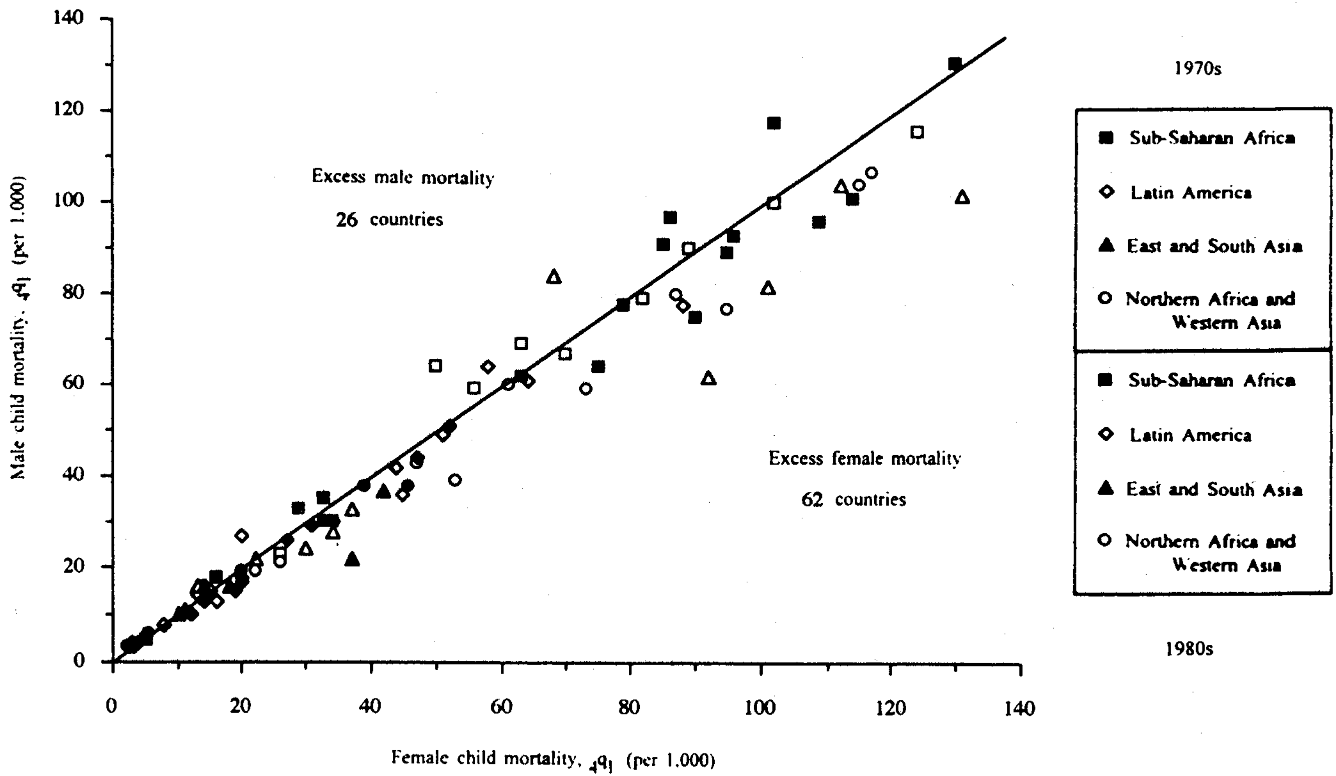
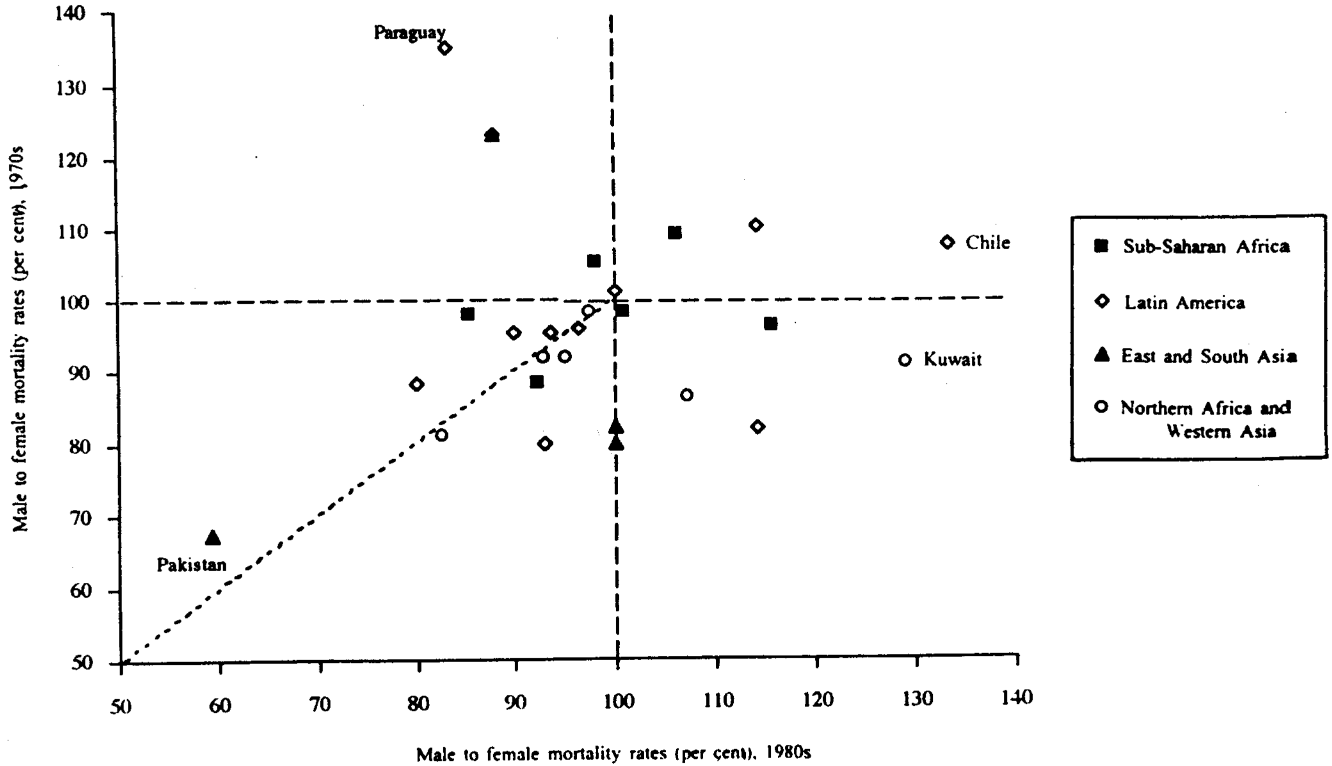


Figure IV. Sex ratios of child mortality, $_4q_1$, 1970s and 1980s



(*d*) It disappeared altogether in four countries (Costa Rica, Jordan, Kuwait and Nigeria). Costa Rica is currently experiencing very low mortality rates in age group 1-4 (about 4 per 1,000).

Finally, there are only three countries among those studied here which did not experience excess female child mortality in the 1970s and 1980s: Chile, Cuba and Kenya. The first two have had relatively low child mortality rates since the 1970s.

It is important to exercise caution in analysing and interpreting these findings by country. Some of the developments may partly be due to a change in the quality of the two sets of data (this could be the case when the phenomenon appears, increases or disappears abruptly). Others undoubtedly indicate a real trend. Despite the variability and uncertainty of the trends, however, excess mortality among girls aged 1-4 still remains a reality.

AGE-SPECIFIC MORTALITY AMONG GIRLS FROM THE POST-NEONATAL PERIOD TO AGE 5

What happens among more specific age groups within the first five years of life? Are there some ages that are more affected than others by the phenomenon? Problems with data are even more difficult here because of the small number of deaths when broken down into smaller age groups, possible differences in the accuracy of reporting deaths by age and sex, and the lack of published figures for smaller age groups. With the exception of China, only the results of 18 DHS surveys from the 1980s will be used, distinguishing between neonatal, post-neonatal, age 1, and age 2-4 mortality rates (table 5).

In 9 out of 18 countries, excess female mortality occurs as early as the post-neonatal period (1-11 months), while the child is still totally dependent on the mother. This is mainly true in sub-Saharan Africa and the Arab Muslim countries.[4] In a country with relatively low mortality, such as Jordan, excess female mortality now occurs only in the post-neonatal period.[5] On the other hand, in Latin America, with the exception of Mexico, mortality is significantly higher among boys until the first birthday; excess mortality among girls occurs only after age 1. The same applies to Pakistan, according to the 1990-1991 DHS, although the findings could be affected by data problems.[6]

For the five countries with data for smaller age groups between ages 1 and 5 shown in table 5, excess mortality among girls is found at age 1 as well as at ages 2-4 (except in Tunisia), but its severity varies according to age: it increases at ages 2-4 in Mexico and Morocco and remains at the same level elsewhere. Additional data would be needed to see the age patterns more clearly.

TABLE 5. RATIOS OF MALE-TO-FEMALE MORTALITY RATES, BY AGE, 18 DEMOGRAPHIC AND HEALTH SURVEYS, 1980S

Region and country	Ratios of male-to-female mortality rates (percentage)					Mortality levels, both sexes (per 1,000)	
	Neo-natal	Post-neonatal	${}_1q_1$	${}_3q_2$	${}_4q_1$	${}_1q_0$	${}_4q_1$
Sub-Saharan Africa							
Cameroon . .	104	79	69	75	73	93	70
Mali	136	88	..	..	95	132	170
Namibia . .	124	109	..	..	87	62	32
Nigeria . . .	118	94	..	..	116	91	109
Senegal . . .	140	97	97	98	98	100	140
Sudan	139	97	..	..	99	77	63
Zambia . . .	137	106	..	..	107	98	88
Latin America							
Bolivia . . .	128	120	..	..	99	97	51
Brazil (north-eastern)	154	145	..	..	82	94	18
Mexico . . .	128	100	95	66	81	47	16
Paraguay . .	119	118	..	..	81	35	11
Peru	122	109	..	..	94	64	30
Dominican Republic . .	185	121	..	..	86	44	19
Eastern and Southern Asia							
Indonesia . .	114	121	..	..	103	74	35
Pakistan . . .	130	107	..	..	60	95	29
Northern Africa and Western Asia							
Jordan	106	86	..	..	107	37	6
Morocco . .	106	98	99	94	97	83	40
Tunisia . . .	125	84	83	103	93	57	19

Source: DHS national reports (average mortality rates in the 10 years preceding the survey). For Mexico, data provided by C. Echarri, referring to the five years preceding the survey. For Senegal, rates were calculated by M. Biaye for cohorts born in 1972-1981; and for Cameroon, by A. Noumbissi for cohorts born in

A FEW COMMENTS ON CHINA

What is the situation in China, which has experienced rapid declines in mortality and fertility since the beginning of the 1970s and where, in addition, there has long been considerable discrimination on the basis of gender? According to the 1982 census,[7] the country as a whole experienced, on the one hand, excess male infant mortality (8 per cent) and, on the other, a considerable excess mortality among girls aged 1-4 years in both rural areas (10 per cent) and urban areas (6 per cent). The result is an almost equal risk for the two sexes in the age group 0-4.

According to the national life-tables, based on the census data (table 6), excess female mortality rises rapidly after the first birthday,[8] is most severe at ages 2-3 years (14 and 12 per cent), declines at age 4 and disappears at age 5, giving way to a high degree of excess mortality among boys. Data for other periods are unfortunately not available.

RELATIONSHIP BETWEEN SEX DIFFERENTIALS IN MORTALITY AND THE LEVEL OF MORTALITY

Excess female child mortality still occurs in many societies in the developing world, but to a varying degree. In this section, the relationship between excess female child mortality and the level of mortality will be explored. It is generally acknowledged that in the transition from high to low mortality, the female advantage increases at every age (Nadarajah, 1983). Is this relationship found with the data examined here? Infant mortality will be considered first, followed by child mortality.

All 90 available estimates of infant mortality will first be considered together, even if they relate to two different periods (the 1970s and the 1980s). They present great diversity and do not show any clear relationship between the level of mortality (measured by the rate for the

TABLE 6. SEX/AGE-SPECIFIC MORTALITY RATES, AGES 0-9, CHINA, 1982

Age	*Male*	*Probabilities of dying (per 1,000)* *Female*	*Total*	*Male-to-female ratios (percentage)*
0	35.6	33.7	34.7	105.6
1	6.7	7.3	7.0	91.8
2	4.3	5.0	4.6	86.0
3	3.0	3.4	3.2	88.2
4	2.1	2.2	2.2	95.4
5	1.8	1.7	1.7	105.9
6	1.5	1.3	1.4	115.4
7	1.2	1.0	1.1	120.0
8	1.1	0.8	0.9	137.0

Source: Chinese Academy of Social Sciences, *Almanac of Chinese Population* (Beijing, Population Research Institute, 1985).

two sexes combined) and the sex ratio of the rates. The correlation coefficient, although statistically significant, is lower than one would expect at the aggregate level ($N = 90, r = -0.31, p < 0.002$).

The same findings apply when the estimates for the 1970s and for the 1980s are considered separately (figure V). Thus, in the 1970s, similar ratios of male-to-female infant mortality rates (approximately 120 per cent) appear at very different levels of infant mortality, ranging from 30 to 140 per 1,000. Similarly, the rare situations where there is excess female infant mortality are associated with very diverse levels of infant mortality (65 and 125 per 1,000). In statistical terms, this is reflected in a fairly low correlation coefficient ($N = 46, r = -0.32, p < 0.03$). In the 1980s, the dispersion of the sex ratios increased slightly with generally higher values at lower levels of mortality. There are exceptions, such as Jordan and Trinidad and Tobago, where mortality is low but the data show excess female infant mortality. The correlation coefficient is still lower than that for the 1970s and, this time, it is not significant ($N = 44, r = -0.24, p < 0.12$).

The regrouping of infant mortality rates into four different levels[10] somewhat clarifies the perception of the phenomenon (table 7). The averages and medians of the ratios of male-to-female infant mortality rates, in both the 1970s and the 1980s, indicate that the sex ratios are a little higher when the level of mortality is low (< 50 per 1,000) and lower when the level is high (> 100 per 1,000), but also that the relationship is not linear to intermediate levels of mortality. Moreover, as has already been noted (table 2), there is no relationship at the regional level between the level of excess male infant mortality and the levels and trends of infant mortality.

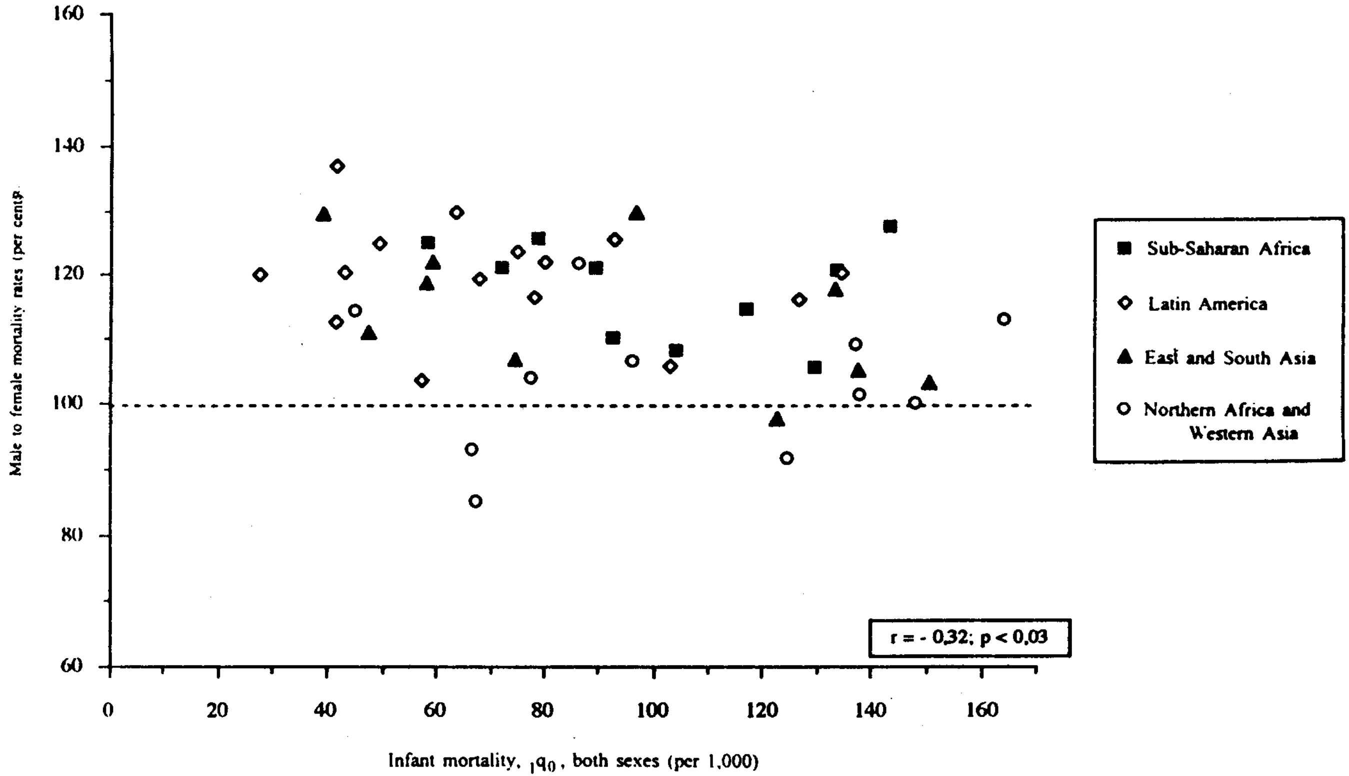
With regard to ages 1-4, no clear relationship emerges from the 90 data sets, as in the case of infant mortality. The degree of excess female

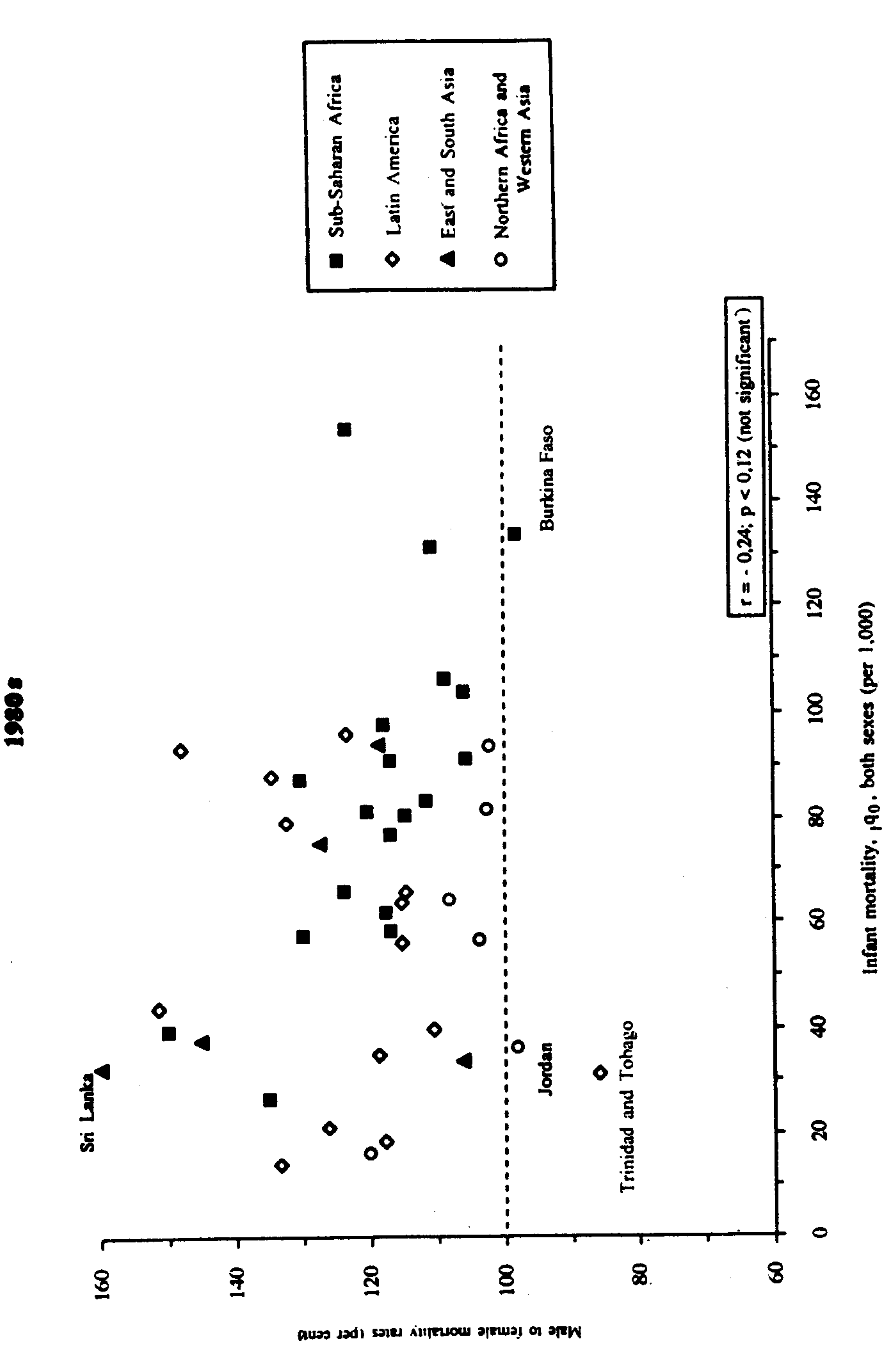
TABLE 7. LEVELS OF INFANT MORTALITY, ${}_1q_0$, AND AVERAGE AND MEDIAN RATIOS OF MALE-TO-FEMALE MORTALITY RATES, BY PERIOD

	1970s			*1980s*		
Infant mortality ${}_1q_0$ *(per 1,000)*	*Number of countries*	*Average male-to-female ratio (percentage)*	*Median male-to-female ratio (percentage)*	*Number of countries*	*Average male-to-female ratio (percentage)*	*Median male-to-female ratio (percentage)*
Less than 50	8	121	121	14	126	123
50-74	10	112	119	9	116	115
75-99	11	119	122	16	120	119
100 and over	17	109	108	5	109	109
Total	46	114	117	44	120	118

Figure V. Sex ratios of infant mortality, by level of infant mortality

1970s





1980s
Sub-Saharan Africa
Latin America
East and South Asia
Northern Africa and Western Asia
r = - 0,24; p < 0,12 (not significant)
Sri Lanka
Jordan
Trinidad and Tobago
Burkina Faso
Infant mortality, 1q0, both sexes (per 1,000)
Male to female mortality rates (per cent)

child mortality does not depend on the level of mortality, with only 2 per cent of the variance explained ($r = -0.14$, $R^2 = 0.0211$, $p < 0.17$).

In the 1980s, as well as in the 1970s (figure VI), excess female child mortality occurred at very different levels of mortality: a male-to-female ratio of approximately 90 per cent is found at levels of child mortality ranging from 10 per 1,000 (Colombia, 1981, and Kuwait, 1975) to 110 per 1,000 (Burundi, 1981, or Yemen, 1973). Excess mortality among males appears more frequently at the lowest levels of mortality, but from a statistical standpoint no correlation can be identified.

By regrouping the estimates into four different levels (table 8), it can be shown that excess female child mortality is absent only at the lowest levels of mortality (less than 25 per 1,000). Above that level, the ratios vary, although there is a preponderance of excess mortality among females.

At the regional level, using the same 90 estimates, the diversity is clearly indicated in table 9. The average mortality rates by region and the sex ratios of the rates show that contrasting levels of mortality and different rates of decline correspond to similar changes in excess mortality (as in sub-Saharan Africa and Latin America). In addition, similar levels and similar changes in mortality rates are associated with different changes in excess mortality (as in Eastern and Southern Asia and Northern Africa and Western Asia). Finally, the region with the highest level of mortality (sub-Saharan Africa) is not the region where excess female child mortality is most apparent. The findings are the same if medians are used instead of averages.

By considering only the 26 countries with two sets of comparable data, it is possible to look at the relationships between mortality decline and changes in the sex ratios. Table 10 shows rates of mortality decline

TABLE 8. LEVELS OF CHILD MORTALITY, $_4q_1$, AND AVERAGE AND MEDIAN RATIOS OF MALE-TO-FEMALE MORTALITY RATES, BY PERIOD

	1970s			*1980s*		
Child mortality $_4q_1$ *(per 1,000)*	*Number of countries*	*Average male-to-female ratio (percentage)*	*Median male-to-female ratio (percentage)*	*Number of countries*	*Average male-to-female ratio (percentage)*	*Median male-to-female ratio (percentage)*
Under 25	14	101	100	19	101	100
25-49	8	85	85	11	92	94
50-79	11	101	98	4	95	98
80 and over	13	91	92	10	98	96
Total	46	95	94	44	97	96

Source: Annex table A.2.

TABLE 9. AVERAGE LEVELS OF CHILD MORTALITY, $_4q_1$, AND RATIOS OF MALE-TO-FEMALE MORTALITY RATES, BY REGION

Region	1970s Number of countries	1970s Average mortality rates, $_4q_1$ (per 1,000)	1970s Average male-to-female ratio (percentage)	1980s Number of countries	1980s Average mortality rates, $_4q_1$ (per 1,000)	1980s Median male-to-female ratio (percentage)
Sub-Saharan Africa . .	10	84	101	19	75	98
Latin America	15	32	100	14	19	99
Eastern and Southern Asia	10	60	92	5	21	87
Northern Africa and Western Asia	11	60	87	6	20	101
Total	46	56	95	44	44	97

TABLE 10. RATES OF MORTALITY DECLINE, BY SEX, AND RATIO OF MALE-TO-FEMALE MORTALITY RATES, BY PERIOD

Level of child mortality, both sexes, $_4q_1$, 1970s (per 1,000)	Number of countries	Rate of decline: Male (percentage)	Rate of decline: Female (percentage)	Ratio of male-to-female mortality rates: 1970s (percentage)	Ratio of male-to-female mortality rates: 1980s (percentage)
Under 25	8	– 68	– 69	99	100
25-49	6	– 58	– 60	87	91
50-79	7	– 40	– 37	98	92
80 and over	5	– 29	– 33	94	99
Total	26	– 41	– 42	94	96

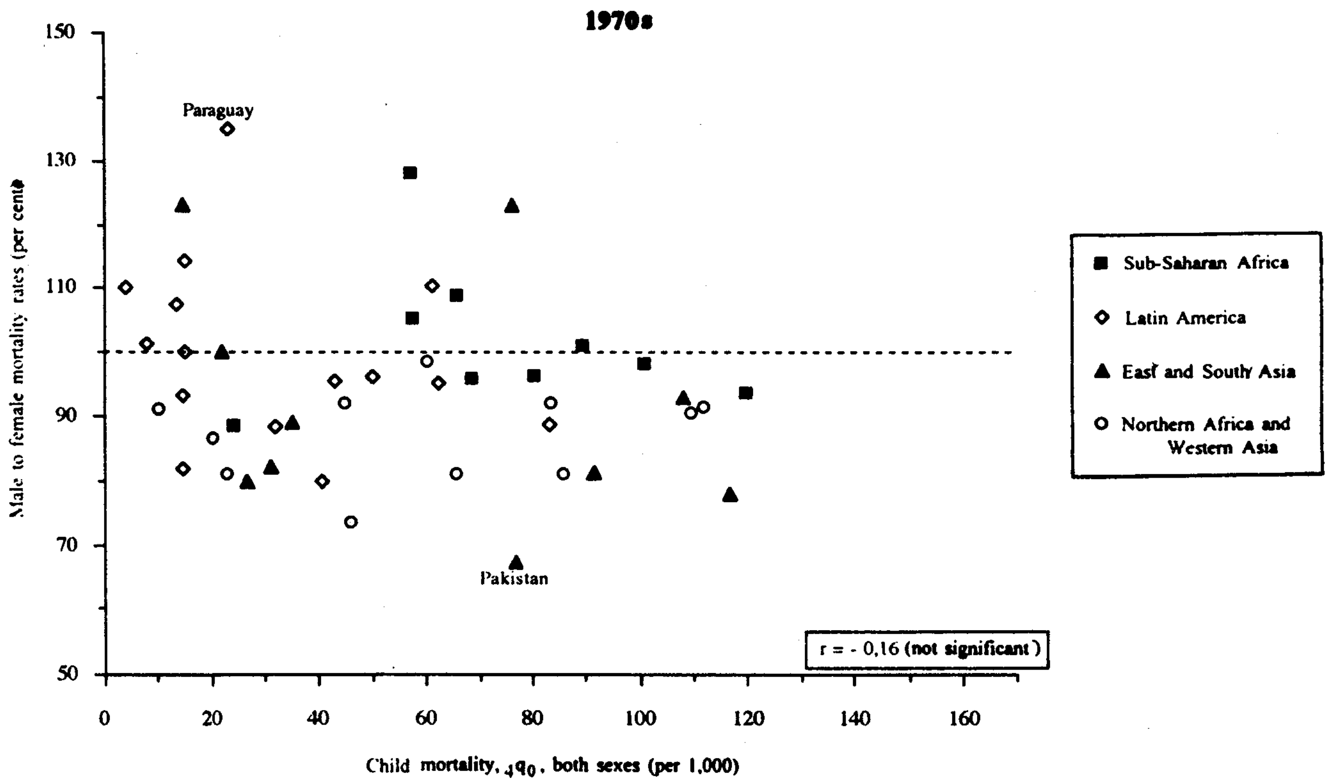
Source: Annex table A.2.

by sex and the sex ratios of the mortality rates at different levels of mortality.

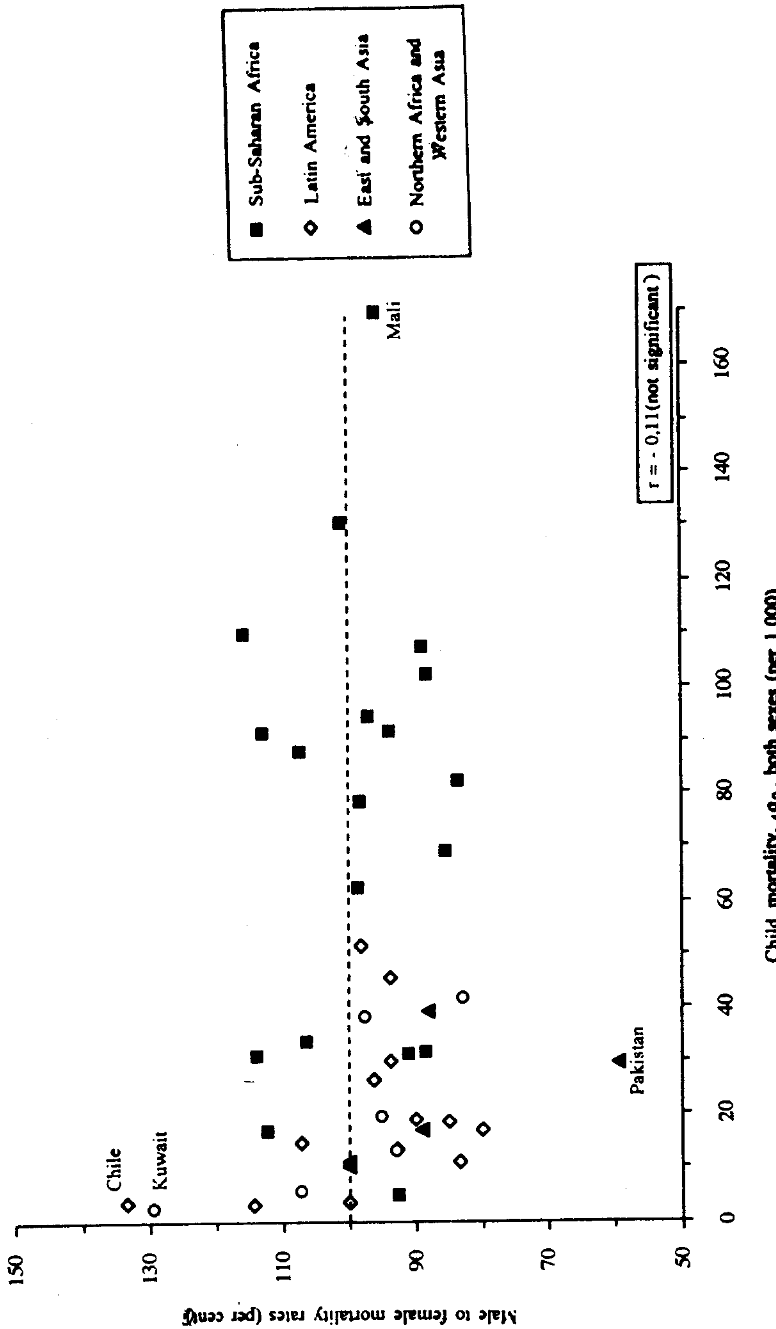
The decline in child mortality has been more rapid where the level was already low in the 1970s. Thus, according to these data, advances in health have benefited particularly those countries and regions where the mortality rate was already the lowest. Moreover, in three out of the four groups, the decline in female mortality was slightly more rapid, which led to a somewhat lower excess female child mortality in the 1980s.[11]

In general, the trend indicates that excess female child mortality is reduced when the level of mortality declines. However, because of the great diversity between countries, the trend is insufficient to predict the

Figure VI. Sex ratios of child mortality, by level of child mortality



1980s


Sub-Saharan Africa
Latin America
East and South Asia
Northern Africa and Western Asia
r = - 0,11 (not significant)
Chile
Kuwait
Mali
Pakistan
Male to female mortality rates (per cent)
Child mortality, $_4q_0$, both sexes (per 1,000)
150
130
110
90
70
50
0
20
40
60
80
100
120
140
160

existence of excess mortality on the basis of the level of mortality alone. While excess mortality among males increases only when levels of mortality are low, excess mortality among females shows a favourable trend at all levels of mortality between the 1970s and 1980s. Although the decline is limited, it indicates nevertheless that, in this period, girls have benfited a little more than boys from advances in health care.

RELATIONSHIP BETWEEN EXCESS FEMALE CHILD MORTALITY AND SOME SOCIAL DEVELOPMENT INDICATORS

Forty-three countries with available data for the 1980s[12] are used to explore the relationship between sex differentials and some recent socio-economic indicators such as the per capita gross domestic product (GDP) (1990), the average annual growth of GDP in the 1980s, life expectancy at birth (1980-1985), the adult literacy rate (1990), the mean years of schooling of women expressed as a percentage of that for men (1990), the difference between girls and boys in the level of primary school enrolment (1988-1990), the average age at first marriage of women (1980-1985) and the UNDP human development index (1990) (see annex table A.3).

In general, the correlations are relatively weak (table 11) and often of little significance. Only the education variable, which measures gender inequalities in primary schooling, departs from this general rule, with a significant correlation coefficient of 0.34. The economic indica-

TABLE 11. LEVEL OF CORRELATION BETWEEN EXCESS FEMALE CHILD MORTALITY, AGES 1-4, AND VARIOUS SOCIO-ECONOMIC INDICATORS

Indicators	*N*	*r*	*p*
Per capita GDP	43	0.25	0.10
Rate of growth of GDP	40	0.21	0.19
Life expectancy at birth	43	0.28	0.09
Adult literacy	40	0.30	0.06
Mean years of schooling for women[a]	42	0.29	0.07
Primary school enrolment among girls[a]	38	0.34	0.03
Average age at first marriage for women	38	0.30	0.07
Human development index . .	43	0.29	0.06

NOTES: N Number of countries for which information is available.
r Bravais-Pearson correlation coefficient.
p Level of significance.
[a] Percentage of level attained by men.

tors are far less relevant (lower correlation coefficients which are not significant).

With regard to primary school enrolment, excess female child mortality is observed wherever school enrolment for girls is less than 85 per cent of that for boys. A clear difference in the investment on the part of families in the school enrolment of girls and boys, in favour of boys, is always associated with an excess female child mortality. However, equal access to primary schooling does not guarantee the disappearance of that excess mortality, which can occur at all levels of primary school enrolment of girls; in some extreme cases, it is even higher than that of boys.

Excess female child mortality can be observed at all levels of the human development index. From Burkina Faso (0.074) to Trinidad and Tobago (0.877), one finds situations of excess mortality among females or males at all levels of "human development".

There is no clear link either between excess female child mortality and the average age at first marriage. While a very early age at marriage (under 18 years) is always associated with excess female child mortality, excess mortality among girls appears also at intermediate and higher ages at first marriage.

The analysis of these few relationships has been purely exploratory. The small sample size, the limited number of indicators, the different periods that these indicators refer to make it impossible to derive any significant explanation. In addition, weak relationships between the level of mortality and excess female child mortality have already indicated a lack of relationship between this phenomenon and the usual social indicators. It is probably at a less aggregate level (region, place of residence, social class and family) that explanations can be found. Excess female child mortality relates above all to behaviour, standards and attitudes and culture, elements which are difficult to measure at the aggregate level.

Conclusion

At the end of this descriptive international comparison of the social phenomenon of excess female child mortality, the following main conclusions emerge:

(*a*) The problem is still widespread in the developing world, although it is somewhat less prevalent in the 1980s (two out of three countries) than in the 1970s (three out of four countries). No developing region is exempt;

(*b*) Where it exists, excess female child mortality has declined slightly in the countries included here (from 11 to 9 per cent), but the trend has varied by region: an increase in sub-Saharan Africa (from 5 to 9 per cent), no change in Latin America (9 per cent) and a significant decline in Northern Africa and Western Asia (from 13 to 8 per cent);

(*c*) Excess female mortality often starts as early as the post-neonatal period, or a few months of age, and lasts until age 4 or 5. Early excess female mortality occurs particularly in the Arab Muslim world and in sub-Saharan Africa, but not in Latin America;

(*d*) Contrary to the patterns shown in the United Nations model life-tables for developing countries, no firm and solid relationship is found here between the existence of excess female child mortality and the level of mortality during the 1970s and 1980s. Excess mortality among girls between the ages of 1 and 5 is found at very different levels of mortality, from 7 to 110 per 1,000. On average, however, it occurs less in countries with low mortality;

(*e*) Lastly, as expected, at the national level studied here, no significant statistical relationship was found between sex differentials in child mortality and levels of socio-economic development measured by per capita GDP, growth of GDP, adult literacy or the human development index. Only variables measuring inequality in education between men and women yield any significant results.

It is important, however, to continue these descriptive international comparisons, making more use of analysis of differentials by place of residence, by level of parental education, by major social group etc., even if it is only supplementary to the micro-approaches or community approaches necessary for an understanding and an explanation of the problem.

NOTES

[1]Constructed on the basis of 36 carefully evaluated life-tables for developing countries. The sex differentials are determined by regressions of the female/male differential in life expectancy at birth for both sexes combined.

[2]In Western countries during the nineteenth and twentieth centuries until 1940, it was the age group 10-14 that was more resistant to change.

[3]The trend could be due to data problems—different degrees of completeness of reporting in the two surveys.

[4]This was observed in the WFS surveys carried out in the 1970s in Jordan, Egypt, Syrian Arab Republic, Tunisia and Turkey (Rutstein, 1983 and 1984) as well as in Algeria in the early 1970s (D. Tabutin, *Mortalité infantile et juvénile en Algérie*, Travaux et documents de l'Institut national d'études demographiques, Cahier No. 77 (Paris, INED, 1976).

[5]The level has declined from 30 per cent, according to the 1976 WFS, to 14 per cent, according to the 1990 DHS.

[6]Excess female mortality during the neonatal period was 18 per cent, according to the 1975 WFS.

[7]Data on deaths by age and sex during 24 months prior to the census (see G. Calot and G. Caselli, "La mortalité en Chine d'après le recensement de 1982:

analyse selon le sexe et l'âge au niveau national et provincial", *Population*, vol. 44, No. 4-5 (July-October 1989), pp. 841-872.

[8]Possibly earlier, in view of the low sex ratio of the infant mortality rate.

[9]The coefficient of variation increased from 10 per cent in the 1970s to 13 per cent in the 1980s.

[10]Combining the quartiles of the distribution of the rates for the two periods.

[11]The progress for girls was less than that for boys in the group with child mortality between 50 and 75 per 1,000. This group includes Indonesia, where the male-to-female ratio declined from 123 per cent, according to the 1976 WFS, to 88 per cent, according to the 1987 DHS, an abrupt change which is difficult to explain. If Indonesia is excluded, excess mortality among girls remains unchanged (93 per cent).

[12]Excluding Brazil. The DHS data included in the study covered only the north-east.

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ANNEX TABLES

TABLE A.1. SOURCES OF DATA AND NUMBER OF COUNTRIES, BY REGION AND PERIOD

Region and period	*Census*	*Civil registration*	*Retrospective fertility surveys*[a]	*Multi-round surveys*	*Number of countries*
Sub-Saharan Africa					
1970-1979		18	1		10
1980-1989	1	1	17		19
Latin America					
1970-1979		3	12		15
1980-1989		3	11		14
Eastern and Southern Asia					
1970-1979	1		9		10
1980-1989			4		4
Northern Africa and Western Asia					
1970-1979		1	8	2	11
1980-1989		2	4		6
China					
1982	1				1
Total					
1970-1979	1	5	37	3	46
1980-1989	2	6	36		44

[a]Data mainly from the World Fertility Survey (WFS) and the Demographic and Health Surveys (DHS).

TABLE A.2. MORTALITY RATES, BY AGE AND SEX (PER 1,000) AND RATIOS OF MALE-TO-FEMALE RATES

(*Percentage*)

Region and country	Date and source of data	Average date of estimation	$_1q_0$ Male	$_1q_0$ Female	$_1q_0$ M/F	$_4q_1$ Male	$_4q_1$ Female	$_4q_1$ M/F	$_5q_0$ Male	$_5q_0$ Female	$_5q_0$ M/F
Sub-Saharan Africa											
Benin	WFS (1981)	1975	146	121	121	116	124	94	245	230	107
Botswana	DHS (1988)	1983	48	32	150	18	16	112	65	47	138
Burkina Faso	Census	1985	133	135	98	93	96	97	214	219	97
Burundi	DHS (1987)	1981	99	76	130	101	114	89	190	181	105
Cameroon	WFS (1978)	1973	108	100	108	100	102	98	197	191	103
	DHS (1991)	1985	86	75	115	64	75	85	144	144	100
Cape Verde	DHS (1988)	1983	73	59	124	33	29	114	104	86	121
Côte d'Ivoire	WFS (1981)	1976	144	116	124	87	78	111	218	184	118
	EPR (1978-1979)[a]	1978	161	126	128	90	89	101	237	204	117
Ghana	WFS (1979)	1974	79	65	121	59	56	105	134	118	114
	DHS (1988)	1983	89	74	120	78	79	98	160	147	109
Kenya	WFS (1977)	1972	97	88	110	69	63	109	159	146	109
	DHS (1989)	1984	63	54	117	35	33	106	96	86	112
Lesotho	WFS (1977)	1972	133	126	106	64	50	128	188	170	111
Liberia	DHS (1986)	1981	170	138	123	89	95	94	244	219	111
Mali	DHS (1987)	1982	138	125	110	166	174	95	281	277	101
Mauritius	Civil registration	1972	65	52	125	23	26	88	87	77	113
	Civil registration	1986	31	23	135	4.8	5.2	92	36	28	129
Namibia	DHS (1992)	1987	67	57	118	30	34	88	94	99	95

TABLE A.2 (*continued*)

Region and country	Date and source of data	Average date of estimation	$_1q_0$ Male	$_1q_0$ Female	$_1q_0$ M/F	$_4q_1$ Male	$_4q_1$ Female	$_4q_1$ M/F	$_5q_0$ Male	$_5q_0$ Female	$_5q_0$ M/F
Nigeria	WFS (1981)	1976	98	81	121	79	82	96	170	156	109
	DHS (1990)	1985	94	89	106	118	102	115	200	182	110
Rwanda	ENF (1983)[b]	1981	107	101	106	96	109	88	193	199	97
Senegal	WFS (1978)	1973	125	109	115	175	178	98	279	267	104
	DHS (1986)	1981	98	84	117	131	130	101	216	202	107
Sudan											
Northern	WFS (1978)	1973	88	70	126	67	70	95	149	135	110
Country	DHS (1990)	1985	83	71	117	62	63	98	141	129	109
Togo	DHS (1988)	1983	88	79	111	75	90	83	156	162	96
Uganda	DHS (1989)	1984	111	102	109	97	86	112	198	179	111
Zambia	DHS (1992)	1987	106	90	118	91	85	107	188	168	112
Zimbabwe	DHS (1988)	1983	65	50	130	30	33	91	93	81	115
Latin America											
Bolivia	DHS (1989)	1983	106	86	123	51	52	98	151	132	114
Brazil											
Country	DHS (1986)	1981	101	75	135	15	14	107	113	87	130
North-eastern	DHS (1991)	1986	111	75	148	17	20	85	126	94	134
Chile	Civil registration[c]	1970	84	72	117	14	13	108	94	84	112
	Civil registration	1987	20	17	118	4.0	3.0	133	24	20	120
Colombia	WFS (1976)	1971	74	62	119	36	45	80	107	105	102
	DHS (1986)	1981	42	38	111	13	14	93	55	51	108

Costa Rica	WFS (1976)	1971	72	55	130	13	16	82	84	70	120
	Civil registration	1984	24	19	126	3.2	2.8	114	27	22	123
Cuba	Civil registration[c]	1975	30	25	120	4.3	3.9	110	34	20	117
	Civil registration	1986	16	12	133	3.2	2.8	114	19	15	127
Dominican Republic	WFS (1975)	1970	103	82	126	42	44	95	141	123	115
	DHS (1991)	1986	53	35	151	18	20	90	70	55	127
Ecuador	WFS (1980)	1975	88	72	122	49	51	96	133	120	111
	DHS (1987)	1982	70	61	115	26	27	96	94	86	109
Guatemala	DHS (1987)	1982	90	68	132	44	47	94	130	111	117
Haiti	WFS (1977)	1972	147	122	120	78	88	89	213	199	107
Honduras	United Nations[c]	1974	136	117	116	64	58	110	192	169	114
Jamaica	WFS (1976)	1971	48	35	137	16	14	114	62	48	129
Mexico	WFS (1976)	1972	83	67	124	30	34	88	110	99	111
	DHS (1987)	1983	60	52	115	15	19	80	74	70	106
Panama	WFS (1976)	1971	44	39	113	14	15	93	57	55	104
Paraguay	WFS (1979)	1974	58	56	104	27	20	135	83	77	108
	DHS (1990)	1985	38	32	119	10	12	83	47	43	109
Peru	WFS (1978)	1973	106	100	106	61	64	95	160	157	102
	DHS (1991)	1986	68	59	115	29	31	94	95	88	108
Trinidad and Tobago	WFS (1977)	1972	47	39	121	7.9	7.8	101	55	46	120
	DHS (1987)	1982	29	34	86	3.4	3.4	100	32	37	86
Venezuela	WFS (1977)	1972	55	44	125	15	15	100	69	58	119
Eastern and Southern Asia											
Bangladesh	WFS (1976)	1971	144	122	118	82	101	81	214	210	102
India	United Nations[c]	1971	121	124	98	102	131	78	211	240	88

TABLE A.2 (*continued*)

Region and country	Date and source of data	Average date of estimation	${}_1q_0$ Male	${}_1q_0$ Female	${}_1q_0$ M/F	${}_4q_1$ Male	${}_4q_1$ Female	${}_4q_1$ M/F	${}_5q_0$ Male	${}_5q_0$ Female	${}_5q_0$ M/F
Indonesia	WFS (1976)	1971	109	84	130	84	68	123	184	146	126
	DHS (1987)	1982	84	66	127	37	42	88	118	105	112
	DHS (1991)	1986	80	68	118	36	35	103	113	100	113
Malaysia	WFS (1975)	1970	44	34	129	16	13	123	59	46	128
Nepal	WFS (1976)	1971	153	148	103	104	112	93	241	244	99
Pakistan	WFS (1975)	1970	141	134	105	62	92	67	194	214	91
	DHS (1990)	1985	102	86	119	22	37	59	122	119	103
Philippines	WFS (1978)	1973	63	53	119	33	37	89	93	87	107
Republic of Korea	WFS (1974)	1969	50	45	111	22	22	100	71	66	108
Sri Lanka	WFS (1975)	1970	65	53	122	24	30	80	87	81	107
	DHS (1987)	1982	40	25	160	10	10	100	49	34	144
Thailand	WFS (1975)	1970	77	72	107	28	34	82	102	103	99
	DHS (1987)	1982	45	31	145	11	11	100	56	42	133
Northern Africa and Western Asia											
Algeria	ENSP (1970-1971)[a]	1970	148	148	100	80	87	92	216	222	97
	Civil registration	1987	67	62	109	13	14	93	78	75	104
Egypt	WFS (1980)	1975	139	137	101	77	95	81	206	219	94
	DHS (1988)	1983	95	93	102	38	46	83	130	135	96
Iran, Islamic Republic of	EPR (1973-1974)[a]	1974	119	130	92	59	73	81	171	194	88
Jordan	WFS (1976)	1971	62	73	85	19	22	86	80	93	86
	DHS (1990)	1985	36	37	98	6.0	5.6	107	42	43	98

Kuwait	Civil registration	1975	48	42	114	10	11	91	57	52	110
	Civil registration	1987	18	15	120	3.1	2.4	129	21	17	123
Mauritania	WFS (1982)	1977	95	78	122	107	117	91	192	186	103
Morocco	WFS (1980)	1975	99	93	106	60	61	98	153	148	103
	DHS (1987)	1982	83	81	102	38	39	97	118	117	101
Syrian Arab Republic	WFS (1978)	1973	64	69	93	21	26	81	84	93	90
Tunisia	WFS (1978)	1973	79	76	104	43	47	92	118	120	98
	DHS (1988)	1983	58	56	104	19	20	95	76	75	101
Turkey	WFS (1978)	1973	143	131	109	39	53	74	177	177	100
Yemen	WFS (1974)	1973	174	154	113	104	115	90	260	253	103
China	Census[a]	1981	35	33	108	16	18	90	51	50	101
Rural areas	Census	1981	38	35	107	18	20	90	55	54	101
Urban areas	Census	1981	22	19	112	7.8	8.2	94	29	27	107

Sources: For WFS: S. O. Rutstein, *Infant and Child Mortality: Levels, Trends and Demographic Differentials*, World Fertility Survey Comparative Studies, No. 24 (Voorburg, Netherlands, International Statistical Institute, 1983); and S. O. Rutstein, *Infant and Child Mortality: Levels, Trends and Demographic Differentials*, World Fertility Survey Comparative Studies, No. 43 (Voorburg, Netherlands, International Statistical Institute, 1984). For DHS: Various national reports. For China: G. Calot and G. Caselli, "La mortalité en Chine d'après de recensement de 1982: analyse selon le sex et l'âge au niveau national et provincial", *Population* (Paris), vol. 44, No. 4-5 (1989).

[a]National multi-round survey.

[b]National fertility survey, with similar questionnaires to those for the WFS.

[c]Life-table estimated for construction of the United Nations model life-tables for developing countries (United Nations, "Patterns of sex differentials in mortality in less developed countries", in *Sex Differentials in Mortality, Trends, Determinants and Consequences*, A. D. Lopez and L. T. Ruzicka, eds., Miscellaneous Series, No. 4 (Canberra, Australian National University, Department of Demography, 1982), pp. 7-32).

TABLE A.3. RATIOS OF MALE-TO-FEMALE CHILD MORTALITY RATES, $_4q_1$, AND VARIOUS SOCIO-ECONOMIC INDICATORS, 1980s

Region and country	*Average date of mortality estimate*	*Ratio of male-to-female child mortality (percentage)*	*Life expectancy at birth, both sexes (years), 1980-1985*	*Mean years of schooling F/M (percentage)*	*Average age at first marriage (years), 1980-1985*	*Adjusted real GDP per capita, 1990*	*Average annual growth of GDP, 1980-1988 (percentage)*	*Human development index, 1990*	*Adult literacy rate, 1990 (percentage)*	*Primary school enrolment, F/M, 1985-1990 (percentage)*
Sub-Saharan Africa										
Botswana	1983	112	56.0	97	26.4	3 419	11.4	0.552	74	106
Burkina Faso	1985	97	45.2	54	17.4	618	5.5	0.074	18	64
Burundi	1981	89	48.0	33	20.8	625	4.3	0.167	50	84
Cameroon	1985	85	51.0	33	17.5	1 646	5.4	0.310	54	86
Cape Verde	1983	114	64.1	39	..	1 769	..	0.479	67	95
Ghana	1983	98	52.0	46	19.3	1 016	2.1	0.311	60	81
Kenya	1984	106	55.8	42	20.4	1 058	4.2	0.369	69	96
Liberia	1981	94	51.5	26	..	857	–1.3	0.222	40	..
Mali	1982	95	42.0	27	18.1	572	3.2	0.082	32	58
Mauritius	1986	92	66.7	68	21.7	4 890	5.7	0.794	..	102
Namibia	1987	88	53.7	..	..	1 400	..	0.289	..	..
Nigeria	1985	115	48.5	26	18.7	1 215	–1.1	0.246	51	93
Rwanda	1981	88	46.5	31	21.1	657	2.1	0.186	50	100
Senegal	1981	101	45.3	29	17.7	1 248	3.3	0.182	38	75
Sudan	1985	98	47.8	45	21.3	949	2.5	0.152	27	71
Togo	1983	83	50.5	31	..	734	0.5	0.218	43	68

Uganda	1984	112	47.2	41	..	524	1.4	0.194	48	88
Zambia	1987	107	51.0	45	19.4	744	0.7	0.314	73	98
Zimbabwe	1983	91	55.9	40	20.4	1 484	2.7	0.398	67	100
Latin America										
Bolivia	1983	98	56.2	60	22.1	1 572	–1.6	0.398	78	90
Brazil	1981	107	63.4	94	22.6	4 718	2.9	0.730	81	..
Chile	1987	133	71.0	92	23.6	4 862	1.9	0.864	93	92
Colombia	1981	93	67.2	106	20.4	4 237	3.4	0.770	87	103
Costa Rica	1984	114	73.8	97	22.7	4 542	2.4	0.852	93	100
Cuba	1986	114	74.1	103	19.9	2 200	..	0.711	94	99
Dominican Republic	1986	90	64.0	87	20.5	2 404	2.2	0.586	83	100
Ecuador	1982	96	64.3	92	22.1	3 074	2.0	0.646	86	98
Guatemala	1982	94	58.9	86	20.5	2 576	–0.2	0.489	55	85
Trinidad and Tobago	1982	100	68.6	101	22.3	4 913	–6.1	0.877	..	100
Southern and Eastern Asia										
China	1981	90	67.8	60	22.4	1 990	10.3	0.566	73	100
Indonesia	1982	88	56.2	58	20.0	2 181	5.1	0.515	82	96
Pakistan	1985	59	54.0	25	19.8	1 862	6.5	0.311	35	55
Sri Lanka	1982	100	68.9	80	24.4	2 405	4.3	0.663	88	100
Thailand	1982	100	64.4	76	22.7	3 986	6	0.715	93	..
Northern Africa and Western Asia										
Algeria	1987	93	60.5	18	21.0	3 011	3.5	0.528	57	88
Egypt	1983	83	56.6	42	21.3	1 988	5.7	0.389	48	79
Jordan	1985	107	63.6	66	22.6	2 345	4.2	0.582	80	..

TABLE A.3 (*continued*)

Region and country	*Average date of mortality estimate*	*Ratio of male-to-female child mortality (percentage)*	*Life expectancy at birth, both sexes (years), 1980-1985*	*Mean years of schooling F/M (percentage)*	*Average age at first marriage (years), 1980-1985*	*Adjusted real GDP per capita, 1990*	*Average annual growth of GDP, 1980-1988 (percentage)*	*Human development index, 1990*	*Adult literacy rate, 1990 (percentage)*	*Primary school enrolment, F/M, 1985-1990 (percentage)*
Kuwait	1987	129	71.6	79	22.9	5 039	−1.1	0.815	73	98
Morocco	1982	97	58.2	36	21.3	2 348	4.2	0.433	50	68
Tunisia	1983	95	63.1	41	24.3	3 579	3.4	0.600	65	91

Sources: *World Population Prospects: The 1992 Revision* (United Nations publication, Sales No. E.93.XIII.7); United Nations Development Programme, *Human Development Report, 1993* (New York, Oxford University Press, 1993); and World Bank, *World Development Report, 1990* (New York: Oxford University Press, 1990).

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SEX DIFFERENCES IN MORTALITY AMONG YOUNG CHILDREN IN THE SAHEL*

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SUMMARY

Prior research has shown evidence of slight excess female child mortality in several areas in sub-Saharan Africa. The existence and determinants of sex differences in mortality are studied, using longitudinal data on more than 21,000 children between the ages of one month and two years from the cities of Bamako (the capital of Mali) and Bobo-Dioulasso (the second largest city in Burkina Faso), and from a rural area of Senegal. Results indicate excess female mortality for certain age ranges and excess male mortality for others. There is little evidence of sex differences in vulnerability to specific causes of death, discrimination in nutrition and health care, or systematic effects of household socio-economic status, mother's education, parity or urban/rural residence on child mortality by sex. Only ethnicity appears to be associated with sex mortality differentials, suggesting that traditional, cultural practices such as female circumcision and sex-specific food taboos may underlie the findings.

INTRODUCTION

Mortality rates for boys are systematically above those for girls in the developed world. In low-income countries and historically in some European populations, however, female child mortality rates are often higher. Tabutin and Willems (in this issue), in a comparative study of data from 62 developing countries, report a general tendency of excess

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male mortality during infancy and excess female mortality during the following four years (ages 1-5). For the neonatal period, there is a general consensus that, throughout the world, boys tend to face much higher health risks due to biological factors—primarily complications from birth trauma and congenital anomalies (e.g., Waldron, 1983 and 1987; Preston, 1976). While the relative importance of biological versus behavioural factors for explaining mortality differences of older children remains a subject of debate, numerous studies have linked excess female child mortality in the Indian subcontinent to discrimination against girls in terms of nutrition and health care.

To date, few studies have focused on sex differences in child mortality in sub-Saharan Africa. Although sex mortality differentials appear to be much less pronounced in this region than in Southern Asia or Western Asia, Tabutin and Willems (in this issue) report excess female mortality for post-neonates and children aged 1-5 in the majority of countries for which reliable data exist (see also Gbenyon and Locoh, 1989, and Akoto, 1985). Like Southern Asia, Africa is characterized by distinct social and economic roles for men and women, and polygamy is fairly common. Further, in the Sahel, as in parts of Asia, one often hears that girls do not belong to their families, since they will marry and leave. Throughout most of Africa and Southern Asia, families sharply discriminate against daughters in terms of schooling, leading to higher enrolment rates for boys than for girls. Finally, despite a paucity of hard evidence,[1] there is a widespread perception that African parents would prefer to have more sons than daughters. This situation has led several researchers to suggest that, as in Southern Asia, African boys may be favoured in health care and nutrition, leading to excess female child mortality.

This study uses data from three longitudinal surveys on over 21,000 children to examine sex differences in early child mortality in the cities of Bamako (the capital of Mali) and Bobo-Dioulasso (the second largest city in Burkina Faso) and in a rural region in Senegal. In each of these countries, previous research has revealed generally small degrees of excess female child mortality among national or subnational populations (Mbacké and LeGrand, 1991; Fargues and Ouaïdou, 1988; Barbieri, 1989; Cantrelle and others, 1986; Tabutin and Willems, in this issue). The possible causes of sex mortality differences reported by other studies are reviewed. Data and methodological issues are presented, followed by an analysis of levels and possible causes of differential mortality. The final section is a discussion of the findings.

REVIEW OF PREVIOUS RESEARCH

Girls appear to be generally more resistant to health risks than boys. In the absence of female infanticide, excess female mortality can be attributed to either:

(*a*) Strictly biological causes: girls' greater vulnerability to various illnesses that are important causes of death in the area; or

(*b*) Social factors: discrimination in nutrition and health care or other types of behaviour that differentially expose girls and boys to health risks.

Biological causes of death

After the first month of life, the most important cause of death for Sahelian children is infectious and parasitic diseases—in particular, diarrhoea, respiratory diseases, malaria and measles. The incidence of these diseases is similar for both sexes, although girls appear to have a small, innate advantage in surviving most of them, especially during infancy (Waldron, 1983; see also Chahnazarian and others, 1992; Basu, 1989; Chen, Huq and D'Souza, 1981; Koenig and D'Souza, 1985; Black and others, 1982; Bhuiya 1983; and Aaby and others, 1984).

Boys appear to be especially susceptible to most respiratory diseases. In spite of generally higher birth weights, their lungs tend to be less fully developed at birth, leading to greater vulnerability to respiratory infections during the first months of life (Waldron, 1983). In a study using data from the Institut français de recherche scientifique pour le développement en coopération (ORSTOM) population laboratory in rural Senegal, Cantrelle and others (1986) found that male children are significantly more likely to die from respiratory disease than are girls.

Girls seem to be more vulnerable to measles and perhaps to whooping cough and respiratory tuberculosis (Garenne, 1992; Preston, 1976). Their relative susceptibility to measles has been attributed to biological factors (Garenne, 1992), differences in social interactions, leading to different intensities of initial exposure to the virus (Aaby and others, 1986; Cantrelle and others, 1986; Bonneuil and Fargues, 1989), and discrimination in nutrition and health care. (The current study pertains to children under two years of age, for whom social interactions should be similar for both sexes.) In the Sahel, excess female mortality from measles has been documented for children in Guinea-Bissau (Aaby and others, 1986), rural Senegal (Cantrelle and others, 1986) and Bamako (Fargues and Ouaïdou, 1988).

Reasons for differential treatment

Different treatment of sons and daughters can lead to differential vulnerability to health risks. Research primarily on Asia and the Middle East has highlighted the importance of the economic value of sons and daughters to their families, mother's educational attainment, the sex composition of older siblings in the family, place of residence, cultural and religious attitudes, and perceived differences in the needs of boys and girls as factors underlying parents' decisions to discriminate in the treatment of their children.

Income and earnings potential

An argument made for India and Bangladesh is that boys are of greater value to their families as productive assets (e.g., Rosenzweig and Schultz, 1982; Muhuri and Preston, 1991). Social norms and possibly differences in physical strength constrain women's work activities outside the home, and home production is perceived as having less value than other work. In this context, the long-term economic value of boys exceeds that of girls, leading to biases in the distribution of household resources. Discrimination against girls should be greater in situations where family resource constraints are tight and, therefore, equal treatment of children is viewed as a luxury, affordable only after a certain level of economic security is attained.

Locoh (1986) and Gbenyon and Locoh (1989) have questioned the validity of such arguments in the context of sub-Saharan Africa. In contrast to South Asia, strict restrictions on women's activities outside the family compound are unusual. Girls tend to be heavily involved in economic activities from an early age, bride prices are more typical than dowries, an adult woman's ability to aid her parents is considerable, and women's autonomy in many domains is often large. Although it remains true that women's legal status and decision-making power are often inferior to those of men, the economic rationale for discrimination against girls is less obvious in sub-Saharan Africa than in South Asia.

A counter-argument is made by Dickemann (1979), who contends that, in poor and especially polygamous societies, female infanticide and differential neglect of daughters occurs primarily among the upper classes. In essence, she argues that boys in wealthy families are likely to acquire, when adult, a disproportionately large number of spouses. Their expected reproductive success (number of children) and thus their long-term value to their families is greater than that of their sisters. In contrast, a daughter's expected reproductive success and her value exceeds that of sons in poorer families. Parents will tend to discriminate against, and perhaps eliminate, less-valued children in the family—girls in the upper classes and, more rarely, boys in the lower classes.

Rising incomes can affect mortality risks by sex for a number of other reasons. Greater resources increase the potential scope of favoured treatment given to more valued children (Das Gupta, 1987). On the other hand, diminishing returns to expenditures on health and nutrition can cause sex mortality differentials to fall, even when the degree of discrimination remains unchanged. Finally, with higher incomes comes a declining importance of infectious and parasitic diseases, for which the biological female advantage is comparatively small, acting to reduce relative female mortality.

Evidence on the relationship between household resources and mortality by sex is largely non-existent for sub-Saharan Africa, and mixed elsewhere. D'Souza and others (1988); Bairagi (1986); Choe and Razzaque (1990); and Behrman and Kenen (1985) found boys to be favoured in terms of nutrition and survival during the 1974-1975 famine in Bangladesh and during the lean season in India. A large number of other studies have found either no effect or a positive effect of household income or wealth on the relative female mortality risk; Muhuri and Preston (1991) present a partial review of this literature. Finally, excess female child mortality is observed almost entirely in high mortality populations, which are characterized by, among other things, low levels of income (Preston, 1976; Rutstein, 1984). However, Tabutin and Willems (in this issue) report that, within the set of high mortality countries, the level of mortality is a poor predictor of differential mortality by sex. Moreover, neither these authors nor Gbenyon and Locoh (1989) found a significant link between child mortality levels and sex differentials in sub-Saharan Africa.

Mother's education

According to Caldwell (1979), mothers are more concerned than fathers with their children's welfare, regardless of sex. As a woman's educational attainment increases and her decision-making power in the family improves, the allocation of household resources to children should increase and discrimination against girls—where it exists—should decrease, leading to a fall in relative (excess) female mortality.

To our knowledge, this hypothesis has never been tested in Africa. In the Indian subcontinent, contradictory results abound: mother's education has been found to be associated with lower female relative risks of death in India (Bourne and Walker, 1991; Caldwell, Reddy and Caldwell, 1983); higher relative risks in Bangladesh (Huda, 1980; Bhuiya and Streatfield, 1991) and in the Punjab (Das Gupta, 1987); and roughly equal relative risks in India (Basu and Basu, 1991), Bangladesh (Muhuri and Preston, 1991), and Pakistan (Sathar, 1987). For Brazil, Thomas (1990) reports that a mother's own income—another measure of her power in the family—has a greater impact on child health than does a father's income. Mothers were also found to favour girls—and fathers, boys—in the allocation of income. In contrast, Akin and Guilkey (1990) found that mother's unearned income has a greater positive effect on the health of sons than that of daughters, in the Philippines.

Sex composition of older siblings

The sex composition of older surviving siblings in the family can also affect a child's mortality risk. Boys and girls are not perfect substitutes in terms of their economic and "consumption" values—the pleasure they give their parents. In general, the first son and daughter are highly prized by their parents; as the number of surviving sons or daughters grows, the relative importance placed on the next son or daughter can fall, leading to a greater likelihood of their facing discrimination.

The relationship between a child's wantedness and the number of older siblings of the same sex can also differ for boys and girls. Das Gupta (1987) found that Punjabi girls are especially disadvantaged when they have at least one older sister. Amin and Pebley (1991) and Muhuri and Preston (1991) document similar adverse effects of the number of surviving older sisters on female child mortality in rural areas of Punjab and Bangladesh (see also Ben-Porath and Welch, 1976, and Khan and others, 1989), and a much weaker relationship between the number of surviving brothers and male mortality. In contrast, Stanton and Clemens (1986) report that the estimated increase in mortality risk linked to the number of older siblings of the same sex is roughly the same for boys and girls in Dhaka, Bangladesh.

Urban/rural residence

Community-level factors affect the degree to which sex preferences can be translated into differential mortality. Gbenyon and Locoh (1989) found evidence of higher relative female mortality risks in African urban areas, despite the presence there of higher levels of income. They argue that the more extensive medical facilities in urban areas increase the scope of possible discrimination and that the high costs of these services occasions a more explicit choice within the household of who receives high quality health care. In rural areas, the provision of quality care to a child is often not an option. They conclude that the relative prices of health care options in an area are a critical determinant of differential mortality.

Other researchers have argued that the male advantage is larger in rural areas. Preston (1976), citing evidence from several studies, argues that men's comparative economic advantage is greater in heavy agricultural work in rural areas. In the African context, urban parents may also find it increasingly difficult to monitor and acquire a sizeable proportion of a son's earnings with the monetarization of economies. Daughters are more likely to work in the family environment, where shirking is less feasible and their importance as caregivers for the elderly remains undiminished. For these reasons, the relative value of sons to their families may be lower in urban than in rural areas. Evidence on this issue from Senegal is contradictory: Cantrelle and others (1986) report that excess female child mortality is more pronounced in rural areas, while Barbieri (1989) found son preferences to be stronger in urban areas.

Culture and religion

Culture, social norms, and religious doctrines can dictate different ways of treating boys and girls. It has been argued that Islamic doctrines defining women's roles and activities underlie discrimination against daughters. While several studies have documented excess female mortality for children in Northern Africa and Western Asia (Akoto, 1985; Suchindran and Adlakha, 1985; Tabutin, 1990; Vallin, 1983), Gbenyon and Locoh (1989) show that the geographical pattern of sex differentials in mortality is not closely related to the Islamic religion in sub-Saharan Africa. In Senegal, Barbieri (1989) reports that son preference is stronger among Muslims than Christians. Cultural practices such as male and female circumcision and food taboos also affect child survival. However, the diversity of cultures and practices in Western Africa makes it difficult to generalize about their overall impact on sex mortality differentials.

Parents' perception of health risks

Lastly, Locoh (1986) and Trussell, van de Walle and van de Walle (1989) note that parents may discriminate between sons and daughters even in the absence of sex preferences, if they perceive them to have different needs or to be differentially vulnerable to diseases.

Evidence on sex discrimination in child care

In the Sahel, evidence on sex differences in nutrition is mixed; if anything, girls appear to be slightly advantaged. Cantrelle and others (1986) and Aaby and others (1986) did not find evidence of discrimination in rural Senegal and Guinea-Bissau. According to Barbieri (1989), Demographic and Health Surveys (DHS) data for Senegal reveal that boys are more likely to receive bottled milk, and that their nutritional status, measured by anthropometric indicators, is somewhat worse between 20 and 30 months—the age of weaning. Garenne and others (1987) found girls to be slightly better off in terms of anthropometric measurements in a rural area of Senegal. Mbacké and LeGrand (1991) did not find significant sex differences in nutritional status in a study of 1987 Malian DHS data. Guèye (1987), using data from the Enquête sur la mortalité infantile dans le Sahel (EMIS) in Bobo-Dioulasso on young children taken to health centres for medical care, showed that growth faltering starts earlier and is more severe for boys. Trussell, van de Walle and van de Walle (1989) report that some women interviewed for the same survey stated that sons suckled more vigorously than daughters and hence received more breast milk. They also found amenorrhoea to be shorter after the births of daughters than sons, again suggesting a more intensive breast-feeding of male children. A number of anthropological studies have reached similar, contradictory results; see, for example, Wagennar-Brouwer (1985).

Elsewhere in Western Africa, Deaton (1988) did not find evidence of differential treatment of boys and girls within households, either in terms of total expenditures or expenditures on food, in a study of World Bank Côte d'Ivoire Living Standards Survey data. Sahn (1990), analysing anthropometric data collected by the same survey, reports that male children in urban areas are significantly more likely to be chronically malnourished, based on height for age. Concerning current malnutrition (based on weight for height) and in rural areas in general, there are no significant differences between the sexes. Aldeman (1990), studying similar data from Ghana, found female children to be insignificantly better off in terms of anthropometric measures of nutritional status.

It is important to recognize that, even when parents discriminate in favour of sons or daughters in terms of food, their discrimination does not necessarily translate into relatively better nutrition and lower mortality risks. Families are not always aware of the nutritional value of foods; Barbieri (1989), for instance, notes that boys in Senegal may be "favoured" with more bottled milk, which is less healthful than breast milk. Poor anthropometric status reflects the effects of prior or ongoing illnesses as well as inadequate nutrition *per se*. Finally, there is growing evidence that mild and moderate levels of malnutrition do not greatly affect a child's risk of death; see, for example, Behrman, Deolalikar and Wolfe (1988).

Concerning health care, the few existing studies on Western Africa indicate a favoured treatment of boys. Locoh (1986) reports that boys in Lomé are more likely to be hospitalized than girls, and Fargues and Ouaïdou (1988) note similar findings for Bamako. Mbacké and LeGrand (1991) found that Malian boys are more likely to be taken to a health centre for treatment of diarrhoea and fevers and to receive multiple inoculations for poliomyelitis and DPT (diphtheria, tetanus and pertussis). Barbieri (1989) reports that Senegalese boys are more likely to receive some form of treatment for malaria or diarrhoea. On the other hand, Cantrelle and others (1986) found no evidence of discrimination in health care in rural Senegal.

DATA AND ANALYSIS

Data are from three EMIS surveys for the cities of Bamako and Bobo-Dioulasso and for the rural areas of Fissel and Thiénaba in the Thiès region of Senegal. These are multi-round surveys, fielded between 1981 and 1985 by the Institut du Sahel in collaboration with national agencies. They are similar in design and provide detailed socio-economic, demographic, health and nutritional information on over 21,000 children aged 1-23 months (see table 1). The size and quality of data allow for a more extensive study of the factors believed to underlie sex differences in mortality than in most other research to date.

TABLE 1. STATUS OF CHILDREN AT AGE 2 IN THE THREE EMIS DATA SETS

	Bamako	*Bobo-Dioulasso*	*Senegal*	*Total*
Total children at age 1 month	9 491	7 217	4 696	21 404
Observed survival to 24 months	6 896	5 825	3 974	16 695
Observed death 1-23 months	629	565	584	1 778
Post-neonatal death	408	341	303	1 052
Toddler death (12-23 months)	221	224	281	726
Lost from observation	1 966	827	138	2 931

NOTE: Only children under observation for at least two consecutive rounds (at risk of an "observed" death) are included in the data.

Data were first collected at the time of birth for a cohort of children born to resident mothers over a one-year period, 1 April 1981 to 31 March 1982 for Bobo-Dioulasso and Senegal, and 1 April 1982 to 31 March 1983 for Bamako. The children were then revisited seven times over the following two years, at ages one month, four months, and thereafter every four months. An effort was made to include all births occurring during the year in Bobo-Dioulasso and in the Senegalese area. For Bamako, hospital and clinic births—the large majority of births occurring in the city—were surveyed for three days out of five, and a small proportion of home births was also captured. For the rural area in Senegal, all children were first surveyed shortly after the birth, based on a prior census of pregnant women in the area and on information provided by village-level informants.

The longitudinal design permits a more accurate measurement of events (for example, a child's age at weaning or at death), and differential misreporting of deaths by sex, a problem with retrospective surveys, is not possible. Irrespective of their sex, children are observed at birth, and their survival or death is recorded at each round. A major problem with the data concerns sample selectivity over the two-year survey period. Losses from observation, important in the urban areas, can systematically alter the composition of the data sets, causing estimated levels of mortality to be biased. The effect of sample selectivity on relative risks of death by sex is less clear, although it appears to be small.[2]

Two measures are taken to reduce the possible effects of such selectivity. First, the neonatal period is dropped from the analysis. Data on this age span are especially flawed due to underreporting of perinatal deaths and to losses from observation strongly linked to socio-economic variables caused by the difficulty of locating city children from addresses reported at the time of birth (see note 2). In any case, neonatal deaths are predominately due to complications from birth trauma and congenital anomalies, for which girls are at an advantage. The risk of death for female neonates estimated from EMIS data is considerably lower than that of males in every area. Secondly, discrete hazard regressions are used in the study of mortality determinants. This allows available data on children lost from observation to be fully used, and the dummy variables for age spans (corresponding to the periods between survey interviews) should partially control for potential biases from sample selectivity.

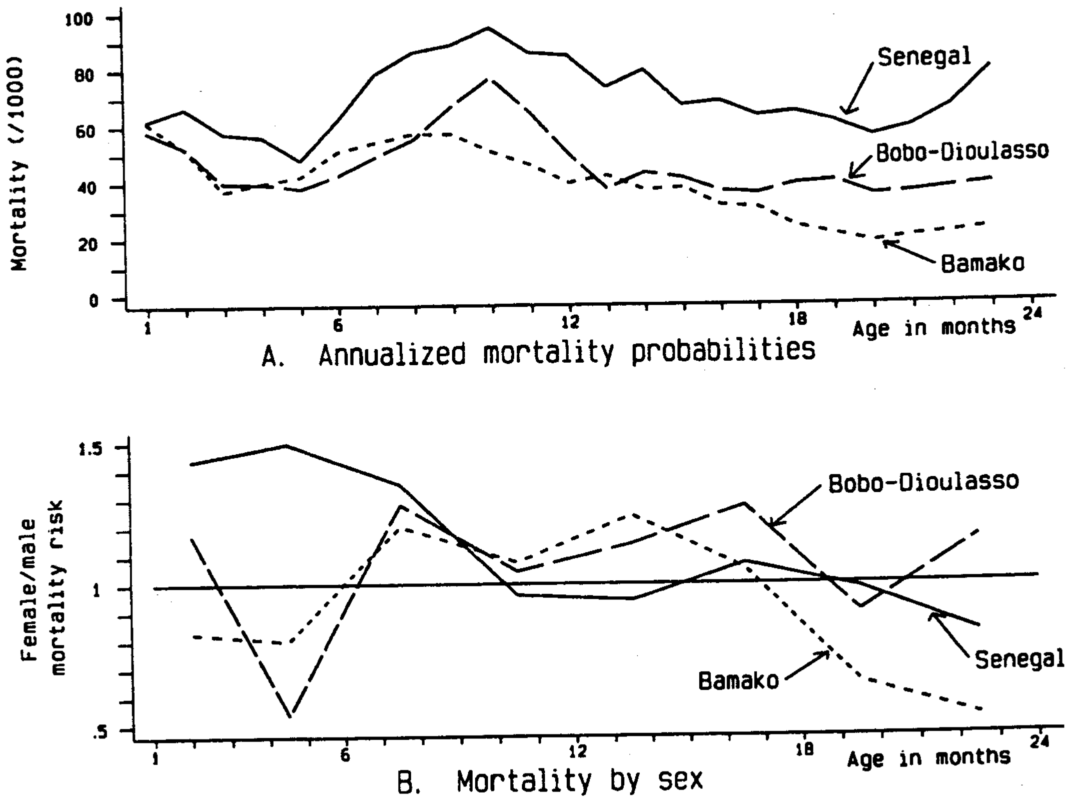
Empirical analysis

Figure I (A) shows annualized mortality probabilities by month of age for the three areas. Mortality follows the typical Sahelian pattern: falling risks over the first few months of life, followed by an increase starting about month 5, due to infections caused by the introduction of supplemental foods, children being placed more frequently on the ground, and the declining stock of maternal immunoglobulins. After a peak late in the first year of life, mortality levels gradually fall. In all three areas, and especially in Senegal, mortality levels rise again at about 20 months of age, the usual age for weaning. On the whole, children in Bamako face the lowest risks and children in rural Senegal the highest risks.

The lower graph shows female-to-male mortality ratios for three-month age groups: 1-3, . . . 19-21, and 22-23. In Bamako and Bobo-Dioulasso, the age profile is roughly similar: generally excess male mortality for the first half-year, followed by excess female mortality for the next year. For months 17-23, boys again appear to be at a disadvantage in Bamako; in Bobo-Dioulasso, the pattern is less clear. The pattern of relative risks in rural Senegal is strikingly different. Female infants experience much higher mortality risks between months 1 and 9, ages at which boys are generally thought to be at a disadvantage. For months 9-20, risks appear to be similar, followed by three months of slight excess male mortality.

Table 2 presents mortality probabilities by sex for three age groups that appear most to emphasize sex mortality differences in exact month data from the cities of Bamako and Bobo-Dioulasso: 1-5, 6-15 and 16-23 months. In each of the two cities, insignificant excess male mortality occurs for ages 1-5 months; in pooled data it would be significant at the 5 per cent level.[3] In the Senegalese area, girls of the same ages face mortality risks that are nearly 50 per cent above those of boys. In exact month data for Senegal, girls appear to face higher mortality over the 1-8 month span; for this age group the female

Figure I. Mortality patterns in the EMIS study areas



disadvantage is similar: a sex mortality ratio of 1.41 that approaches the 1 per cent level of significance. Girls aged 6-15 months experience higher mortality in all three areas. This excess risk is significant at the 5 per cent level in the pooled urban areas and at the 10 per cent level in the city of Bamako alone. Finally, boys aged 16-23 months in Bamako face significantly (5 per cent level) higher mortality risks than girls.

TABLE 2. MORTALITY PROBABILITIES, BY SEX AND AGE

(per 1,000)

Age group	*Bamako*	*Bobo-Dioulasso*	*Senegal*
1-5 months			
Female	18.1	16.8	27.7
Male	22.4	21.5	18.8
F/M	0.81	0.78	1.47[a]
6-15 months			
Female	43.2	48.1	69.3
Male	36.1	42.0	63.4
F/M	1.20	1.15	1.09
16-23 months			
Female	13.1	24.2	39.7
Male	19.9	23.5	44.3
F/M	0.66[a]	1.03	0.90
1-23 months			
Female	72.8	86.7	131.0
Male	76.4	84.6	121.7
F/M	0.95	1.02	1.08

[a]Significant at $p < 0.05$.

Changes in relative risks by sex between age groups are also often statistically significant (see note 3). In Bamako, the increase in the female-to-male mortality ratio between months 1-5 and 6-15, and the subsequent decrease for months 16-23, are both significant at the 5 per cent level. In Senegal, the decrease in the ratio between 1-8 and 9-23 months is significant at the same level. Changes in relative risks with children's age in Bobo-Dioulasso never attain significance.

The absence of a clear, overall male or female child survival advantage in any of the areas does not rule out the existence of systematic patterns of male and female excess mortality, patterns linked to factors whose effects may cancel out in the aggregate. Differential vulnerability to specific causes of death, discrimination in health care and nutrition, and the socio-economic and demographic correlates of mortality risks by sex are examined in order to investigate this possibility and to explain the varying relative mortality risks by sex observed across narrow age groups.

Biological causes of death

EMIS cause of death data are of uncertain accuracy. The information is reported by the mother, who may not have been aware of the true cause of death. Cause-of-death categories are aggregations of more detailed classifications that vary from one EMIS to the next. While every effort was made to create coherent disease groups, the data remain, to some degree, inconsistent. A single other category, accounting for 21 per cent of deaths occurring between 1 and 23 months in the combined data sets, includes all deaths that could not be assigned to one of the major disease categories. Nevertheless, Kuate Defo (1993) found reported cause of death to be "quite accurate" in a study using data from a Yaoundé EMIJ survey of very similar design. Deaths caused by clearly identifiable and well-known diseases such as measles are likely to be relatively well measured by the data.

Table 3 presents the percentages of female and male deaths over the entire 1-23-month age span attributed to five causes: measles; respiratory diseases; diarrhoea, stomach illnesses and malnutrition; malaria and fevers; and other or unknown causes of death. There are no significant differences between the percentages for boys and girls, a finding that is largely repeated when the data are disaggregated to the age groups found to emphasize sex differences in mortality (results not shown). The one exception concerns deaths for ages 16-23 months in Bamako, where boys appear to be at a disadvantage. Measles, a disease for which several other studies have found a male survival advantage, accounts for 11.2 per cent of female deaths and 11.0 per cent of male deaths for children aged 1-23 months in the combined data sets.[4] Respiratory diseases, for which boys are at a presumed disadvantage,

TABLE 3. CAUSE OF DEATH, BY SEX, FOR CHILDREN AGED 1-23 MONTHS
(*Percentage*)

	Bamako		*Bobo-Dioulasso*		*Senegal*	
Cause of death	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*
Measles	5.1	3.9	17.9	20.6	11.0	9.6
Respiratory	9.7	10.7	6.5	7.8	7.8	10.6
Diarrhoea	34.7	32.9	43.4	42.6	40.9	36.3
Malaria	17.2	15.8	16.5	15.2	19.9	25.1
Other	33.2	36.8	15.8	13.9	20.3	18.5

NOTE: "Malaria" includes deaths attributed to fever; "diarrhoea" includes deaths attributed to stomach illnesses and malnutrition; and "other" includes unknown and multiple causes of death. Differences between boys and girls are never significant, even at the 10 per cent level.

are the reported cause of death for 9.7 per cent of female and 8.1 per cent of male deaths in the areas.

The seasonal distribution of male and female deaths by sex, age group, and area was also examined. Month of death is well measured by the EMIS and, given that diseases follow distinct seasonal patterns, the analysis provides a further opportunity to study sex differences in cause of death. The results did not reveal a clear seasonal pattern of mortality by sex in any of the areas or age groups. Clearly, EMIS data do not support the contention that young boys and girls are differentially vulnerable to any of the major causes of death in the Sahel.

Discrimination in health care and nutrition

There is also little evidence in EMIS data of discrimination between boys and girls in terms of medical visits, vaccinations, and child-feeding. Table 4 shows the probability of being vaccinated by sex for tuberculosis, measles and the disease set of diphtheria, pertussis and tetanus (DPT)—in Bobo-Dioulasso, and polio (DPT+P)—for children surviving under observation to age 24 months. Statistics on meningitis and a separate polio vaccination, available only for Bamako, are also presented.[5]

TABLE 4. PERCENTAGE OF CHILDREN VACCINATED BY AGE 2 AMONG THOSE WHO SURVIVED UNDER OBSERVATION, BY SEX AND TYPE OF VACCINATION

	Bamako		*Bobo-Dioulasso*		*Senegal*	
Vaccination	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*
Tuberculosis	94.3	93.4	79.5	79.5	51.5	51.5
Measles	39.6	38.6	65.9	68.3	37.5	37.4
DPT: 1+ vaccination . .	26.2	25.5	83.1	83.3	58.2	56.5
2+ " . .	21.0	19.7	..	..	19.5	17.8
3+ " . .	18.8	17.8	..	..	1.9	2.1
Meningitis	4.2	3.2	..	..	..	..
Polio	21.1	21.9	..	..	..	..

NOTE: In Bobo-Dioulasso, the DPT vaccination includes polio (DPT+P).

Vaccination rates for boys and girls are always very similar. Differences are significant for meningitis in Bamako (male advantage at the 5 per cent level) and perhaps measles in Bobo-Dioulasso (female advantage at the 10 per cent level), although their size remains small. The number of DPT vaccinations given to children was also recorded for Bamako and Senegal. Three separate vaccinations, necessary for maximal protection, require more effort on the part of the family and are probably less subject to misreporting errors due to memory lapses; moreover, discrimination may be more pronounced when greater parental attention and effort are required. In both EMIS areas, boys appear to face a small, insignificant advantage for receiving the full set of these vaccinations.[6]

Among children surviving under constant observation up to 24 months, differences between girls and boys in the number of inter-round periods during which a medical visit was recorded are not significant in any of the areas. EMIS/Senegal also contains information on the type of curative health care given to children prior to death. Among children observed to die between 1 and 23 months, 82.8 per cent of girls and 75.1 per cent of boys received modern medical care, a difference that is significant at the 5 per cent level. Moreover, the percentage of girls receiving modern medical care prior to death exceeds that of boys for all age groups, including the 1-8- (and 1-5-) month group, for which excess female mortality was documented. This finding may be due to the fact that girls are often viewed as being more robust than boys by both the Serrer and Wolof ethnic groups in Senegal, groups which make up the bulk of the sample. It is possible that sick boys tend to be brought more rapidly to the medical centre, and are hence more likely to survive their illnesses, effectively removing them from these calculations.

Variables were constructed that measure roughly the same phenomenon for Bamako and Bobo-Dioulasso. In Bamako, 79.4 per cent of boys and 77.7 per cent of girls visited a medical centre during the inter-round period for which they are recorded as dying. For Bobo-Dioulasso, 35.1 per cent of girls and 32.1 per cent of boys were reported to receive modern medical care for an illness during the period of death. In neither city are differences between male and female percentages significant.[7]

Age at the introduction of non-milk foods and at weaning is recorded for all three areas. The pattern for introducing supplemental foods is very similar for boys and girls: for both sexes, the median age is 5 months for Senegal and 6 months for Bamako and Bobo-Dioulasso. The median age at weaning for boys and girls is also equal, at 20 months for Bamako and Bobo-Dioulasso and 22 months for Senegal. Mantel-Haenszel tests show that sex differences in the age profile for supplemental feeding and weaning are highly insignificant in all three areas. For Bamako and Senegal, additional information exists on the use of non-mother's milk (infant formula etc.). There are no significant differences in the percentage of boys and girls reported to receive this food, and the age pattern for its introduction into their diets is similar in both areas.

Socio-economic, demographic and ethnic factors

Discrete hazard logit regressions are used to examine the effects of socio-economic, demographic and ethnic factors on sex mortality differentials. The model focuses on three hypotheses frequently considered in the literature: Do higher levels of income and wealth act to decrease or increase female-to-male relative mortality risks? Do higher levels of maternal education decrease these relative mortality risks? Do girls of higher birth orders tend to face greater relative mortality risks? Concerning the last hypothesis, EMIS data do not include the sex composition of older surviving children in the household. However, if the degree of discrimination increases with the number of older siblings of the same sex and the effect is more pronounced for girls than for boys, then an excess female mortality-birth order link should be apparent.

The discrete hazard approach allows the baseline risk of dying to vary with the child's age, it fully accounts for the timing of losses from observation, and it permits the reinclusion in the data of children who return to observation after being lost (left censoring). A record is included in the regression each time that a child is observed alive at one round and observed to have died or survived at the next. Thus, a child who survives under constant observation from 1-23 months (covering seven interview rounds) is counted as six observations, one for each of the inter-round periods. Dummy variables for inter-round periods are included in the regressions to control for varying baseline risk caused by changing ages and differing period lengths (3 or 4 months). To some extent, these variables also control for the possible effects of sample selectivity due to losses from observation.

Mortality outcomes were regressed against a set of dummy variables for the child's sex and birth order, mother's schooling, marital status and ethnic group, household socio-economic status, a full set of sex interaction terms, and control variables for the inter-round periods. Definitions of variables and their means for the first inter-round period (1-3 months) are presented in table 5. Socio-economic status is a three-level index based on housing quality. Less detailed information on housing conditions is available for Senegal; given the general living conditions in rural areas, it was assumed that there were no cases of high socio-economic status in that area. Certain ethnic groups incorporate other closely related ethnicities: the Sarakolé include the Soninké and Maraka, and the Poulaar include the Peulh, Toucouleur and Djogoramé. In Senegal, the Wolof include a small number of children from other ethnic groups. Regressions were estimated for the period of 1-23 months for each area; additional regressions were also estimated for age groups that appear to emphasize sex mortality differences: 1-5, 6-15 and 16-23 months for Bamako and Bobo-Dioulasso, and 1-8 and 9-23 months for rural Senegal.

Based on the regression results, female-to-male mortality ratios were calculated by age group for children of specific characteristics. Estimated coefficients were first used to compute the probability of dying for each inter-round period. Mortality probabilities for the relevant age groups were then derived, from which the sex mortality ratios were computed. The reference (R) mortality ratios refer to children with

TABLE 5. DISTRIBUTION OF EXOGENOUS VARIABLES FOR CHILDREN AGED 1-3 MONTHS
(*Percentage*)

Variable group	*Category*	*Bamako*	*Bobo-Dioulasso*	*Senegal*
Sex				
	(R) Male	50.7	49.2	49.7
	Female . . .	49.3	50.8	50.3
Birth order				
	1	19.4	20.8	13.2
	(R) 2-5	60.3	53.0	54.1
	6+	20.4	26.2	32.7
Household socio-economic status				
	(R) Low	62.6	65.3	73.8
	Middle . . .	24.3	23.2	26.2
	High	13.2	11.5	..
Mother's schooling				
	(R) None	67.9	75.2	96.1
	Some	32.1	24.8	3.9
Mother's marital status				
	Unmarried .	14.9	8.9	1.9
	(R) Monogamous	52.5	56.1	57.5
	Polygamous	32.6	35.0	40.7
Mother's ethnicity				
Bamako	(R) Bambara . . .	34.4	..	..
	Malinke . . .	15.5	..	..
	Poulaar . . .	14.0	..	..
	Sarakole . .	10.3	..	..
	Other	25.8	..	..
Bobo-Dioulasso				
	(R) Mossi	..	26.1	..
	Dioula, Dafing . .	..	23.8	..
	Bobo	..	18.0	..
	Other	..	32.1	..
Senegal	(R) Serrer	..	..	66.6
	Wolof and others . . .	..	..	33.4
Number of observations		8 871	6 917	4 594

NOTE: Only children with valid data for all variables are included in the data. (R) denotes omitted reference categories in the regressions. Other variables used in the regressions are the interaction terms between sex and the variables above (except for sex) and the inter-round period dummy variables.

modal characteristics: birth order 2-5, of monogamously married mothers with no schooling, residing in low-quality housing, and of the Bambara (Bamako), Mossi (Bobo-Dioulasso) or Serrer (Senegal) ethnic group. These characteristics were then changed one by one to calculate the other mortality probabilities and ratios by sex. Regression coefficients and significance levels are shown in the annex below. One-tailed significance levels are used for testing hypotheses and two-tailed levels for evaluating the importance of other factors.

Tables 6-8 present the results of this analysis. The argument that poorer families tend to discriminate more between children, acting to increase levels of relative female mortality, finds limited support in Bamako and no support elsewhere. In Bamako, the mortality ratios for children of middle and high socio-economic status, considered together, are systematically lower than those for children of low status, a relation that is significant for age groups 1-23 months and 1-5 months. For the age group 1-5 months, children of intermediate status have a significantly lower mortality ratio than poor children. Their ratio is also significantly below unity, indicating excess male mortality rather than simply lower levels of excess female mortality.

In the other areas, girls of wealthy families appear to face higher relative risks, in line with Dickemann's (1979) hypothesis. In Bobo-Dioulasso, high status children have the greatest mortality sex ratios in all age groups, ratios that are significantly above those of the poorest children for the 1-23 month and 16-23 month age groups. On the whole, children of low and middle socio-economic status display similar relative mortality risks by sex. In rural Senegal, high mortality ratios are also observed for the middle class, the highest socio-economic category defined for the area, in both age groups.

The notion that mother's schooling causes relative female mortality to fall is also not confirmed with EMIS data. Compared to children of uneducated mothers, the female-to-male mortality risks of children born to mothers with some education tend to be slightly higher in Bamako, considerably higher in rural Senegal, and somewhat lower in Bobo-Dioulasso, although differences are never significant. The hypothesized birth order/relative mortality risk link similarly does not receive support. Only among children aged 16-23 months in Bamako is there a significant difference between the sex mortality ratios by birth order, and for that group, first-born girls face the highest—not the lowest—relative risks. In Bobo-Dioulasso, there is a slight tendency for sex mortality ratios to increase with parity and in Senegal, for them to decrease, although differences are insignificant.

The overall small number of statistically significant results, even at the 10 per cent level (two-tailed tests; 5 per cent level for one-tailed tests), is striking. Even in regressions on pooled data from Bamako and Bobo-Dioulasso, in which dummies for ethnicity are replaced by vari-

TABLE 6. FEMALE-TO-MALE MORTALITY RATIOS: BAMAKO

	1-23 months			*1-5 months*			*6-15 months*			*16-23 months*		
	Mortal-ity,	*Signif-icance*		*Mortal-ity,*	*Signif-icance*		*Mortal-ity,*	*Signif-icance*		*Mortal-ity,*	*Signif-icance*	
	F/M	*1.0*	*R*	*F/M*	*1.0*	*R*	*F/M*	*1.0*	*R*	*F/M*	*1.0*	*R*
Parity: 1 . .	1.25			0.52			1.55			3.06	b	a
2-5 .	1.07		R	0.57		R	1.73	a	R	0.80		R
6+ . .	0.89			0.81			1.13			0.62		
No education	1.07		R	0.57		R	1.73	a	R	0.80		R
Educated . .	1.28			0.48	b		2.75	a		1.02		
Socio-economic status												
Low	1.07		R	0.57		R	1.73	a	R	0.80		R
Middle . .	0.79			0.25	a	a	1.49			0.72		
High . . .	0.81			0.55			1.23			0.44		
Unmarried .	0.66		a	0.81			0.86		b	0.20	a	a
Monogamous	1.07		R	0.57		R	1.73	a	R	0.80		R
Polygamous	1.04			0.73			1.46			0.70		
Bambara . .	1.07		R	0.57		R	1.73	a	R	0.80		R
Malinke . . .	1.42			1.01			2.15	a		0.73		
Sarakole . .	1.71	b		0.99			3.69	a		0.71		
Poulaar . . .	0.94			1.04			0.92		b	0.79		
Other	1.02			1.09			1.23			0.51		
Number of:												
observations	45 759			17 206			23 455			13 380		
deaths . .	589			168			311			110		
Percentage of deaths, female . .	48.7			43.5			54.7			40.0		

NOTE: Measures of significance for the sex mortality ratios:
1.0 It is significantly different from 1.0.
R It is significantly different from that of children with the reference characteristics.
[a]Significant at $p < 0.05$ (2-tailed tests).
[b]Significant at $p < 0.05$ (1-tailed tests).

ables for city of residence, none of the relationships considered by the hypotheses and questions is statistically significant for any of the age groups (results not shown). The lack of clear patterns across age groups and study areas, even for insignificant results, strongly suggests the absence of real differences in the impact of these variables on boys' and girls' survival.

Dummy variables for marital status and ethnicity were included in

TABLE 7. FEMALE-TO-MALE MORTALITY RATIOS: BOBO-DIOULASSO

	1-23 months			*1-5 months*			*6-15 months*			*16-23 months*		
	Mortality, F/M	*Significance 1.0*	*Significance R*	*Mortality, F/M*	*Significance 1.0*	*Significance R*	*Mortality, F/M*	*Significance 1.0*	*Significance R*	*Mortality, F/M*	*Significance 1.0*	*Significance R*
Parity: 1 . . .	0.90			0.80			1.08			0.72		
2-5 .	1.05		R	0.96		R	1.09		R	1.02		R
6+ . .	1.18			1.82			1.24			0.75		
No education	1.05		R	0.96		R	1.09		R	1.02		R
Educated . .	0.87			0.68			1.07			0.61		
Socio-economic status												
Low	1.05		R	0.96		R	1.09		R	1.02		R
Middle . .	0.91			0.99			0.98			0.65		
High . . .	2.25	a	a	2.30			1.88			3.35		b
Unmarried .	0.89			1.07			0.94			0.57		
Monogamous	1.05		R	0.96		R	1.09		R	1.02		R
Polygamous	0.78		b	0.53			0.82			0.90		
Mossi	1.05		R	0.96		R	1.09		R	1.02		R
Bobo	1.31			0.61			1.42			1.98		
Dioula, Dafing . .	1.26		R	0.89			1.32			1.56		
Other	1.29			0.97			1.30			1.53		
Number of:												
observations	37 813			13 626			19 177			11 683		
deaths . .	560			130			290			140		
Percentage of deaths, female . .	51.6			44.6			54.5			52.1		

NOTE: Measures of significance for the sex mortality ratios:
1.0 It is significantly different from 1.0.
R It is significantly different from that of children with the reference characteristics.
[a]Significant at $p < 0.05$ (2-tailed tests).
[b]Significant at $p < 0.05$ (1-tailed tests).

the regressions to control for possible confounding effects. Compared to children born of monogamous mothers, children of unmarried mothers in Bamako have significantly lower sex mortality ratios after their first six months of life. In Senegal, the very small number of children born to unmarried mothers have higher ratios, although differences are insignificant.

The effect of ethnicity on relative risks by sex is never significant

TABLE 8. FEMALE-TO-MALE MORTALITY RATIOS: SENEGAL

	1-23 months			1-8 months			9-23 months		
	Mortality, F/M	Significance 1.0	Significance R	Mortality, F/M	Significance 1.0	Significance R	Mortality, F/M	Significance 1.0	Significance R
Parity: 1 . .	1.26			1.76			1.14		
2-5 .	1.11		R	1.21		R	1.09		R
6+ . .	1.05			0.93			1.11		
Uneducated .	1.11		R	1.21		R	1.09		R
Educated . .	2.11	b		1.79			2.43		
Socio-economic status									
Low	1.11		R	1.21		R	1.09		R
Middle . .	1.45	b		1.46			1.47		
High . . .	—			—			—		
Unmarried .	1.55			1.51			1.63		
Monogamous	1.11		R	1.21		R	1.09		R
Polygamous	0.93			1.39			0.78		
Serrer	1.11		R	1.21		R	1.09		R
Wolof and others . . .	0.97			1.81	b		0.70	b	
Number of:									
observations	25 831			13 479			16 710		
deaths . .	578			196			382		
Percentage of deaths, female . .	52.1			58.7			48.7		

NOTE: Measures of significance for the sex mortality ratios:
1.0 It is significantly different from 1.0.
R It is significantly different from that of children with the reference characteristics.
[a]Significant at $p < 0.05$ (2-tailed tests).
[b]Significant at $p < 0.05$ (1-tailed tests).

in any area for the full age span of 1-23 months, although it appears to have an important effect in several smaller age groups. In Bamako, the male advantage during the age span of 6-15 months is largely due to severe excess female mortality among the Sarakolé, Malinké and, to a lesser extent, Bambara. In fact, if the Sarakolé and Malinké ethnicities were pooled, their sex mortality ratio would be significantly greater than that of the combined Poulaar and other ethnicities at the 1 per cent level, and of the Bambara at the 10 per cent level. These differences are caused by both lower male mortality and higher female mortality among the Sarakolé and Malinké, compared to other groups. Interestingly, girls of these ethnicities are not at a disadvantage for either the periods 1-5 months or 16-23 months, suggesting that excess female mortality during the intermediate period is not caused by a long-lasting pattern of discrimination against daughters.

According to EMIS/Senegal data, female Wolof children face high relative risks during the age span of 1-8 months and low relative risks during the age span of 9-23 months. The change in the mortality ratio between these periods is significant at the 5 per cent level. In contrast, Serrer girls appear to be at a small disadvantage in both periods. The high Wolof sex mortality ratio during the first period is caused by unusually low male mortality probabilities; estimated female risks are similar to those of both Serrer boys and girls. In Bobo-Dioulasso, sex mortality ratios do not appear to be influenced by mothers' ethnicity.

SUMMARY AND DISCUSSION

This article studied sex differences in mortality among children aged 1-23 months in the cities of Bamako and Bobo-Dioulasso and in a rural area of Senegal. No significant differences between male and female mortality risks were found in any of the areas for the full age span of 1-23 months. For smaller age groups, patterns of excess female and male child mortality are evident. Excess female mortality, statistically significant in standard tests, exists among children aged 1-8 months in the Senegalese area and 6-15 months in the combined urban areas of Bamako and Bobo-Dioulasso. Excess male mortality occurs for ages 16-23 months in the city of Bamako.

Why do sex mortality ratios seem to vary across narrow age ranges in these areas? One explanation is that this is simply an artefact of the selection of age groups that maximize variation in mortality by sex. For Bamako, however, other research also indicates the appearance of excess female mortality starting early in the first year. Fargues and Ouaïdou (1988), in a study of Bamako death registration data, report excess female mortality starting at 4 months and continuing through age four years. Mbacké and LeGrand (1991), using DHS/Mali data for urban areas, found that girls aged 3-11 months and, less clearly, during the second year of life face higher mortality risks than boys. There are no comparable studies using small age groups for Bobo-Dioulasso and the rural Senegal study area.[8]

Even in the absence of a clear male or female child survival advantage, there may exist systematic sex differences in vulnerability to disease or in the provision of child care, differences whose effects cancel out in the aggregate. The biological causes of death, child health care and feeding practices, and the socio-economic and demographic correlates of mortality were examined to investigate both this possibility and the causes of variation in sex mortality ratios across narrow age groups.

The data do not reveal important differences between boys and girls in either cause of death or access to health care and nutrition in any of the areas or age groups. Girls are not found to be particularly vulnerable to measles nor boys to respiratory diseases, as has been suggested by other studies. The seasonality of female and male deaths is also similar, further supporting the idea that differential mortality by sex is not strongly linked to specific health risks. In all three areas, the treatment of girls and boys, in terms of vaccinations, modern medical care, supplemental feeding and weaning, is also very similar. These findings must be qualified by recognizing the limits of the data. Cause of death was declared by the mother, and reporting errors may be masking small systematic differences between boys and girls. Detailed information on factors such as the intensity of breast-feeding or type of modern medical care provided to children was also not collected. That said, the EMIS surveys provide unusually large and accurate data sets for studying differences in basic child-care behaviour. The lack of evidence of sex differences in a variety of feeding and health care practices, as well as in easily recognized causes of death (such as measles), indicates that unequal treatment and differential vulnerability to health risks for sons and daughters do not greatly affect young children's mortality risks in the region.

The results of discrete hazard regressions similarly do not reveal systematic effects of socio-economic and demographic variables on child mortality by sex. Excess female mortality is not generally more pronounced among poorer families, where tight resource constraints have been hypothesized to give rise to greater discrimination in parents' allocative decisions in studies on South Asia. Mother's educational attainment does not appear to influence differential mortality by sex to any significant degree. No clear relationship is found between higher birth orders and relative mortality risks. This suggests that, to the extent that parents discriminate against girls or boys as their relative numbers in the household increase, the degree of discrimination is roughly the same for both sexes. Similarly, no systematic link was found between mother's marital status and relative risks by sex. Finally, the pattern of sex mortality differentials in the cities of Bamako and Bobo-Dioulasso and in the rural Senegalese study area does not support either Preston's (1976) hypothesis that excess female mortality occurs primarily in rural areas or Gbenyon and Locoh's (1989) argument that it occurs mostly in urban areas.

On the whole, the results are striking in their absence of systematic effects of socio-economic and demographic factors on sex differences in mortality or of clear differences in parents' treatment of boys and girls in feeding and health care. There is no evidence of pervasive "rational" discrimination by parents against young daughters—discrimination based on perceptions that boys or girls are of greater value and thus merit favoured treatment in ways that affect their health and survival. Other studies, noted earlier, have occasionally reported such discrimination against Sahelian girls or boys, although results were often inconsistent and statistically insignificant.

Only ethnic affiliation appears to be an important determinant of levels and changes in sex mortality differences across small age ranges, especially in Bamako and rural Senegal. Even here, there is little evidence of specific ethnicities "favouring" boys or girls throughout the entire age span of 1-23 months. Ethnicity is a variable that can reflect both cultural practices and the effects of poorly measured or omitted socio-economic variables, making it difficult to interpret these results. A possible explanation is that mortality differences by sex, to the extent that they exist, are caused by cultural practices associated with a child's age or level of physical development that are not necessarily related to "rational" discrimination. In sub-Saharan Africa, these practices include female and male circumcision, sex-specific food taboos, certain child fosterage practices, and even the piercing of girls' ears in generally unhygienic conditions. For example, many ethnic groups in Bamako circumcise daughters between the ages of 40 days and about six months. This operation can provoke serious infections that can cause death or render the child more vulnerable to other health risks. Female circumcision is frequent among the Malinké, Sarakolé and Bambara ethnicities, for whom the estimated female relative risk of dying is very high for ages 6-15 months; it is more rarely practised by the Poulaar, who display the lowest female relative and absolute mortality risks in the data. The fact that female circumcision is less common among residents of Bobo-Dioulasso may underlie the lesser degree of excess female mortality observed for the same ages. However, female circumcision is not practised by either the Serrer or Wolof in Senegal, and cannot explain the elevated risks observed for Wolof girls aged 1-8 months.

EMIS data do not include information on traditional cultural practices, making it impossible to further investigate their effects on sex differences in child health and survival. Other types of data and perhaps comparative anthropological methodologies are needed to interpret the impact of ethnicity found by this analysis.

ANNEX

Hazard logit regression results used to calculate the mortality sex ratios

TABLE A-1. BAMAKO

	1-23 months		*1-5 months*		*6-15 months*		*16-23 months*	
	Coeffi-cient	*t-statistic*	*Coeffi-cient*	*t-statistic*	*Coeffi-cient*	*t-statistic*	*Coeffi-cient*	*t-statistic*
Female child	0.073	0.404	–0.563	–1.619	0.562	2.187	–0.225	–0.532
Parity 1 . . .	0.218	1.349	0.314	1.117	0.378	1.637	–0.342	–0.891
" and girl .	0.167	0.734	–0.099	–0.225	–0.107	–0.344	1.366	2.552
Parity 6+ . .	–0.026	–0.161	0.057	0.199	–0.088	–0.372	–0.005	–0.015
" and girl .	–0.196	–0.856	0.344	0.841	–0.438	–1.326	–0.259	–0.473
Unmarried .	0.554	3.128	–0.017	–0.052	0.742	2.901	1.036	2.723
" and girl .	–0.523	–2.010	0.347	0.704	–0.715	–2.007	–1.420	–2.297
Polygamous	0.055	0.404	–0.186	–0.747	0.191	0.954	0.136	0.469
" and girl .	–0.031	–0.160	0.238	0.648	–0.168	–0.630	–0.141	–0.313
M educated .	–0.325	–2.267	0.180	0.757	–0.668	–3.017	–0.414	–1.319
" and girl .	0.182	0.905	–0.179	–0.490	0.469	1.632	0.250	0.524
Socio-economic status middle	0.010	0.074	0.216	0.909	–0.032	–0.152	–0.234	–0.725
" and girl .	–0.324	–1.559	–0.840	–2.078	–0.155	–0.544	–0.109	–0.215
Socio-economic status high	–0.275	–1.333	–0.454	–1.168	–0.184	–0.618	–0.218	–0.517
" and girl .	–0.289	–0.953	–0.035	–0.061	–0.348	–0.837	–0.612	–0.817
Malinke . . .	–0.115	–0.634	–0.256	–0.820	–0.030	–0.110	–0.041	–0.108
" and girl .	0.292	1.171	0.578	1.248	0.226	0.640	–0.090	–0.153
Sarakole . .	–0.507	–1.962	–0.815	–1.700	–0.729	–1.655	0.157	0.356
" and girl .	0.483	1.432	0.550	0.794	0.771	1.487	–0.123	–0.182
Poulaar . . .	0.095	0.540	–0.142	–0.465	0.394	1.571	–0.242	–0.557
" and girl .	–0.141	–0.532	0.602	1.292	–0.644	–1.721	–0.018	–0.027
Other	0.046	0.314	–0.503	–1.827	0.363	1.699	0.134	0.427
" and girl .	–0.052	–0.239	0.648	1.541	–0.350	–1.184	–0.450	–0.868
Months 4- 5	..	..	–0.718	–4.306	..	..	..	..
4- 7 .	0.150	1.150	..	..	..	..	..	..
8-11	0.304	2.384	..	..	0.709	4.839	..	..
12-15	0.089	0.650	..	..	0.497	3.207	..	..
16-19	–0.338	–2.146	..	..	..	..	..	..
20-23	–0.574	–3.301	..	..	..	..	–0.236	–1.219
Constant . .	–4.328	–28.281	–4.071	–18.274	–5.032	–22.599	–4.498	–15.699
Number of:								
observations	45 759		17 206		23 455		13 380	
deaths . .	589		168		311		110	

TABLE A-2. BOBO-DIOULASSO

	1-23 months		1-5 months		6-15 months		16-23 months	
	Coeffi-cient	t-statistic	Coeffi-cient	t-statistic	Coeffi-cient	t-statistic	Coeffi-cient	t-statistic
Female child	0.054	0.262	–0.037	–0.085	0.091	0.315	0.022	0.055
Parity 1 . . .	0.334	2.151	0.642	2.238	0.188	0.825	0.255	0.797
" and girl .	–0.169	–0.783	–0.192	–0.438	–0.008	–0.027	–0.355	–0.795
Parity 6+ . .	–0.543	–3.174	–0.518	–1.471	–0.613	–2.520	–0.430	–1.306
" and girl .	0.117	0.502	0.643	1.312	0.130	0.396	–0.311	–0.677
Unmarried .	0.360	1.641	0.542	1.418	0.278	0.842	0.257	0.556
" and girl .	–0.177	–0.578	0.108	0.192	–0.154	–0.351	–0.589	–0.818
Polygamous	0.323	2.405	0.392	1.468	0.381	2.004	0.135	0.499
" and girl .	–0.320	–1.697	–0.617	–1.500	–0.304	–1.165	–0.133	–0.358
M educated .	–0.058	–0.378	–0.080	–0.271	–0.063	–0.285	–0.035	–0.113
" and girl .	–0.205	–0.939	–0.355	–0.769	–0.020	–0.066	–0.525	–1.147
Socio-economic status middle	–0.001	–0.010	–0.050	–0.174	0.031	0.149	–0.013	–0.043
" and girl .	–0.157	–0.750	0.025	0.057	–0.117	–0.410	–0.459	–1.027
Socio-economic status high .	–0.890	–3.161	–0.785	–1.486	–0.866	–2.170	–1.057	–1.751
" and girl .	0.788	2.272	0.880	1.298	0.553	1.118	1.207	1.698
Bobo	–0.177	–0.945	0.032	0.089	–0.217	–0.790	–0.316	–0.862
" and girl .	0.228	0.875	–0.464	–0.818	0.267	0.724	0.676	1.347
Dioula, Dafing . .	–0.066	–0.396	0.113	0.351	–0.132	–0.544	–0.123	–0.389
" and girl .	0.192	0.819	–0.085	–0.179	0.197	0.586	0.437	0.961
Other	–0.293	–1.754	–0.286	–0.850	–0.134	–0.580	–0.643	–1.847
" and girl .	0.214	0.917	0.002	0.005	0.182	0.571	0.412	0.836
Months 4-5 .	..	..	–0.934	–4.744	..	..	..	..
4-7 .	0.023	0.159	..	..	..	..	..	..
8-11	0.560	4.216	..	..	1.026	6.549	..	..
12-15	0.013	0.087	..	..	0.479	2.768	..	..
16-19	–0.100	–0.633	..	..	..	..	..	..
20-23	–0.127	–0.791	..	..	..	..	–0.026	–0.154
Constant . .	–4.202	–24.123	–4.303	–14.151	–4.722	–19.622	–4.100	–14.103
Number of:								
observations	37 813		13 626		19 177		11 683	
deaths . .	560		130		290		140	

TABLE A-3. RURAL SENEGAL

	1-23 months		*1-8 months*		*9-23 months*	
	Coeffi-cient	*t-statistic*	*Coeffi-cient*	*t-statistic*	*Coeffi-cient*	*t-statistic*
Female child	0.109	0.739	0.197	0.751	0.090	0.499
Parity 1	–0.142	–0.667	–0.378	–0.844	–0.064	–0.263
" and girl	0.138	0.489	0.382	0.703	0.053	0.158
Parity 6+	0.232	1.764	0.547	2.318	0.094	0.587
" and girl	–0.057	–0.307	–0.278	–0.889	0.021	0.091
Unmarried	–0.100	–0.192	–0.174	–0.168	–0.068	–0.114
" and girl	0.370	0.565	0.226	0.179	0.438	0.571
Polygamous	0.125	0.988	–0.078	–0.335	0.211	1.406
" and girl	–0.186	–1.049	0.143	0.467	–0.354	–1.615
M educated	–0.423	–1.085	–0.340	–0.466	–0.457	–0.989
" and girl	0.704	1.445	0.397	0.445	0.858	1.478
Socio-economic status middle	–0.385	–2.466	–0.219	–0.783	–0.455	–2.422
" and girl	0.288	1.364	0.188	0.526	0.312	1.186
Wolof and others	–0.317	–2.285	–0.550	–2.030	–0.228	–1.407
" and girl	–0.142	–0.725	0.410	1.202	–0.454	–1.846
Months 4- 7	0.170	1.084	0.172	1.092	..	..
8	..	..	–0.905	–4.180	..	..
8-11	0.616	4.260	..	..	..	..
12-15	0.394	2.593	..	..	0.031	0.222
16-19	0.232	1.463	..	..	–0.131	–0.886
20-23	0.283	1.797	..	..	–0.078	–0.535
Constant	–4.037	–26.657	–4.187	–19.159	–3.614	–23.630
Number of:						
observations	25 831		13 479		16 710	
deaths	578		196		382	

NOTES

[1]Barbieri (1989), Locoh (1986) and Orubuloye (1987) have examined parents' sex preferences in Senegal, Mali, Togo and Nigeria, respectively. On the whole, they report very weak levels of son preference.

[2]Births outside of maternity clinics and hospitals are underenumerated in the urban areas, especially in Bamako. In so far as these births disproportionately occur to impoverished women, the sample systematically differs from the total population of births. Some hospital and clinic births are also missed, and it appears that a relatively large number of these ended in the death of the child at or shortly after birth (van de Walle, 1986). Further selectivity occurs from children being lost from observation during the subsequent seven interview rounds. Losses were greatest in the first passage following birth, when many newborns could not be located at addresses recorded at clinics and hospitals. Again, children of the lower

classes, who tend to live in the crowded and unzoned areas of the city, are more likely to be lost from observation. Losses from observation after the first passage were less frequent and appeared to be more random—little affected by place of residence of household socio-economic status. Sample selectivity problems were less severe for EMIS/Senegal, where essentially all births were recorded and only a small proportion were lost from observation during the two-year period. For discussions of these issues, see van de Walle (1986), Ouaïdou and van de Walle (1987), Mbacké (1986, 1989) and Kuate Defo (1992).

In an effort to assess the effect of sample selection on estimated mortality by sex, logit regressions were used to impute the probability of dying for all children for each inter-round period, based on observed survival and deaths and a broad set of socio-economic, demographic and ethnic variables collected at the time of birth. The average risk of death by sex was then estimated for the entire data set (including those lost from observation) and for the subset of children observed to survive or die, for the age span of 1-23 months. Finally, these were used to compute female-to-male mortality ratios for both the total and observed populations. The ratios are nearly identical in all areas, never differing by more than 0.004, suggesting that sample selectivity does not greatly affect the results. The Yaoundé Enquête sur la mortalité infantile et juvénile (EMIJ) survey, based on a similar survey design and beset with losses from observation on the order of those in EMIS/Bamako, has been extensively analysed and provides another means for assessing the extent of selectivity biases. The results of competing risks hazard models controlling for unobserved heterogeneity consistently show that sample attrition has little effect on estimated levels and differentials of either infant and child or maternal mortality and morbidity (Kuate Defo and Palloni, 1993; Kuate Defo, 1992, 1993a and 1993b).

[3]Significance levels presented in the text will overestimate to some degree the true levels for age groups 1-5, 6-15 and 16-23 months. These age groups were chosen to maximize differences in mortality risks by sex, and thus their estimated statistics are conditional on earlier observations (figure I).

[4]The relatively small proportion of deaths from measles is caused in part by the lack of a measles epidemic in Bamako for most of the study period. A measles vaccination campaign occurred in Bamako in 1983 (UNICEF, 1989). Note that Fargues and Ouaïdou (1988) found that excess female child mortality in Bamako between 1974-1985 was almost entirely due to girls' greater vulnerability to this disease.

[5]In so far as disadvantaged children are more likely to die and be excluded from the calculations, the probabilities will tend to understate somewhat the degree of discrimination in the provision of health services. DPT vaccination rates seem low in Bamako, compared to Bobo-Dioulasso. However, there is no reason to believe that an underenumeration of vaccinations, if it exists, would be systematically related to a child's sex. Mothers may be less likely to report vaccinations that are not the result of the family's initiative (for example, those done during EPI-style vaccination campaigns or routinely at birth) and when they occurred well in the past (for example, tetanus inoculations during a prenatal visit). If such "forgetfulness" is unrelated to children's sex, the estimated differences in vaccination rates will still provide useful information on discrimination between sons and daughters.

[6]Mbacké and LeGrand (1991), estimating a logit regression from 1987 DHS/Mali data, found that urban boys are significantly (1 per cent level) more likely to receive the full set of DPT vaccinations. Similar logit regressions, with independent variables for child's sex, parity, mother's education, and ethnic group, reveal a small, insignificant male advantage in both EMIS areas. The difference between DHS and EMIS/Bamako results may be due to the fact that DHS vaccination data were limited to the small number of children having a vaccination registration booklet (*carnet de vaccination*), making them probably more accurate and less representative than EMIS data.

[7]For Bamako, 43 per cent of boys and 39 per cent of girls were missing data for medical visits during the period of death. Differences between male and female medical visit rates prior to death remain insignificant when either all or none of the children missing data are assumed to have received medical treatment.

[8]Studies using national data and standard age categories exist for these countries. The 1985 Burkina Faso census reveals a small degree of excess female mortality for both infants and children aged 1-4 (Tabutin and Willems, in this issue). Data from the Senegalese 1978 WFS and 1986 DHS show similar levels of male and female mortality during the post-neonatal period and slight excess female mortality for ages 1-4 (Cantrelle and others, 1986; Barbieri, 1989). (Tabutin and Willems (in this issue) instead report marginal excess male child mortality in DHS/Senegal data.) Data from the ORSTOM Ngayokhème Population Laboratory, located in proximity to the EMIS/Senegal study area, do not reveal significant differences in either infant or child mortality by sex (Cantrelle and others, 1986). However, the ORSTOM study population is in large majority Serrer; the EMIS results indicate that the excess mortality of girls between ages 1 and 8 months, and its disappearance among older children, is due almost exclusively to changes in Wolof—not Serrer—mortality rates.

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AGE PATTERNS OF CHILD MORTALITY IN THE DEVELOPING WORLD

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SUMMARY

Age patterns of child mortality in the developing world are of substantive importance, reflecting underlying etiology, and of methodological importance, affecting indirect estimation methods. A recent compilation of child mortality estimates published by the United Nations provides a basis for examining such patterns and for identifying regional similarities of pattern reflecting common cultural and environmental influences. The main source of information about age patterns of child mortality in the developing world is the birth history, collected in about 60 developing countries, particularly by the two internationally coordinated survey programmes, the World Fertility Survey (WFS) and the Demographic and Health Surveys (DHS). However, for some countries, confirmatory information is available from civil registration or from prospective surveys. The various sources of information are reviewed by comparing observed probabilities of dying by age 1 and between ages 1 and 5, relative to standard patterns incorporated in the Coale/Demeny life-tables. Similarities of pattern within regions are found to be less strong than expected. However, certain clear patterns are found—notably, low post-infant child mortality relative to infant mortality in temperate South America and high post-infant child mortality relative to infant mortality in tropical Africa. Elsewhere, patterns vary from country to country, but by and large fall within the limits defined by the models. Child mortality patterns as recorded by birth histories are found to be in reasonably good agreement with other sources generally regarded as more likely to be accurate. Child mortality patterns, controlling for mortality level, are found to vary with the median duration of breast-feeding: short breast-feeding is associated with relatively high infant mortality, whereas long breast-feeding is associated with relatively high post-infant mortality.

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INTRODUCTION

The United Nations (1992) has recently published a useful database on child mortality in the developing world. The database, compiled and maintained by the Population Division of the Department for Economic and Social Information and Policy Analysis, with the sponsorship of the United Nations Children's Fund (UNICEF), combines all the information available at the time of publication pertaining to the measurement of child mortality from 1960 onwards for developing countries with populations estimated as 1 million or more in 1990. The database includes information from civil registration systems, national life-tables, birth history surveys such as the World Fertility Survey and the Demographic and Health Survey, longitudinal surveys that are nationally representative (or nearly so), and indirect indicators of child mortality from censuses and surveys.

The main purpose of the database is to provide an empirical basis for both assessing infant and child mortality trends in developing countries and for evaluating newly available data sets. However, the database also provides a basis for cross-national comparisons of child mortality levels and trends (Hill and Yazbek, 1993), and for examining age patterns of child mortality, both over time within countries, and across countries.

Age patterns of child mortality are of interest primarily because of what they reveal about the underlying causes of such mortality. Broadly speaking, the ratio of mortality risks in infancy to those in childhood rises as mortality overall falls; within infancy, the ratio of neonatal to post-neonatal mortality risks also rises as overall mortality falls. These patterns reflect the declining relative importance of communicable diseases and the increasing relative importance of non-communicable conditions such as congenital disorders as overall mortality falls. Substantial cross-national variation is observed within these broad patterns, however, reflecting differentials in child-rearing practices (particularly weaning practices), exposure to, and preventive measures for, various diseases.

Coale and Demeny (1983) identify and model four main age patterns ("families") of mortality risks for children under age 5 in mainly European populations in the nineteenth and twentieth centuries. One pattern, associated mainly with countries in eastern Europe, has a uniformly high ratio of infant to child mortality risks.[1] Another pattern, associated mainly with Scandinavian populations, has a uniformly low ratio of infant mortality to child mortality risks. A third pattern, associated mainly with Mediterranean populations, shifts from having a very low ratio of infant mortality to child mortality at high overall mortality levels to having a very high ratio at low mortality levels. The final pattern, observed in North-western Europe and much of the rest of the world, has an intermediate ratio of infant mortality to child mortality at all mortality levels, falling between the Eastern European and Scandinavian patterns. Figure I plots the probability of dying between the ages of one and five against the infant mortality rate for each of the four "families", or patterns, that Coale and Demeny identify.

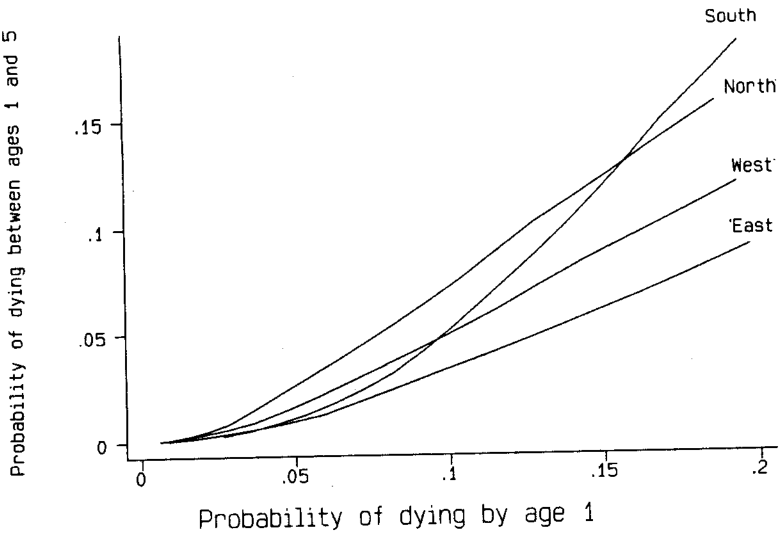
A second reason for identifying the appropriate age pattern of child mortality for a particular population is provided by the methodologies for estimating child mortality themselves. Information on the number of children ever born and the number surviving for women in standard age or duration of marriage groups provides the basis for indirect estimation of levels and trends of child mortality (Brass, 1964; Trussell, 1975; United Nations, 1983). However, before indirect estimation techniques can be applied to the data from a particular country, it is necessary to select an appropriate age pattern of child mortality; making an appropriate choice is particularly important to the estimation of child mortality trends from indirect methods, but the analyst is often as interested in measuring trends over the last 15 years as in measuring some average level.

This article uses the data from the United Nations database, supplemented in a few cases with information from local studies thought to be of particular accuracy, to examine age patterns of child mortality. The focus is on the split between infant mortality—that is, mortality before the first birthday, and child mortality, between the exact ages of 1 and 5 years. The split between neonatal (first month) and post-neonatal (from one month to one year) mortality would also be of interest, but there is no convenient historical yardstick, such as the Coale/Demeny model life-tables, that could be used to calibrate the observed rates. The underlying objective of the article is to identify regional patterns, both because the epidemiology and social behaviours underlying child mortality are likely to be similar across regions and because such identified patterns could then be used to guide the selection of a model life-table family when using indirect estimation methods in countries of a region.

Sources and quality of data

The information on age patterns of child mortality used in this article comes from three main sources. Far and away the most common, providing at least part of the evidence available for 49 of the 55 countries for which data are reviewed in this article, is a birth or maternity history included in a retrospective survey. Most, but not all, such surveys have been conducted over the past 20 years under the auspices of two internationally sponsored and largely comparable survey programmes, the World Fertility Survey (1974-1982, 43 countries) and the Demographic and Health Survey (1984 to the present, 46 national surveys as of mid 1993). A birth history collects information

Figure I. Relations between child and infant mortality in the four Coale/Demeny families



from each sampled woman on the date of birth of each of her live-born children, and, if the child has died, on the child's age at death. Life-table mortality measures for specific time periods can be calculated from such information by standard techniques.

Although birth histories are available for a large number of countries, the life-table measures calculated from them are often distorted by error. Birth history surveys generally use fairly small samples, so random error in mortality rates may be substantial, particularly for specific time periods. Systematic errors also affect the measures. The most widespread is a tendency to report age at death of a child as a round number of years—for example "1 year"—rather than a precise number of months, such as "10 months" or "14 months". Such rounded reporting of a death at 14 months has little effect on the mortality measures used here, the infant mortality rate and the probability of dying between the ages of 1 and 5. But the rounded reporting of a death at 10 months shifts that death out of the infant mortality rate and into the probability of dying between the ages of 1 and 5, biasing the infant mortality rate downwards and the probability of dying between the ages of 1 and 5 upwards, substantially changing their ratio. A further problem widely believed to have affected a number of Demographic Health Surveys is the outright omission or transference to an earlier time period of births in the past five years, a ploy on the part of interviewers to escape the long list of questions asked regarding the health of young children. The effect of this error on age patterns of child mortality for five-year periods is uncertain.

Most of the birth history surveys used here report estimates of infant and child mortality for specified time periods, typically 0-4, 5-9, and 10-14 years before the survey. Having three observations from the same source makes it possible not only to look at the individual period observations on their own but also to see how the pattern of child mortality has changed as the level itself has changed (generally downwards). The standard patterns of child mortality shown in figure I summarize relations between infant and child mortality at different levels of mortality. Thus, superimposing the birth history points on the Coale/Demeny family patterns provides information about not only how one point relates to the standards but also how the pattern changes as mortality falls, again relative to the model families. One caution about trying to interpret not only a particular point but also the pattern of change is that the validity of observations for particular periods may vary systematically with the time before the survey of the period. It is often argued that the information in a birth history about recent events is likely to be of higher quality than that for events in the more distant past, because of increasing memory lapse as time passes. Thus, for example, the propensity to round age at death to "1 year" could be higher for events long ago, thus increasing child mortality relative to infant mortality more for those periods than for recent periods, giving the impression of a more rapid decline in child mortality over time than was actually the case. However, in this situation, a country with two consecutive birth histories should appear on a graph like figure I as two parallel lines sloping steeply down towards the left; the lines would not be expected to link up smoothly.

The second source of information is civil registration. If births and deaths are completely registered, ages at death are accurately recorded, and population numbers of young children are known (for example, from a population census), childhood life-tables can be calculated on a period basis. Numbers of events will typically be quite large (certainly relative to a birth history survey), so random variation should be minimal. However, registration of births and, more importantly, of child deaths may be incomplete. Events most likely to be omitted are births and deaths of children who die very young, in the first few weeks of life. Omission of this sort is likely to reduce the neonatal mortality rate (in particular) and the infant mortality rate relative to the probability of dying between 1 and 5. If births are used as the basis for calculating the infant mortality rate and if an enumerated or estimated population is used as the basis of the mortality after age 1, omission of births may inflate the infant mortality rate relative to the child mortality rate, but any such effect would probably be outweighed by a corresponding omission of infant deaths.

The third, and least common, form of information comes from longitudinal surveys. A population sample is selected and followed over time, while vital events are recorded. The samples used for such surveys tend to be quite small because of the amount of field work required to follow up sample households one or more times a year. Thus sampling errors are potentially quite large. Systematic errors, on the other hand, are small. Ages of children are recorded at the start of the survey (or derived from a recorded date of birth during the survey) and are thus not affected by rounding. Omission of deaths is minimized by probing all cases of children present at one survey round but missing at the next and by recording the pregnancy status of women at each round (in order to probe for the child's survival at the next round if the pregnancy has been completed). Omission of course remains possible, and some misreporting also remains possible, but by and large such longitudinal data are least liable to errors affecting age patterns of child mortality.

Additional information is available from a few countries from sub-national population observatories. The best known examples are the Matlab area in Bangladesh and the Niakhar area in Senegal. The data from such observatories are of extremely high quality but are not nationally representative. They are used here as support for patterns found from nationally representative data sets.

PRESENTATION

Age patterns of child mortality are presented graphically, with each probability of dying between the exact ages of 1 and 5 plotted against its corresponding infant mortality rate. Results from the same survey, but for different time periods, are joined by lines. Model life-table systems provide a convenient basis for identifying age patterns of child mortality, so the standard relationships of the four Coale/Demeny model life-table families are represented on the graphs as solid lines. The Coale/Demeny models are used in preference to the United Nations model life-tables for developing countries (United Nations, 1983) because the Coale/Demeny models show more clearly differentiated patterns. (It is only the Chilean pattern, a bit like the Coale/Demeny "east" family, that is clearly distinctive from the other United Nations models.)

Results are presented primarily by region. This presentation is in part unavoidable, since trying to plot all country results on one graph would lead to an undecipherable tangle. However, the regional presentation has the virtue of helping to highlight similarities or differences in child mortality patterns across regions. Bangladesh and Senegal, the two countries with extensive birth history and population observatory data, are presented separately.

Results

Sub-Saharan Africa

Figures II, III and IV show the available information on the relationships between the probability of dying between the exact ages of 1 and 5 ($_4q_1$) versus the infant mortality rate ($_1q_0$) for Eastern Africa, Southern Africa and Western Africa, respectively. In figure II, results for six countries in Eastern Africa are shown, for two of which, Burundi and Malawi, information on the age pattern of child mortality is also available from multi-round (prospective) surveys. All the data show high levels of child (1-4) mortality relative to infant mortality. In Kenya (both the WFS and the DHS) and in Zimbabwe, the pattern of child mortality closely approximates the Coale/Demeny "north" family. In Burundi, Malawi and Rwanda, child mortality relative to infant mortality is even higher than would be expected on the basis of the "north" family. Uganda shows a pattern intermediate between those of Kenya and Zimbabwe, on the one hand, and Burundi, Malawi and Rwanda on the other. That these patterns are not just the result of misreporting is supported by the fact that both the multi-round survey points (for Burundi and Malawi) also lie above the range of the Coale/Demeny models, indicating high child mortality relative to infant mortality.

Figure III shows results for two countries, Botswana and Lesotho, in Southern Africa. The points from the Botswana DHS fall almost perfectly on the "north" pattern, whereas the Lesotho points, from the WFS, fall close to the other extreme, the "east" pattern. Two data sets are an insufficient base on which to draw conclusions, but it appears possible, at least, that there are marked differences in age patterns of child mortality in Southern Africa.

Figure IV shows results from eight countries, and 13 data sets, from Central and Western Africa. The Senegal WFS, Senegal DHS and Mali DHS show extreme patterns of high child mortality relative to infant mortality, with child mortality well above what would be expected in either the "north" or "south" model families, given the level of infant mortality. A second group of countries from the Western African coast, Ghana, Benin, Nigeria and Cameroon, show patterns that track the "north" pattern quite closely, but at a slightly higher level of child mortality. The results for this group are consistent with the conclusion that the underlying age pattern of child mortality in these countries is close to a "north" pattern, somewhat distorted by the reporting of some infant deaths as child deaths. The third group of countries consists of Côte d'Ivoire and Liberia, which clearly show a "west" pattern, confirmed at least for Liberia by the results of two years of follow-up of a multi-round survey, though multi-round survey data for Côte d'Ivoire indicate a "north" pattern more typical of coastal

Figure II. Age patterns of child mortality in Eastern Africa

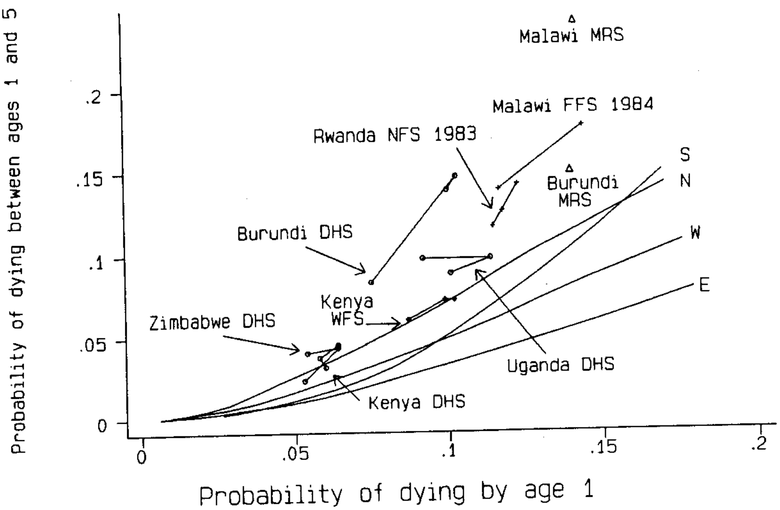
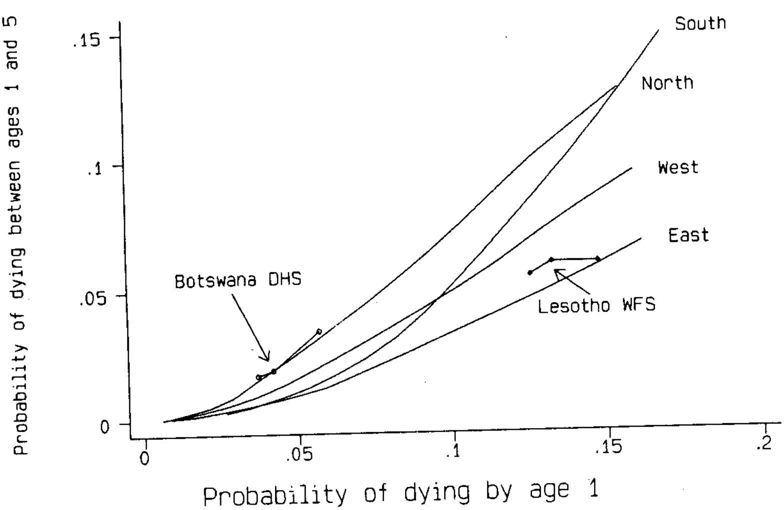


Figure III. Age patterns of child mortality in Southern Africa



Western Africa. The available data suggest large variations in age patterns of child mortality in Central and Western Africa. Senegal, perhaps Mali, and possibly the Sahel in general appear to have extremely high child mortality relative to infant mortality. Countries at the eastern end of the Western African coast appear to have high child mortality relative to infant mortality, roughly similar to that of the "north" model life-tables. Countries at the western end of the Western African coast, however, appear to have lower levels of child versus infant mortality, similar to those of the "west" family of model life-tables.

Figure V uses small area longitudinal data to confirm the extreme patterns observed in WFS and DHS for Senegal. The rural population living around the town of Niakhar in west-central Senegal has been followed regularly since the early 1960s. The relationship between infant and child mortality for the period 1962-1968 (Cantrelle and Leridon, 1971) and for the period 1984-1991 (Chahnazarian and others, 1992) are shown in figure V, together with the national estimates from WFS and DHS. Also shown is the infant/child mortality relationship for the population of Bandafassi, a region in the extreme east of the country, for the period 1971-1991 (Pison and Desgrées du Lou, 1992). The Niakhar data confirm the extreme pattern of high child mortality relative to infant mortality, the 1984-1990 point falling very close to the WFS/DHS data. The Bandafassi observation lies somewhat, but not very far, above the standard Coale/Demeny relationships, suggesting that the extreme high child mortality relative to infant mortality of Niakhar may not be uniform across the country.

Latin America and the Caribbean

Figures VI-IX show age patterns of child mortality for temperate South America, tropical South America, Central America and Mexico, and the Caribbean, respectively. Temperate South America is unique among the regions of the developing world in that all three countries, Argentina, Chile and Uruguay, have complete and accurate civil registration systems, and so age patterns of child mortality can be drawn from essentially accurate life-tables. As is clear from figure VI, all three countries have exceptionally low child mortality relative to infant mortality. As infant mortality has fallen to low levels, below 30 per 1,000, the age patterns of child mortality have moved gradually towards the "west" family, but at higher mortality levels the ratio of child mortality to infant mortality is lower than that even of the "east" family.

Figure VII shows results for seven countries of tropical South America. Data are available from both WFS and DHS for four countries (Colombia, Ecuador, Paraguay and Peru), from WFS alone for Venezuela, and from DHS alone for Bolivia and Brazil. Data from a multi-round survey are available for Peru. The vast majority of the observa-

Figure IV. Age patterns of child mortality in Western Africa

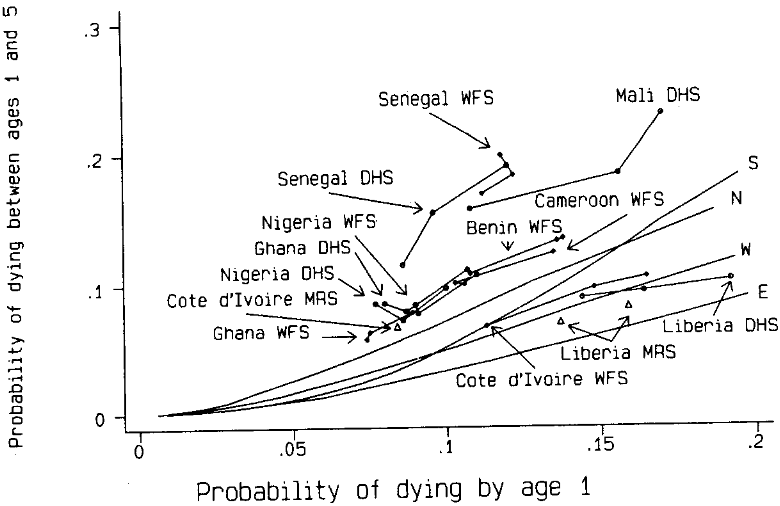


Figure V. Age patterns of child mortality in Senegal

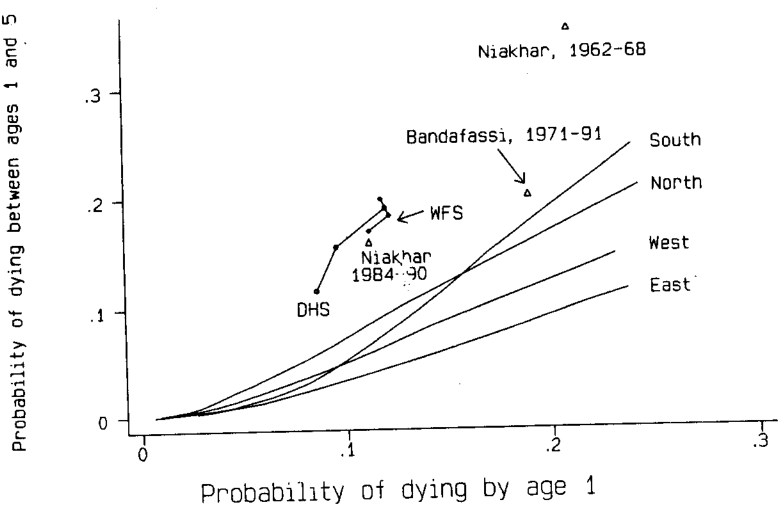


Figure VI. Age patterns of child mortality in temperate South America

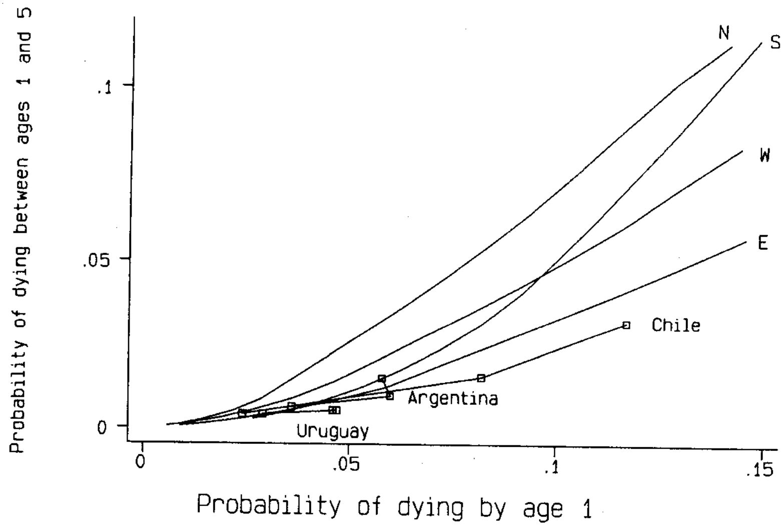
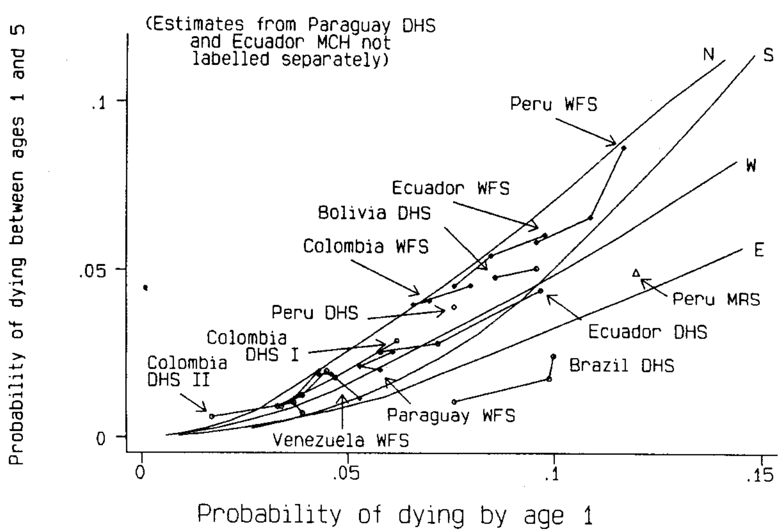


Figure VII. Age patterns of child mortality in tropical South America



tions in figure VII fall between the age patterns of the "north" and the "south" families. However, changes within and between surveys for the same country tend to run parallel between the "north" and the "west" families. The Peru multi-round survey gives a pattern markedly different from the Peru WFS or DHS, the longitudinal survey having a lower ratio of child mortality to infant mortality than the two birth history surveys. The apparent "north" pattern observed for much of tropical South America may, therefore, be a true "west" pattern (or thereabouts) with some shift of infant deaths to above age 1. The major exception to the above discussion is Brazil, for which DHS shows a ratio of infant-to-child mortality higher even than that of the "east" family of models. It is possible that the extreme pattern observed in temperate South America extends up to Brazil, although further analysis—for example, of civil registration data—is needed to confirm this.

Figure VIII shows data from six countries, one (Mexico) with observations from both WFS and the DHS, two (Costa Rica, Panama) with observations from WFS, two with observations from DHS alone (El Salvador, Guatemala), and one (Honduras) with observations from an independent birth history survey. Data from multi-round surveys are available for Honduras and Panama. The birth history observations for Guatemala and Honduras fall very close to the "north" pattern, as do those for Panama with one exception. Results from birth histories in El Salvador and Mexico suggest a "west" pattern, although the Mexico DHS patterns are rather erratic. Observations from Costa Rica fall very close to the "east" pattern. The multi-round survey results for Panama support the fit to the "north" pattern, whereas those for Honduras suggest a pattern very close to the "south" model. Central America appears, from these results, to have a remarkable diversity of child mortality patterns, although within the bounds of historical experience as reflected in the Coale/Demeny models.

Figure IX shows observations for four countries in the Caribbean. Data are available from both WFS and DHS for the Dominican Republic and Trinidad and Tobago, and from WFS and an independent birth history survey for Haiti and Jamaica. The general pattern of the results, with the exception of those from the Trinidad and Tobago WFS, seems to follow the "south" pattern, although it would also be fair to say that, excluding the Trinidad and Tobago DHS, the results also follow the "west" pattern fairly closely. What is clear is that at least until low mortality levels are reached, the pattern of child mortality in the Caribbean is not extreme in either direction.

Northern Africa and Western Asia

Figures X and XI summarize available age patterns of child mortality for Northern Africa and Western Asia. Figure X shows data from four Northern African countries. Egypt, Morocco and Tunisia have

Figure VIII. Age patterns of child mortality in Central America and Mexico

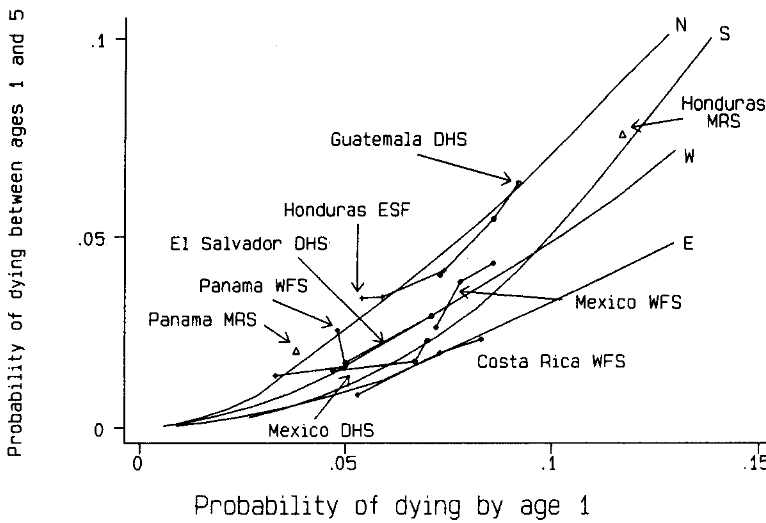
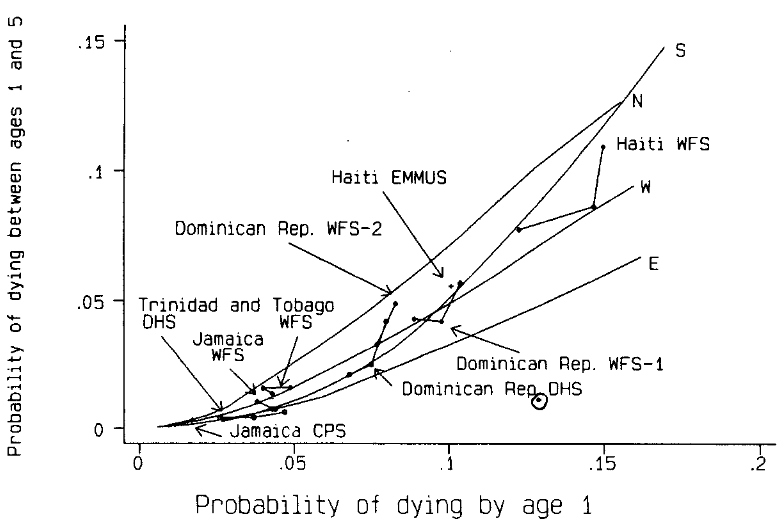


Figure IX. Age patterns of child mortality in the Caribbean



NOTE: CPS Contraceptive Prevalence Survey
EMMUS Enquête de mortalité et morbidité et utilisation des services

Figure X. Age patterns of child mortality in Northern Africa

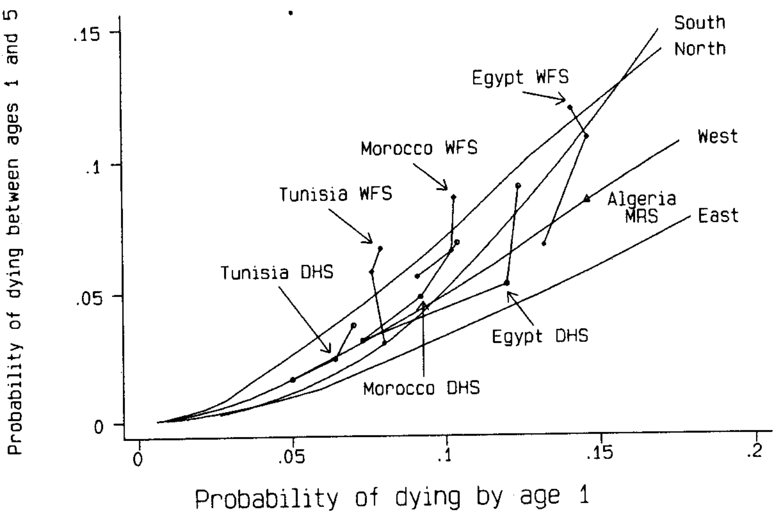
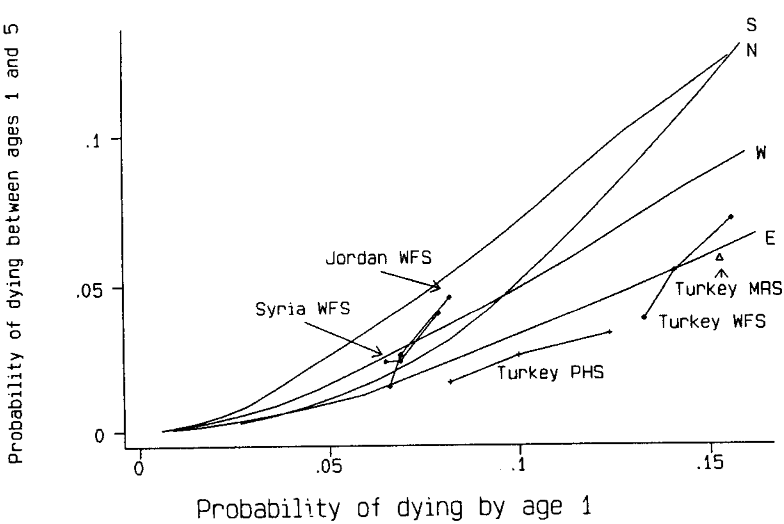


Figure XI. Age patterns of child mortality in Western Asia



results from both WFS and DHS, and information is available from a multi-round survey of Algeria. The birth history results show a fair amount of inconsistency within surveys, but the overall pattern seems to follow the "south" model. However, the single multi-round survey point, for Algeria, falls right on the "west" pattern, which also agrees quite well with all the birth history results for the five years before each survey. If these points and the multi-round survey are most accurate, it may be that the "west" pattern is the most appropriate for Northern Africa.

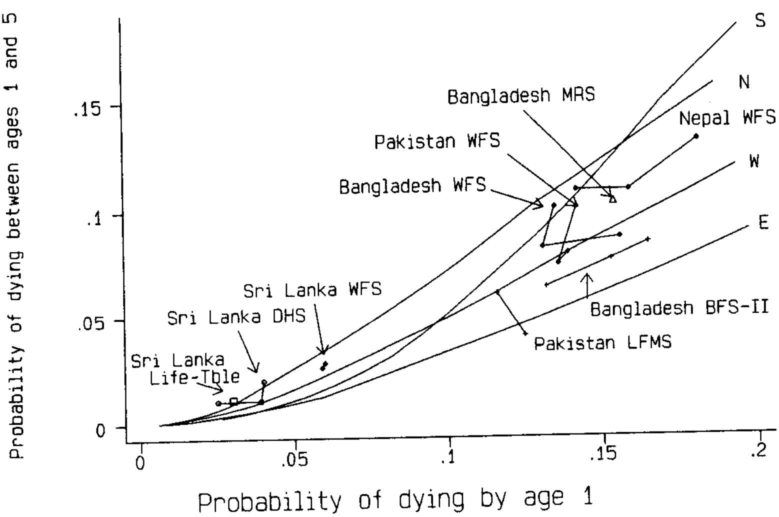
Figure XI shows results for three countries in Western Asia. Data are available for Turkey from two independent birth history surveys and from a multi-round survey. Results for Jordan and the Syrian Arab Republic come from WFS. The results for Turkey unambiguously show low child mortality relative to infant mortality, the ratios being close to, or even lower than, those of the "east" family. Results for Jordan and the Syrian Arab Republic are very similar to one another; they fall around the "west" pattern, but the ratios of child mortality to infant risks fall more steeply as mortality falls than in any of the model families. This pattern may well be due to better reporting of infant deaths in the most recent period. Thus, it appears likely that the "west" family is a reasonable approximation to the age pattern of child mortality in Jordan and the Syrian Arab Republic (and possibly elsewhere in the Arab world), but the appropriate pattern in Turkey is definitely the "east" family.

Southern Asia

Figure XII shows the available information on the age pattern of child mortality for four countries of Southern Asia. Sri Lanka has data from WFS and DHS, as well as a civil registration-based life-table. Both Bangladesh and Pakistan have information from WFS and from an independent birth history survey. Nepal has information from WFS alone. Bangladesh also has one observation from a multi-round survey, the 1962-1965 Population Growth Experiment.

The majority of the points shown in figure XII fall between the "west" and the "north" families. The exceptions are the patterns observed by the second Bangladesh Fertility Survey conducted in 1989 (the data are for birth cohorts, rather than for time periods), which falls consistently between "west" and "east", by the Pakistan Labour Force and Migration Survey of 1980, which are inconsistent in trend but range between "west" and "east", and late 1980s observations for Sri Lanka, at very low child mortality levels, consistent with a "north" pattern. Of particular interest is the multi-round survey point for Bangladesh (then East Pakistan) from the Population Growth Estimation (PGE) Experiment. The pattern of mortality recorded falls between the "west" and "north" patterns, close to the pattern indicated by the Nepal WFS and

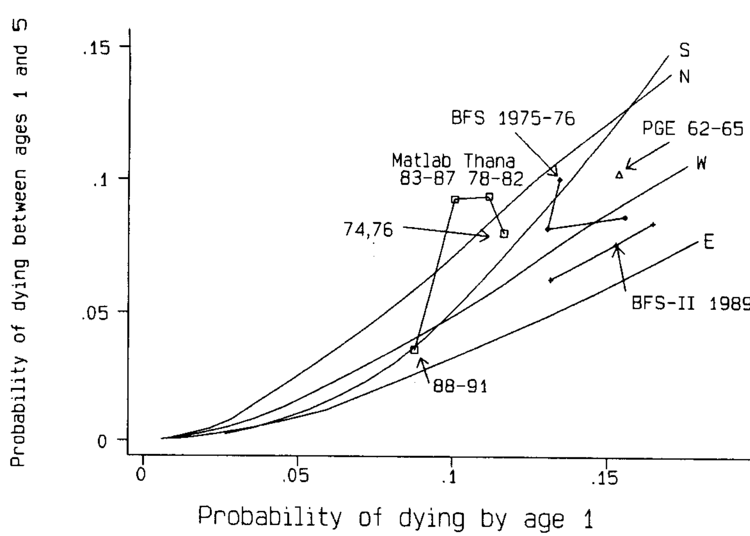
Figure XII. Age patterns of childhood mortality in Southern Asia



by an average of the observations from the Bangladesh Fertility Survey. This point, in combination with the results of the Bangladesh, Nepal and Pakistan World Fertility Surveys, strongly supports a standard northern Indian subcontinent pattern that lies somewhere between "west" and "north".

However, more longitudinal information is available for Bangladesh: a number of years of observation from a longitudinal observation of the population of Matlab Thana of Bangladesh monitored at frequent intervals by the International Centre for Diarrhoeal Disease Research. This population is not nationally representative, but it is included because of the high validity of the underlying data. Results are shown for average patterns over several years (1975 is excluded from these averages because of the severe famine that affected Matlab in that year, and may have distorted the pattern of child mortality), together with PGE and maternity history data, in figure XIII. The Matlab values are very erratic, bouncing from between "west" and "north" to well above "north" to between "west" and "east". The erratic pattern of the Matlab data may be due to small numbers of events (although the values used are averages over a number of years) or to real variations from year to year.[2] These additional data fail to clarify the situation but suggest that a case can be made for either "west" or "north" as best describing child mortality in Bangladesh.

Figure XIII. Age patterns of childhood mortality in Bangladesh



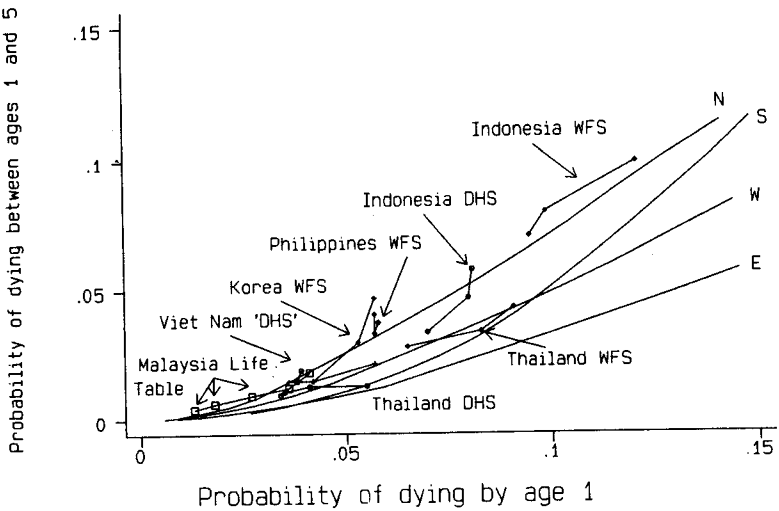
Eastern and South-eastern Asia

Information on age patterns of child mortality is available from a number of birth history surveys in Eastern and South-eastern Asia. Data from surveys under the WFS programme are available for Indonesia, the Philippines, the Republic of Korea and Thailand, and from surveys under DHS for Indonesia and Thailand. A quasi-DHS has been conducted in Viet Nam, and data are available from a series of national life-tables for peninsula Malaysia (here the years 1970, 1974, 1978, 1984 and 1989 have been used). Results are shown in figure XIV. The patterns are not entirely clear, but by and large, with the exception of Thailand, the data seem to point to the "north" family as best summarizing age patterns of child mortality in the region. Thailand is the clear exception, with results from both WFS and DHS supporting (although at very different levels) a "west" pattern.

AGE PATTERNS OF CHILD MORTALITY AND BREAST-FEEDING PATTERNS

Surveys from the WFS and DHS programmes collected information not only on birth histories but also on many other aspects of reproductive behaviour, including breast-feeding. It is thus possible to relate the age pattern of child mortality to information about breast-feeding and, in particular, age at weaning. In order to obtain a stand-

Figure XIV. Age patterns of child mortality in Eastern and South-eastern Asia



ardized data set, age patterns of child mortality have been expressed as an index. This index is the ratio of child mortality to infant mortality in the population divided by the corresponding ratio in the Coale/Demeny "north" family of model life-tables for the same overall value of under-five mortality. For example, suppose that WFS for a given country reported an infant mortality rate of 0.12 and a child mortality rate (probability of dying between exact ages 1 and 5) of 0.08. The ratio of child mortality to infant mortality is 0.08/0.12, or 0.667. The under-five mortality rate (probability of dying by age 5) for the population is thus 1.0 - (1.0 - 0.12)*(1.0 - 0.08) = 0.1904. At that level of under-five mortality, the standard "north" ratio is 0.7564 (see table 1), so the final ratio is 0.667/0.7564 = 0.882. This ratio is interpreted as meaning that, given the overall level of under-five mortality, child mortality is somewhat lower, and infant mortality somewhat higher, than in the "north" model.

Breast-feeding information is available only for recent children. In order to maintain as much overlap as possible in the reference periods of the child mortality and breast-feeding information being used, only mortality observations from the five years before each survey have been used, together with current status estimates of median duration of breast-feeding for all births in the three years preceding the survey.

Figure XV plots the ratio of observed to expected relation between infant and child mortality against the median length of breast-feeding

TABLE 1. RATIOS OF CHILD MORTALITY ($_4q_1$) TO INFANT ($_1q_0$) MORTALITY IN THE COALE/DEMENY "NORTH" FAMILY OF MODEL LIFE-TABLES

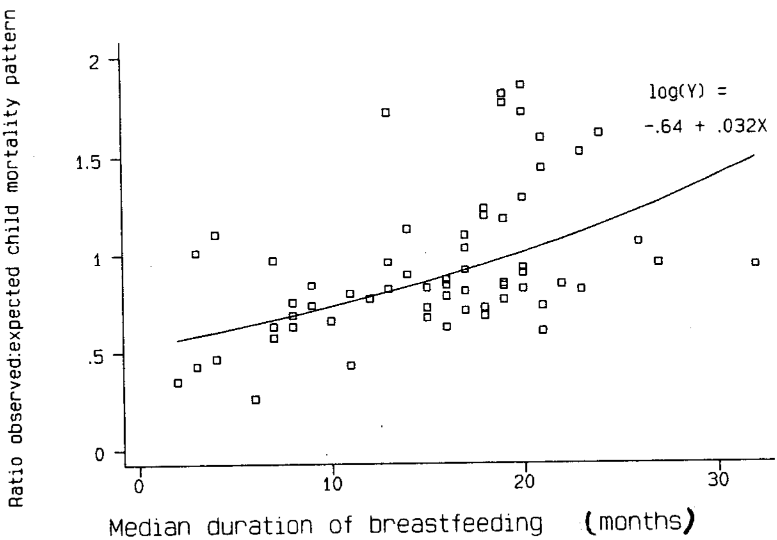
Probability of dying by age 5	*Ratio of $_4q_1$ to $_1q_0$*	*Probability of dying by age 5*	*Ratio of $_4q_1$ to $_1q_0$*
0.5053	0.8730	0.1723	0.7249
0.4682	0.8678	0.1521	0.6893
0.4334	0.8623	0.1330	0.6543
0.4008	0.8562	0.1149	0.6182
0.3700	0.8496	0.0977	0.5794
0.3409	0.8424	0.0813	0.5350
0.3134	0.8343	0.0658	0.4800
0.2873	0.8254	0.0510	0.4064
0.2625	0.8154	0.0367	0.2960
0.2388	0.8041	0.0264	0.2290
0.2163	0.7912	0.0174	0.1757
0.1935	0.7617	0.0104	0.1254

for 62 World Fertility Surveys or Demographic and Health Surveys. The solid line shows the ordinary least squares regression of the logarithm of the mortality ratio against median length of breast-feeding. There is a clear, though far from perfect, relation between the two measures, with the regression explaining 28 per cent of the variance in the logarithm of the ratio, the breast-feeding coefficient of 0.032 being highly significant, with a 95 per cent confidence interval of 0.019-0.046. The relationship is exactly what was expected: longer breast-feeding has the effect of shifting childhood deaths from infancy into childhood, increasing the child-to-infant mortality risks, while shorter breast-feeding has the opposite effect.

CONCLUSION

The expectation prior to carrying out this analysis was that fairly strong regional patterns in the age structure of childhood mortality would appear. This expectation has been only partially confirmed. There appears to be a strong temperate South America pattern of high infant and low child mortality. There appears to be a tropical Africa pattern of low infant and high child mortality, a pattern particularly strong in the Sahel but not found in the west coastal regions of Western Africa. Most of the rest of the developing world seems to follow rather standard patterns similar to those of Northern and Western Europe, though there are clear anomalies, such as Turkey. As child mortality declines to low levels, the pattern appears to converge on a "north" relationship of relatively high child mortality to infant mortality.

Figure XV. The relation between child and infant mortality (relative to "north" family patterns) by median duration of breast-feeding



Source: Sixty-two WFS and DHS.

Some part of the pattern of child mortality appears to be related to breast-feeding patterns. Weaning is a high risk period, and if most children are weaned in infancy, infant mortality will be high relative to child mortality, whereas if most children are weaned after their first birthday, child mortality will be high relative to infant mortality. This analysis of course does not address the issue of the net effect of breast-feeding duration on child mortality, but it does indicate that an analysis of this issue cannot use infant mortality as its only outcome indicator.

NOTES

[1]In the following description, and elsewhere in this article, "infant mortality" is used to mean the probability of dying before age 1, and is contrasted with "child mortality", used to mean the risk of dying between the exact ages of 1 and 5. "Childhood mortality" is used to refer to mortality risks throughout childhood.

[2]It should also be noted that the Matlab population has been used in a number of drug trials. In one of these trials in 1974, tetanus toxoid was administered as a placebo to all children under age 5 and all non-pregnant adult women for a cholera vaccine under trial; the cohorts of women who received tetanus toxoid have had sharply reduced levels of tetanus among their children (Koenig, 1992), possibly raising the child to an infant mortality ratio above its "natural" level.

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RECENT TRENDS AND PROSPECTS IN WORLD POPULATION GROWTH*

*Vasantha Kandiah*** and Shiro Horiuchi****

SUMMARY

This article assesses the causes of the stagnation in the declining trend in world population growth rates over the past decade. Three major factors have been identified as contributing to the stagnation: age structure, fertility trends in India and China, and the fact that although the number of developing countries with sustained declines in fertility levels rose sharply in the late 1960s and 1970s, it dropped off dramatically in the 1980s. Prospects for the growth rate in the 1990s favour a decline, owing to changes in the age structure and indications that China and India have resumed their fertility declines. However, there remain some populous developing countries that continue to have high levels of fertility. Fertility trends in those countries will have a certain influence on the world's growth rate.

INTRODUCTION

Over a period of about 10 years (from 1965-1970 to 1975-1980), there was a steep decline in the world population growth rate, from 2.1 to 1.7 per cent. During that period a number of developing countries (including the two most populous, China and India) experienced significant declines in fertility levels, mostly as a result of increased use of contraceptives through family planning programmes. Between 1975 and 1985, the growth rate remained at about 1.7 per cent, and a recent estimate for the period 1985-1990 shows continued growth at about the same rate (see figure I). This stagnation came as a surprise to demographers, who had expected a continuation of the decline in the growth rate.

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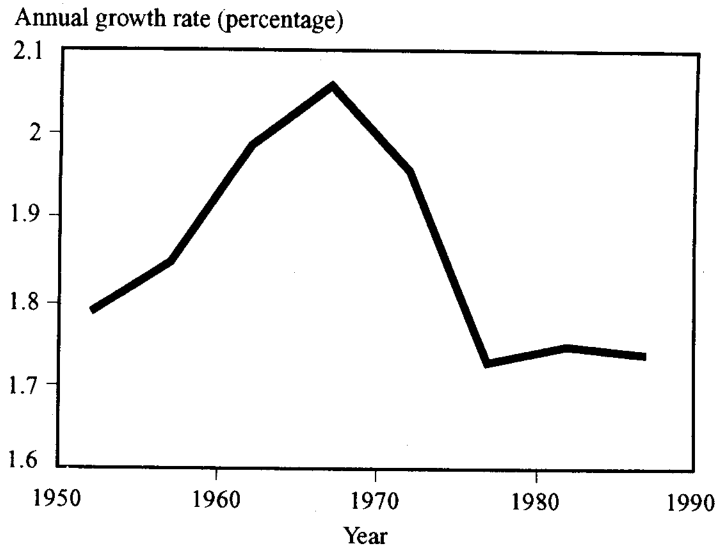
Figure I. Growth rate of world population, 1950-1990



A previous study (Horiuchi, 1992) showed that the trend in the world growth rate in the late 1970s and the early 1980s could be explained to a large extent by three major factors:

(*a*) The effect of the world's age structure on the birth rate;

(*b*) Fertility trends in the two most populous countries in the world, China and India; and

(*c*) The fact that the number of developing countries that started sustained declines in fertility levels in the late 1960s and early 1970s had dropped off dramatically.

The above-mentioned study analysed global population dynamics up to 1985 but did not include the period after 1985, since its major data source was the United Nations 1990 revision of estimates and projections of global population (United Nations, 1991). Because the estimates were prepared in 1989, they did not incorporate the results of the 1990 round of censuses undertaken in many countries around the world. Those censuses are the major sources for determining growth rates in the 1980s. Population counts from two censuses give the growth rate, which in turn could validate the registration-based and survey-based estimates of fertility, mortality and migration or, as is the case in a number of developing countries, allow estimates of those demographic variables. In the 1990 revision, estimates of the demographic indicators (fertility, mortality and migration) that feature in the population growth equation were derived from registration data and survey information for the intercensal period 1980-1990. For countries lacking such data, trends in the previous periods were extrapolated. In the 1992 revision, the United Nations took into account the results of the 1990 round of censuses, wherever available, and updated estimates of fertility, mortality and migration, whenever necessary (United Nations, 1993). The updated indicators relied not only on census results but also on newly available data from demographic surveys. According to the 1992 revision, the updated estimates of the global growth rate are as follows: 1.73 per cent in 1975-1980, 1.75 per cent in 1980-1985 and 1.74 in 1985-1990, thus confirming the growth rate plateau.

In this article we take another look at the recent trend in the world's growth rate by including 1985-1990 in the study period, based on the results of the United Nations 1992 revision of estimates and projections structure of world population. Each of the three factors is considered—namely, the effect of age; fertility trends in China and India; and the initiation of fertility declines in developing countries. In the second part of the article the prospect for the future is discussed.

LEVELLING-OFF OF THE GROWTH RATE, 1975-1990

Age structure

The population age structure of the 1980s favoured a rising birth rate. The proportion of the world's women in the peak child-bearing ages of 20-34 is estimated to have increased from 21.0 per cent in 1970 to 24.4 per cent by 1990. This change reflects the coming of age of the relatively large number of children born during the 1950s and the 1960s. In China and India the substantial impact of the change in age structure on the birth rate has been confirmed at the country level (Chaudhry, 1989; Zeng Yi and others, 1991). Although the change in age structure began to exert upward pressure on the birth rate and the population growth rate in the 1970s, the effect intensified in the 1980s and remained strong through the decade. This can be seen in the trend of the ratio of the crude birth rate (CBR) to the total fertility rate (TFR). The ratio measures the effects of the age structure on the crude birth rate, and, in turn, the population growth rate (Horiuchi, 1991a, annex II). The ratio, estimated for the world total, increased from 6.9 in 1965-1970 through 7.4 in 1975-1980 to 7.9 in 1985-1990.[1] A previous study has shown that the growth rate for the period 1985-1990 would have been 1.56 per cent instead of the actual 1.74 per cent if the age structure of the world population had been the same as in 1975-1980.

Fertility trends in China and India

The fertility decline stalled around 1980 in China and during the late 1970s in India. The total fertility rate in China fell steeply, from 6.45 children per woman in 1968 to 2.24 in 1980. This sizeable reduction of about four children per woman during a single decade may be the fastest fertility decline ever experienced by a large population. The decline, however, stopped suddenly, and TFR fluctuated at about 2.5 births during the 1980s, a level of child-bearing that was comparable to that in some developed countries. Despite the Government's promotion of delayed marriage and limit on the number of children to one per couple, many people in China still marry at relatively young ages (Coale and others, 1991) and have second-order or unplanned births (Feeney and others, 1989; United Nations, 1990; Whyte and Gu, 1987). This has led to a relaxation of the Government's one-child policy and some local flexibility in the interpretation of governmental policies (Greenhalgh, 1986; Kaufman and others, 1989).

Fertility declines in India were more moderate. The total fertility rate fell from about 5.7 births per woman in the late 1960s to 4.7 births in the late 1970s. The National Congress Party, criticized for excessively promoting birth control (with a heavy focus on sterilization), was defeated in the 1977 elections (Chaudhry, 1989; Jain, 1989). Subsequently, more emphasis was placed on the welfare aspect of population programmes, ruling out "compulsion and coercion" of any type (United Nations, 1980, p. 33). This change in policy probably brought about in part the slow-down in the fertility decline there.

The results of the 1990 China census and the 1991 India census are consistent with the previously estimated fertility trends in the 1980s. China and India together make up more than a third of the world population and a slow-down in their fertility declines has a significant impact on the growth rate for the entire world.

Fertility trends in other developing countries

Countries can be classified into three categories according to the timing of the onset of fertility decline (United Nations, 1992, part One). The categories are:

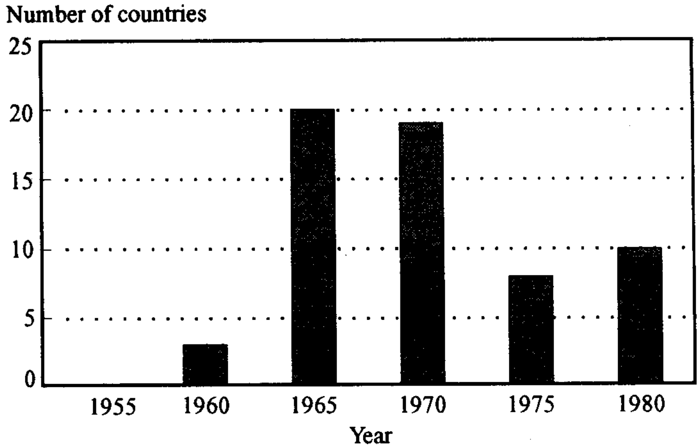
(*a*) Pre-transition countries: those that have not started or are at early stages of the process of fertility decline;

(*b*) Late-transition countries: those that began significant fertility reductions after 1950; and

(*c*) Early-transition countries: those that began significant fertility declines before 1950.

The classification considered the period 1950-1985, using the results of the 1990 revision. There were 67 pre-transition countries, 46 late-transition countries and 37 early-transition countries. The pre-transition group includes most countries in sub-Saharan Africa and a number of countries in Southern Asia (excluding India); late-transition countries, which include China and India, are mostly in Eastern and South-eastern Asia and Latin America; and early-transition countries

Figure II. Number of countries by year of onset fertility transition, late-transition countries

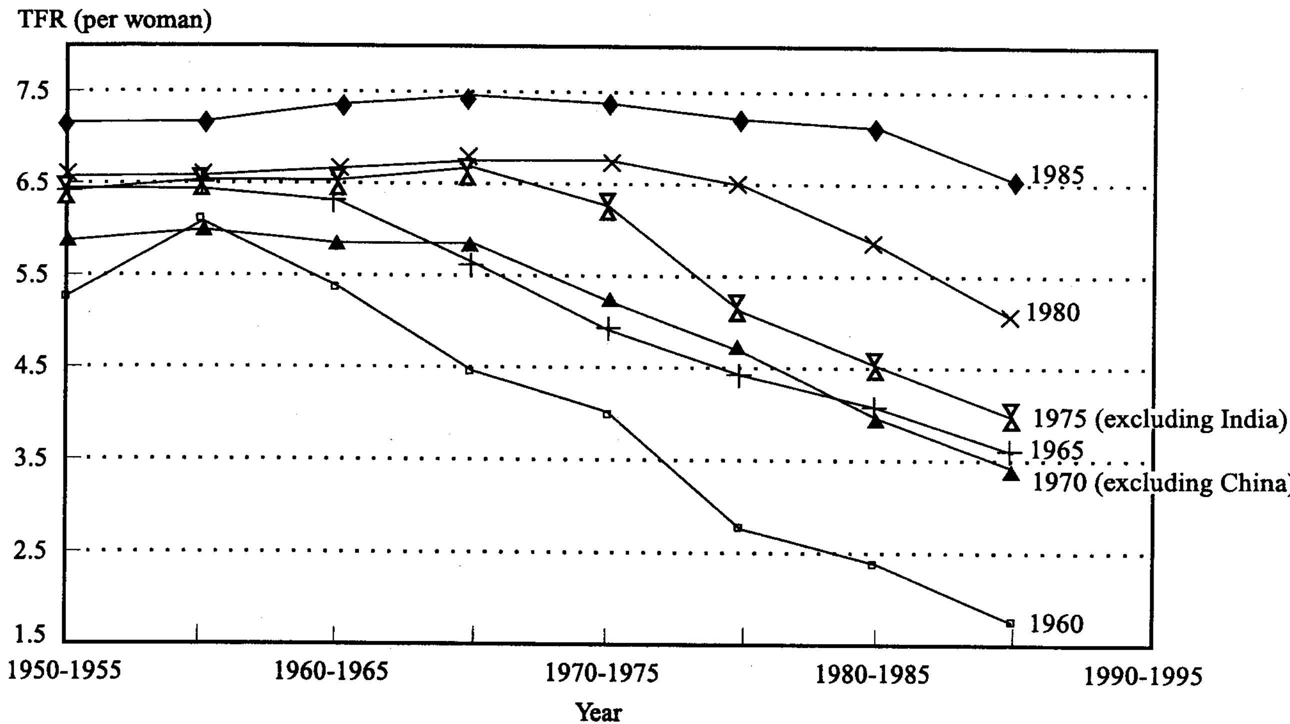


consist mostly of developed countries in Europe and Northern America. Western Asia and Northern Africa are mixed, with some pre-transition and late-transition countries.

Using this classification, it was shown that among the late-transition countries, a majority (more than three quarters) started significant fertility decline around 1965-1970[2] (figure II). These included—in order of current population size—China, India, Brazil, Philippines, Turkey, Thailand and Egypt, all of which had populations of more than 50 million in 1990. (China, India and Brazil had populations of over 100 million.) By 1975, Indonesia and Mexico had joined the group of countries that had started the fertility transition, but there were only a few others. Falling birth rates in those developing countries that had begun their fertility transition accounted for much of the decline in the world growth rate in the 1970s. However, between 1975 and 1985, not many additional countries started significant fertility declines. The fact that the onset of the fertility transition did not occur in any other populous countries between 1975 and 1985 contributed to the stagnation in the decline of the world growth rate.

Has this picture changed, given the new estimates of fertility for the 1980s? In the present analysis, the number of late-transition countries increased from the previous count of 46-57.[3] The 11 new countries include five from sub-Saharan Africa. Despite these adjustments, the effect on the growth rate is minimal, probably because their fertility levels are still very high. The average TFR in 1985-1990 of the countries that started fertility declines in the mid-1980s is about 6.5 children (figure III).

Figure III. TFR for late-transition countries (excluding China and India), according to year of onset of fertility transition



Most notable new inclusions in the late-transition category are Bangladesh and Kenya. In Bangladesh, a strong commitment by governmental and non-governmental organizations to decrease the level of fertility was probably the main reason why contraceptive prevalence in that country increased from only 13 per cent in 1979-1980 to 31 per cent in 1989 (United Nations, 1992, table 42). The total fertility rate in Bangladesh decreased from 6.2 births per woman in 1981 to about 4.8 in 1986-1989 (United Nations, forthcoming, table II.A.1). Kenya, contrary to expectations of many population experts, has experienced increasing contraceptive prevalence rates (from 12 per cent in 1977-1978 to 27 per cent in 1989) and a significant reduction in the level of the total fertility rate (from 8.1 in 1977-1978 to 6.7 in 1989). The fertility transition in Kenya has been attributed to major attitudinal changes by both men and women during the past 20 years. The increasing effectiveness of the family planning programme seems also to have played a major role in facilitating changed behaviour to match the changed attitudes (Robinson, 1992). In both Bangladesh and Kenya, fertility declines took place in the absence of substantial social and economic development, although in the case of Kenya, there was considerable improvement in levels of female education.

PROSPECTS FOR THE 1990S

The global population prospect for the 1990s remains uncertain. The growth rate for 1990-1995 projected in the 1992 revision ranges widely: from a slight increase, to 1.76 per cent, in the high-variant projection; through a moderate decline, to 1.68 per cent, in the medium variant, to a sharp fall, to 1.58 per cent, in the low-variant projection. Whether the stall in the decline will continue into the 1990s as projected in the high-variant projection or follow the course expected in the medium and low variants depends, among other factors, on the age structure, what happens in China and India, and whether more countries in the pre-transition group start their fertility decline. A basic assumption is that once fertility starts to decline, the decline is sustained until low levels of child-bearing are reached. Although this assumption is generally consistent with the majority of national demographic experiences, what happened in India in 1977-1984 indicates that it does not always hold true.

The age structure

Changes in the age structure in the 1990s will begin to favour a decline in the rate of growth. The proportion of the population who are women in their child-bearing ages will start to decrease as the generations of the 1950s and 1960s are replaced by the cohorts born in the 1970s, the decade of remarkable fertility decline. The replacement of cohorts is reflected in the medium-variant projection of the 1992 revision, in which the proportion of women at ages 20-34 in the world is expected to decrease from 24.4 per cent in 1990 to 23.8 per cent in 2000 and the CBR/TFR ratio will be reduced from 7.98 in 1990-1995 to 7.89 in 1995-2000. These changes, though relatively small, will exert a downward pressure on the growth rate. The trend is projected to continue into the early twenty-first century.

Fertility trends in China and India

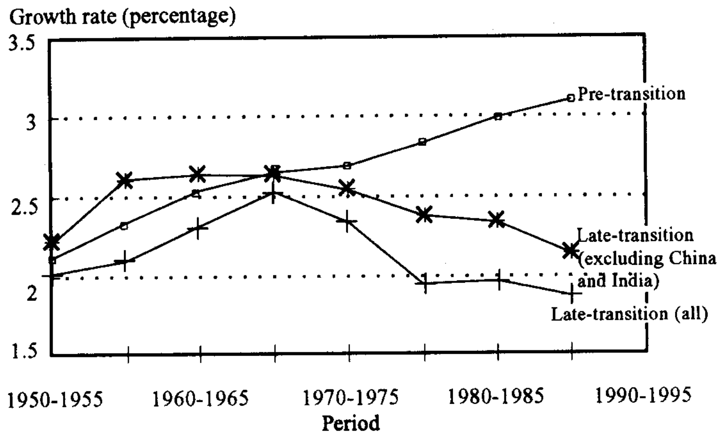
Recent data suggest that China and India have resumed their fertility declines. TFR in China fluctuated at about 2.5 during the 1980s. A close look at the trend shows that there were two small fertility upturns from a TFR of about 2.2 births per woman: the first upturn was in 1982—mostly because of an increase in the number of first marriages and subsequently first births (Blayo, 1992)—and the second in 1987. TFR then fell to 2.2 again around 1990. Most current data show that TFR continued to decline, to 1.9 in 1992, although this estimate has not been thoroughly evaluated as yet.

In the case of India, there is a large difference in levels of fertility between the northern states and the southern states, where fertility is somewhat lower (in some states, below replacement level). The crude birth rate for India as a whole, according to the sample registration system, remained between 33 and 34 for eight years (1977-1984), then declined in the late 1980s and reached 30.2 in 1990.[4] India's TFR is still about four births per woman on the aggregate level. Whether the decline will continue or whether there will be another stagnation makes a substantial difference to the world growth rate trend. India still has a record of poverty, low literacy, high mortality and low per capita income. Despite unfavourable social and economic indicators, change in contraceptive prevalence is very possible, as occurred in the southern states.

Fertility trends in other developing countries

In 1990, there were 56 countries left in the pre-transition category with a total of 728 million persons (14 per cent of the world population) living in them. Nearly half lived in four countries (in order of population size): Pakistan, Nigeria (each with a population of more than 100 million in 1990), Islamic Republic of Iran and Ethiopia (each with a population of more than 50 million in 1990). Almost all of the least developed countries[5] are in the pre-transition group. During 1965-1970, the pre-transition countries were growing at about the same rate as the late-transition countries. Since then, however, the growth rate of the late-transition countries declined to slightly above 2 per cent in 1985-1990, whereas the growth rate of the pre-transition countries increased to above 3 per cent per annum (figure IV). The average total fertility

Figure IV. Population growth rates according to onset of fertility transition

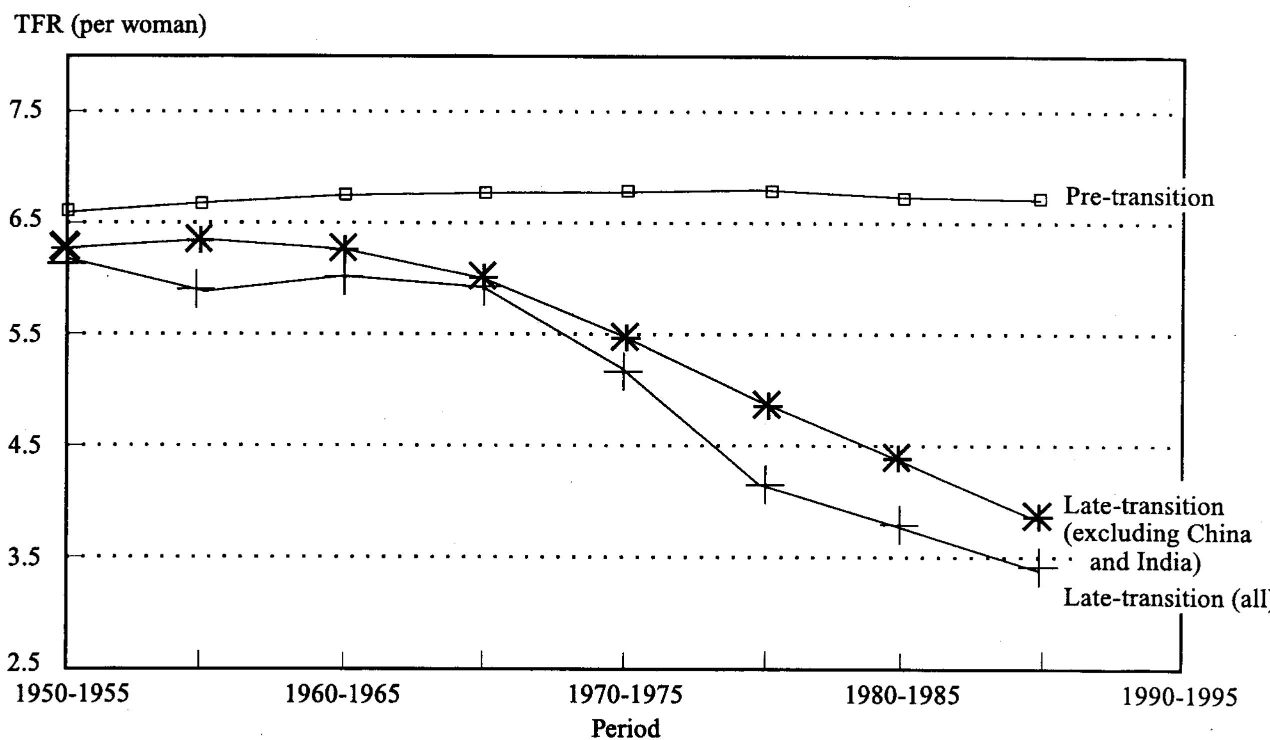


rate among the pre-transition countries has remained nearly constant, at slightly above 6.5 births per woman since at least 1950 (figure IV).

It is difficult to predict the future course of fertility for the pre-transition countries. The experience of the late-transition countries was that, on average, once the process of fertility decline started, declines of more than one child per decade were observed (figure V). For example, among those countries that initiated the process of fertility decline around 1975, the aggregate total fertility rate fell from 6.3 births per woman in 1970-1975 to 4.5 births per woman in 1980-1985. In all of the five late-transition-country categories classified according to the onset of fertility decline, declines in the aggregate fertility rate were sustained, once started. On the other hand, the situation in individual countries can be more uncertain. In Botswana, for example, the total fertility rate, in both urban and rural areas, declined from 6.1 births per woman in 1981 to 5.0 in 1985. Since 1985, no further decline in fertility was observed. The fertility decline in rural areas in the early 1980s is attributed to economic crises caused by drought. Once the period of drought ended and economic recovery began in the second half of the 1980s, fertility increased slightly in rural areas and the decline in fertility stalled in urban areas (Rutenberg and Diamond, 1993). Future declines in fertility and population growth in Botswana are contingent on continued governmental commitment to family planning. The level of education among women is high in Botswana, relative to other countries in the region: 76 per cent of women are literate, a condition that is conducive to fertility decline.

Two of the four largest countries in the pre-transition group are in Asia: Islamic Republic of Iran and Pakistan. The Islamic Republic of Iran has recently taken steps to strengthen its family planning programme,

Figure V. TFR for pre-transition and late-transition countries



and the Government has an explicit policy aimed at reducing the level of fertility (ESCAP, 1993). Whether this commitment pays off will probably be seen over the next 5-10 years. At present, the Islamic Republic of Iran has a total fertility rate of more than five births per woman. In Pakistan, there are indications of the beginning of fertility decline in the urban areas of the country despite the lack of major progress in social and economic development (Pakistan, 1992, chap. 4). A strong commitment by the Government to family planning and improvement of the status of women will be necessary if declines in fertility are to occur.

Demographers have long been pessimistic about the prospects for fertility decline in sub-Saharan Africa. More recently there has been reason for some optimism. Several countries, including Kenya, Botswana and Zimbabwe, have seen a fall in the level of fertility. Nigeria may follow soon. In Nigeria, fertility is high and likely to remain so as long as contraceptive prevalence is low (currently only 6 per cent of married women use contraception) and desired family size is large. The idea of reproductive choice is not widely accepted. Among more educated, urban women, contraceptive use is higher than among uneducated, rural women. Urban women have, on average, one child fewer than rural women, and women who have completed secondary education have about two fewer children than women with no education (Nigeria, 1992). This seems to suggest that further economic and social development, if combined with strong family planning programmes, may induce a significant fertility decline. Nigeria, with a population of more than 100 million in 1992 and a growth rate above 3 per cent per annum, is the tenth most populous country in the world. By 2025, according to United Nations projections, it may double its population to more than 250 million and rank fourth in the world in terms of population size. Thus the future fertility trend in Nigeria is extremely important.

There are great uncertainties in the demographic future of the pre-transition countries. Current levels of fertility are much higher than they were in the late-transition countries when fertility started to decline there. The timing and speed of fertility decline in the pre-transition countries can make a considerable difference in the size of the world population in the long run. Fertility decline in a population is strongly related to the socio-economic development and family planning programmes of the country: economic changes increase the potential benefits of fertility limitation; family planning programmes provide access to effective means of birth control; and exposure to new ideas such as family planning induces a fundamental shift in world view from short-term survival tactics and fatalism to long-term planning and control, including control of the number of children. The "ideational" factors (world view) have been shown to have considerable effect on the fertility transition (Cleland and Wilson, 1987; Van de Walle, 1992), and attitudinal changes may come to have an even greater impact than economic factors.

CONCLUSION

The previous study (Horiuchi, 1992) documented the levelling-off of the world population growth rate in the early 1980s and analysed the major causes of the stagnation. Results of the 1990 round of censuses, incorporated into the 1992 revision of estimates and projections, has confirmed that the growth rate plateau continued into the late 1980s.

The previous study emphasized uncertainties about future fertility prospects in China, India and high-fertility countries. Recently available information seems to shift the prospect to some extent in favour of lower growth rates for the 1990s. China and India resumed their fertility declines. In developing countries that did not begin significant fertility transitions in the 1960s and 1970s, more recent beginnings were confirmed in the present article than in the previous study. In particular, fertility declines in populous Bangladesh and Kenya seem evident, raising expectations for other high-fertility countries. The predicted reversal in the direction of the impact of age structure on the growth rate will also play a part.

The shift from the growth rate plateaus of the 1980s to the resumed decline in the 1990s, however, will not occur automatically. In countries where significant fertility declines have not begun as well as in countries in the middle of the fertility transition, the change must be fuelled by the strong commitment of Governments to population issues, increased resources for family planning programmes and progress in economic and social development.

NOTES

[1]The scale of the ratio is determined by the definitions of the crude birth rate and the total fertility rate, which are the annual number of births per 1,000 population and the number of expected births per woman between ages 15 and 49, respectively.

[2]A country is classified as having started the process of fertility transition when the average total fertility rate falls by 0.5 or more between two successive five-year periods. The approximate year of onset is then taken as the mid-point of the 10-year interval.

[3]The increase in the number of late-transition countries is partly the result of two methodological changes. First, the number of countries for which fertility estimates are available increased between the 1990 and 1992 revisions. In neither revision were fertility estimates prepared for countries with very small populations. In the 1992 revision, the cut-off population size was 200,000 in 1990, whereas in the 1990 revision, the cut-off population size was 300,000. This meant that six more countries (population size between 200,000 and 300,000) were included in the present analysis. Secondly, the criteria for classification have been modified in the

present study. The classification scheme was developed originally for analyses of age structure (Horiuchi, 1991b; United Nations, 1992) but not necessarily for analyses of population growth. A major problem in using the scheme for population growth is that it tends to overlook significant fertility declines at very high levels. In the original classification, all countries with TFR above 5.5 children were placed in the stage of the fertility transition if TFR is over 5.5. Therefore, some countries that have experienced substantial fertility declines (for example, from a TFR of 8 to 6) may still be labelled "pre-transition". We thus change the criterion such that any TFR decline of 0.5 or more children between the two successive five-year periods moves the country out of the pre-transition category. Declines due to catastrophic conditions such as war and famine, however, are not considered.

[4]Although these CBR figures have not been adjusted for underregistration, the omission rate is estimated to be about 3 per cent or lower.

[5]As defined by the General Assembly, there are 48 least developed countries.

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