B. THE MEASUREMENT OF MORTALITY AND CAUSES OF DEATH

Kenneth Hill reviewed several aspects of the measurement of mortality in developing countries. The main sources of data allowing the estimation of mortality over age 15 included: (*a*) the distribution of deaths by age and sex obtained from a civil registration system together with the distribution of the total population classified by age and sex, usually obtained from a census; (*b*) similar information on deaths and the population exposed to the risk of dying obtained from a sample registration system; (*c*) the availability of complete enumerations of a population from successive censuses (which permitted the derivation of probabilities of survival during the intercensal period); and (*d*) the availability of data on the survivorship of kin (mothers, fathers, siblings) or on deaths over a particular period obtained from censuses or from moderate to large-scale household surveys.

Because information on deaths by age derived from a civil registration system had the greatest potential of permitting an in-depth analysis of mortality trends and characteristics, it was important to assess the extent to which such data were available. Using information compiled by the United Nations Statistics Division on the countries reporting that their civil registration system attained at least a 90 per cent completeness in the coverage of deaths, Hill concluded that the availability of such information in terms of number of countries had shown only a modest improvement from the early 1970s to the early 1990s (the proportion of countries with complete reporting of deaths increased from 28 to 35 per cent). However, when countries were weighted by their population size, the improvement disappeared: in terms of total population covered by an adequate system of death registration, the percentage declined from 17 to 16 per cent over the two decades considered. There were also significant differences between the developing regions. Thus, whereas the population covered by adequate death registration amounted to 81 per cent in Oceania, 60 per cent in the Caribbean, 49 per cent in Northern Africa and 41 per cent in Latin America, it was less than 5 per cent in Asia and virtually nil in sub-Saharan Africa.

A second way of assessing the availability of information allowing the estimation of mortality over age 15 was to resort to the information published by the United Nations Population Division regarding the type of method used to derive estimates of adult mortality in preparing projections for all countries of the world. The information available referred to a period preceding 1994 and indicated that registered deaths, which included those obtained via the sample registration system operating in India, served as the basis for the estimation of adult mortality for about 48 per cent of the developing world's population. The second most important source of information was data on deaths over a specific reference period obtained from censuses or surveys, which covered 32 per cent of the developing world's population and included China, whose 1991 census gathered the required information. Among the remaining 20 per cent of the population in developing countries, estimates derived via models from information pertaining exclusively to mortality in childhood were used in most cases (for 13 per cent of the population) and data on adjusted registered deaths were used for another 3 per cent. That is, for 83 per cent of the population of the developing world there was some information about the distribution of deaths by age and their mortality level. However, the proportion covered by region varied considerably and was particularly low in Africa, where it reached only 11 per cent.

Given that over a third of all countries in the developing world lacked adequate data allowing the estimation of adult mortality, it was important to suggest strategies for the improvement of that situation. Since the establishment of a fully functional and reliable system of death registration was judged beyond the means of most of those countries, attention was focused instead on the collection of data allowing the indirect estimation of adult mortality. Information on the number of deaths occurring in a household over a 12 month period together with the age at death and sex of the deceased could be obtained via

censuses or large-scale household surveys. Estimates derived from such information would be more likely to be reliable for populations with moderate to high average levels of educational attainment and for which the dating of events was meaningful. Because the death of an adult was a rare event, large sample sizes were required to obtain reliable estimates of mortality by age and sex.

In countries where the reporting of deaths occurring over a specific reference period was not expected to be sufficiently reliable, it was suggested that gathering information on the survival of close relatives was the next option. The relatively new approach of obtaining information on the survival of siblings had potential advantages because it provided a more recent estimate of mortality than methods based on the survivorship of parents. However, the collection of the data required to estimate mortality from sibling survival was more demanding than that involved in gathering information on the survival of parents. Furthermore, to obtain recent estimates of mortality based on information on the survival of mothers or fathers, that information should be complemented by a question on whether the dead parent had survived to some key event in the life of the son or daughter to which the information referred, such as that person's marriage or the birth of that person's first child.

Eduardo Arriaga addressed the issue of measuring causes of death in developing countries. He remarked that few developing countries gathered and published data on deaths classified by cause and those data often suffered from lack of completeness and errors in the reporting of cause of death. An important indicator of the quality of data on cause of death was the proportion of deaths attributed to ill-defined or unknown causes. Usually, the proportion of deaths with cause unknown was higher at very young ages and among persons belonging to lower socio-economic groups. Furthermore, in countries where persons with certain illnesses were likely to be stigmatized, there was reluctance on the part of both physicians and relatives to declare the true cause of death. Despite these problems, information on the distribution of deaths by cause had proven useful in assessing trends and for the detection of changing patterns, especially in regard to deaths attributable to "external causes". Thus, the available data on deaths classified by cause indicated that rates of suicide were particularly high among Chinese women and that in Colombia in 1986 violent deaths among males aged 15-44 were about nine times higher than those among females in the same age group.

Arriaga noted that in countries where the proportion of deaths with ill-defined or unknown causes was high, there was often no basis on which to adjust the observed distribution of deaths by cause, since it was unlikely that the deaths included in the ill-defined and unknown categories were randomly assigned to it. The possibility of selectivity meant that proportional redistribution would result in biases. Although other methods of redistribution were available, there was usually no basis on which to judge whether the resulting distribution was closer to the true one than the unadjusted one.

An even more serious problem arose when a country lacked information on cause of death altogether. Arriaga suggested that current knowledge about the typical distribution of deaths by cause characterizing the different stages of the epidemiological transition could be used to impute a distribution by cause to the estimated deaths of developing countries on the basis of their level of mortality (which was an indicator of the stage reached in the epidemiological transition). Such imputation was justified by the empirical finding that, among deaths under age 10 and those over age 45, the distribution by cause was fairly similar among countries having similar levels of mortality over those age ranges. Multivariate analysis could be used to derive model patterns and make the necessary imputations. However, there was greater variability in the distribution of deaths by cause over the middle age range, especially because there was not a close correspondence between level of mortality at those ages and the relative weight of mortality due to external causes and to causes related to pregnancy and delivery. To address that problem, Arriaga suggested that censuses or surveys collecting information on

deaths over a specific period should also include a question designed to determine whether the death was caused by external causes. In particular, Arriaga proposed that the respondent be asked whether a reported death occurred as the result of an accident, homicide or suicide. If the deceased person was a woman, a further question on whether her death occurred because of pregnancy or delivery could be added.

Arriaga reviewed briefly the use of surveys and "verbal autopsy" methods to establish the cause of death of persons deceased within a household. He concluded that although such methods had proven useful in investigating the incidence of specific causes of death among small groups of children and women of reproductive age, it was unlikely that similar methods could be extended to gather information on a wider range of causes of death for a whole population. Consequently, barring the substantial improvement of systems of death registration in developing countries, the gathering of information such as that suggested above that would allow the indirect estimation of the distribution of deaths by cause seemed the most cost-efficient approach over the near future.

The presentation by Rosario Cárdenas focused on the changing causes of death in Mexico, as measured by the death registration system of that country. The coverage of that system had generally been high and by the 1990s about 95 per cent of all deaths were medically certified. However, the data were not considered to be free from error and misreporting of age at death was still considered to be a problem. Comparison of the standardized mortality rates estimated for 1979 and 1996 showed that mortality levels had declined substantially, with the reduction being larger for males than for females, so that the sex differentials diminished. Three mutually exclusive groups of causes of death were considered: (*a*) communicable diseases plus maternal and peri-natal causes of death; (*b*) non-communicable diseases; and (*c*) injuries. In accordance with the epidemiological transition, a large proportion of the gains in life expectancy registered between 1979 and 1996 was attributable to the reduction of mortality from infectious and parasitic diseases among both sexes. In addition, mortality due to injuries declined significantly among men. Already by 1979, non-communicable diseases accounted for most of the mortality among men and women in Mexico and, among men, injuries accounted for a larger share of mortality than communicable diseases. By 1995 the estimated number of years lost because of non-communicable diseases were 9.8 for men and 8.4 for women. In addition men lost over 4 years because of deaths caused by injuries and women lost about half that amount.

Analysis of specific causes of death in Mexico indicated that mortality due to diabetes was rising but that there was lower mortality caused by peptic ulcer and stomach cancer. Among men, mortality due to lung and prostate cancer was rising, whereas among women, mortality from cervical cancer and, to a lesser extent, from breast cancer was increasing. An analysis of mortality at the state level indicated the existence of large differentials in survivorship, but a trend towards convergence was noticeable. Despite the severe economic recession that Mexico experienced during most of the 1980s, mortality had continued to decline. Several factors might have contributed to maintain such decline, especially the expansion of interventions aimed at improving the health status of children. However, much remained to be done to understand fully the processes leading to the reduction of mortality among adults. Policies aimed at combatting the known causes of non-communicable diseases had yet to be put in place, especially regarding the prevention of automobile accidents, and the reduction of smoking and alcohol abuse.

In the discussion that followed it was noted that different types of data or estimates of mortality were needed to fulfill different needs. Thus, a general level of mortality was needed to estimate population growth rates. Complete life tables were necessary to project a population but more detailed information was needed to address issues of equity, quality of life or to track emerging causes of death. It was suggested that different sources of data be combined to obtain a more comprehensive

view and that non-traditional sources, such as hospital records or reports by physicians, be used to obtain information on morbidity and causes of death. It was pointed out that the deficiencies or shortcomings of one source of data could sometimes be palliated or compensated by information obtained from other sources. Thus, although the estimates derived from reports of deaths occurring over a specified period might not be perfect, they could provide a basis for comparison with estimates obtained from the survivorship of close relatives in countries where other sources of data were deficient or non-existent.

The strengths and limitations of traditional sources of data for demographic estimation were reviewed in terms of the potential of the different sources to yield data classified by age, sex, socio-economic status, region, and reference period (recent vs. further in the past). The problem of deciding which source of data to promote in countries where resources were scarce and registration systems non-existent was judged to depend on a consideration of cost vs. accuracy. From that perspective surveys could be considerably less costly than censuses but their effectiveness in producing reliable estimates of mortality depended on ensuring that they were truly representative of the population under study and that adequate sample sizes were used. It was noted that, to estimate with a 5 per cent error a mortality rate over ages 15 to 60 that was expected to be in the range of 3 to 8 deaths per 1,000, a sample of 103,000 households was needed. Although the sample size could be considerably smaller if the method based on the survivorship of siblings was used (provided total fertility had been moderate to high in the past), the numbers involved were still four or five times larger than the typical sample size of the demographic and health surveys normally undertaken (about 4,000 respondents).

Several participants expressed concern about the quality of the data available. Age misreporting was recognized as a major problem affecting the reliability of estimated age-specific mortality rates. The problem was especially serious in cases where the patterns of misreporting differed between the source of deaths by age and that of population by age. Age misreporting was expected to be particularly acute among populations characterized by low levels of educational attainment for whom dates had little meaning. Although it was suggested that the use of historical calendars could improve the quality of information on age and on dates of events in such populations, studies on the use of such devices were said to have shown that their use improved only the smoothness but not the quality of age reporting.

Regarding information on cause of death, it was noted that even in developed countries, where most deaths were medically certified, that information was not totally reliable. Furthermore, although a high percentage of deaths reported as having ill-defined or unknown causes signaled that the information was probably deficient, it was not necessarily the case that information on cause of death was better when the proportion of deaths in such categories was low. In some of the successor States of the former USSR, for instance, causes were assigned to most deaths, but erroneous reporting of such causes was high.

With respect to developing countries lacking vital registration systems, several participants cast doubts about the possibility of obtaining useful information on causes of death from a few questions added to censuses or large-scale surveys. Thus, it was thought that respondents would be reluctant to report that the death of a household member had resulted from violence. Distinguishing deaths due to suicide from those due to homicide might also prove to be problematic in practice. It was further argued that even the usefulness of information obtained from “verbal autopsies” was generally limited because different diseases could present similar symptoms and the respondent might not recall or might never have been aware of the full array of symptoms experienced by the deceased. Yet, although epidemiological research required detailed and reliable information on causes of death, for the purpose of setting priorities for public health interventions in contexts where other information was lacking, the rough data yielded by verbal autopsies could be helpful. In addition, given that high mortality countries

were also the most likely to lack information on both mortality levels and causes of death, it was important to use any suitable opportunity to try to fill such information gap. The preparations for the 2000 round of censuses presented such opportunity and, although the tendency was to reduce the number of questions included in censuses, it was noted that the recommendations for the 2000 round of censuses about to be issued by the United Nations included a question on deaths in the household over the 12 months preceding enumeration. The prospects regarding the introduction of other questions in the upcoming round of censuses were judged to be slim, but in order to enhance them it was suggested that efforts be made to test the proposed questions in pilot surveys or pilot censuses, since evidence validating their adequate performance in the field was a pre-requisite for their inclusion in censuses or large-scale surveys.

Some participants suggested that another way of improving data availability would be through the use of surveillance systems in multiple sites so that certain representativeness could be achieved. The Sample Registration System of India was provided as an example of such surveillance systems, but it was noted that its operation was costly and that, in order to ensure the representativeness of the system, the areas covered had to be changed periodically. In the case of India, the Sample Registration System had last been "re-based" using the results of the 1991 Census. Other surveillance systems, particularly those used to gauge the effects of particular health interventions, had soon lost their representativeness and could no longer be used to produce data reflecting national conditions.

There was some discussion about the problems faced in collecting the data needed for the application of the estimation method based on the survivorship of siblings. It was noted that when such questions were included in a household questionnaire where only the head of household provided information about household members, requesting information about siblings from every person listed led to needless repetition and did not elicit the cooperation of the respondent. There were also problems about the performance of the method, since in a number of countries it had produced estimates of mortality that suggested increasing rather than decreasing trends over time, but the general conclusion was that this method was sufficiently promising as to deserve further use and testing. To make such testing possible, it was recommended that information allowing the application of multiple indirect methods of mortality estimation be collected.