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United Nations Expert Group Meeting on Current Issues in the Estimation of Adult Mortality

New York, 26-27 October 2006

Report of the Meeting

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Department of Economic and Social Affairs
Population Division

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DESA

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Note

PREFACE

The Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat is in charge of estimating levels and trends of mortality for all the countries of the world. The work of the Population Division in this area has encompassed both the preparation of estimates of mortality indicators and the development of methods to estimate mortality, particularly when the data available are incomplete or deficient. The most recent contribution of the Population Division in the area of methodology is the report entitled *Methods for Estimating Adult Mortality,*[1] which presents the major approaches to the estimation of adult mortality using indirect or incomplete information.

The Population Division has also contributed to the development of mortality models that may be used in conjunction with available evidence to derive full life tables for populations lacking complete and reliable information on deaths by age. The United Nations model life tables for developing countries[2] provide a set of models that were derived in the early 1980s on the basis of the mortality experience of developing countries with reliable information.

With the establishment of the Mortality Section in 2004, the Population Division is devoting more attention to the improvement of both the methods used to estimate mortality and the development of flexible models allowing the derivation of life tables from partial information. This work benefits from a dialogue with experts engaged in similar work both within and outside the United Nations system. The Expert Group Meeting on Adult Mortality convened by the Population Division provided an opportunity to discuss ongoing activities in other institutions and to obtain feedback on the work carried out by the Population Division. As mortality levels continue to decrease in most countries of the world, deaths become increasingly concentrated at older ages and it becomes more pressing to estimate mortality in adult ages with accuracy. In addition, as the AIDS epidemic continues to expand, accounting for its effect on adult mortality is essential. These are some of the issues discussed by the Expert Group Meeting, as reflected in this report.

This report as well as other population information can be accessed via the Internet on the official website of the Population Division, www.unpopulation.org. For further information concerning this publication, please contact the office of Ms. Hania Zlotnik, Director, Population Division, Department of Economic and Social Affairs, United Nations, New York, NY 10017, USA; telephone number +1 212-963-3179; fax number +1 212-963-2147.

[1] United Nations publication, ESA/P/WP.175, 2002.
[2] United Nations, *Model Life Tables for Developing Countries*, United Nations publication, Sales No. E.81.XIII.7, 1982.

Explanatory Notes

The following acronyms are used in the report:

DDM	Death Distribution Methods
DHS	Demographic and Health Surveys
DSP	Disease Surveillance Points
GGB	General Growth Balance
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
INED	Institut national d'études démographiques
INDEPTH	International Network for the continuous Demographic Evaluation of Populations and their Health in developing countries
MDG	Millennium Development Goals
MICS	Multiple Indicator Cluster Surveys
PAHO	Pan American Health Organization
SEG	Synthetic Extinct Generations
SRS	Sample Registration System
UNAIDS	Joint United Nations Programme on HIV/AIDS
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
WHO	World Health Organization

UNITED NATIONS EXPERT GROUP MEETING ON CURRENT ISSUES IN THE ESTIMATION OF ADULT MORTALITY

A. OPENING OF THE MEETING

Ms. Hania Zlotnik, Director of the Population Division, opened the meeting by welcoming participants and noting that the topic they would discuss had particular relevance in the context of recent trends and developments in the areas of health and mortality. She pointed out that there was an increasing need for reliable estimates of adult mortality, particularly for developing countries. These estimates would allow to establish whether, as was expected in the 1970s or early 1980s, the populations of developing countries would undergo the epidemiological transition as those of developed countries had. She recalled that, according to the epidemiological transition, mortality decline would be accompanied by a reduction of mortality caused by infectious disease and a predominance of deaths caused by chronic or degenerative diseases. The advent of HIV/AIDS and its rapid spread in sub-Saharan Africa already meant that the countries most affected by the epidemic were not experiencing a reduction of mortality due to infectious diseases but adequate estimates of adult mortality for those countries were largely lacking. Furthermore, recent research had shown that some diseases once considered degenerative, such as liver, stomach or cervical cancer, were actually caused by infectious agents. It was an open question whether the spread of those diseases would be controlled rapidly enough through relatively low-cost interventions such as vaccines. Recent evidence suggested that the prevalence of diabetes was increasing in many developing countries. Whether their health systems would be capable of providing the treatments necessary to extend the life of those affected was another important question. Better estimates of adult mortality that allowed tracking changes over time would facilitate planning and decision-making regarding the type of interventions that were necessary or most effective in different contexts.

In presenting mortality estimates for countries and areas of the world, Ms. Zlotnik noted that it was important to make clear whether they were derived from empirical data or were the result of modelling. She stressed the importance of having ready access to the data yielded by original sources so their quality and reliability could be assessed. She hoped the meeting would set the basis for embarking in a more systematic assessment of available data but noted that this was a major task and several years would be necessary to accomplish it. The Mortality Section of the Population Division was committed to improving the estimates of adult mortality produced by the Division and hoped to do so in collaboration with the experts attending the meeting. As the work progressed, the Population Division planned to convene this type of meeting at regular intervals to facilitate the exchange of information and the discussion of methodological issues with key experts and institutions.

B. OVERVIEW OF THE PLANS FOR THE ESTIMATION OF ADULT MORTALITY AT THE POPULATION DIVISION

Mr. John Wilmoth, Chief of the Mortality Section of the Population Division, presented an overview of the Population Division's plans to improve existing methodology for the estimation of mortality. An overall objective was to establish a unified and well-documented system for deriving historical trends and current estimates of age-specific mortality and life expectancy for all countries and areas for which the Population Division prepared cohort-component population projections.

He noted that this work was necessary because there was increasing demand for comparable estimates of mortality to guide programme planning and implementation and because of the increasing prominence that health outcomes had attained in relation to the achievement of the Millennium Develop-

ment Goals (MDGs). Mortality indicators had gained the attention of policy-makers particularly as measures relevant for the attainment of the MDGs and as components of the Human Development Index, a key indicator of improvement in development. Partly for that reason, there was a need to improve transparency of the data and methods used to derive the relevant indicators.

A number of challenges had to be addressed when attempting to provide a comprehensive set of mortality estimates for all countries of the world. The first was related to deficient data on mortality, data that did not achieve full coverage of relevant events or that were plagued by inaccuracies. The second was the need to improve or update existing methodology and develop updated models for use in countries lacking relevant information. The third was the need to adjudicate among different estimates, each potentially subject to bias. The fourth was the challenge of deriving estimates in populations highly affected by HIV/AIDS but lacking direct information on mortality due to AIDS. Lastly, there was the issue of quantifying and communicating the level of uncertainty to which the estimates derived might be subject. There were also the logistical challenges of obtaining, organizing and maintaining the increasing variety of basic data that shed light on mortality, and of making the data available to those interested in exploring their quality and reliability.

Mr. Wilmoth commended the work of the Inter-Agency Group for Mortality Estimation in bringing together the main actors in the United Nations system to discuss the available estimates of child mortality and, in the process, work toward reducing differences in the estimates issued by different United Nations entities. He felt that a similar model was needed with respect to estimates of adult mortality and proposed that the Population Division take the lead in convening coordinating meetings to elicit discussion about the work of relevant United Nations entities and other actors on the estimation of adult mortality. He hoped that this meeting would be the start of a more systematic collaboration in sharing data and information, comparing all available estimates and discussing methodology with a view to eventually establish a protocol for choosing best estimates. He noted that estimation methods needed improvement, especially those appropriate for countries with incomplete data. The reliability of indirect estimation methods required testing. It would also be useful to reassess traditional model life tables and to consider the benefits of existing or perhaps novel mortality models.

He reported that the Population Division was developing a database system that would contain the basic data allowing the estimation of mortality and, eventually, the estimates derived from those data. The Division was in the process of developing the database design, producing a strategy to populate it with the basic data, finding ways to allow shared access to the database for purposes of both adding basic information and using the data, and deciding on methods of data quality control. The Division welcomed the contributions of collaborators from United Nations entities, universities and research institutes.

With regard to the specific objectives of the meeting, Mr. Wilmoth remarked that it would first review the activities relevant to the estimation of mortality of the different entities participating in the meeting. Second, it would consider two approaches to the generation of life tables from partial information: one used by WHO and another under development by the Population Division. Third, it would discuss the performance of methods to estimate adult mortality from incomplete or deficient information. Fourth, it would consider the work of the Population Division in developing a database to contain the empirical data permitting the estimation of mortality. Fifth, it would review current knowledge of mortality levels and trends in different regions or countries and discuss the challenges faced in estimating mortality in particular contexts, especially in countries affected by the HIV/AIDS epidemic. It was expected that the meeting would establish a framework for continued collaboration in improving the estimation of adult mortality in all countries of the world.

C. REVIEW OF ACTIVITIES RELEVANT TO THE ESTIMATION OF MORTALITY BY THE REPRESENTATIVES OF PARTICIPATING INSTITUTIONS

World Health Organization

The representative of the World Health Organization, Mr. Kenji Shibuya, noted that WHO's primary focus was on the distribution of deaths by cause. WHO was expanding its mortality database. It was working with China on that country's Disease Surveillance Points system (DSP) and Sample Registration System (SRS). WHO was also considering expanding the availability of basic data on mortality.

WHO's mortality estimates were produced following a four-step process which started with the compilation and input of available empirical data into WHO's database. Then, estimates were derived for countries with incomplete or deficient data. The estimation methods used had been published in peer-reviewed journals and independent advisory groups had been convened to assess them. The estimates derived were examined for consistency with other sets of estimates. After the estimates were completed, a consultation process at the country level assessed them again. This consultation was carried out with representatives of either the ministry of health of each country or the national statistical office.

Mr. Shibuya also reported on the activities of the Health Metrics Network, a group of independent partners whose secretariat was located at WHO Headquarters in Geneva. The Network was focusing on the improvement of health information systems and assessing the quality of vital registration data in developing countries.

Pan American Health Organization

The representative of the Pan American Health Organization (PAHO), Mr. John Silvi, said that PAHO had the mandate of compiling mortality data directly from the countries in the Americas. After the quality of these data was validated, they were sent to WHO Headquarters. PAHO also conducted analyses of cause-of-death data provided by countries.

PAHO had undertaken a programme to improve vital registration in the Americas and had sponsored a meeting in Buenos Aires on that topic in 2005. The programme assisted countries in diagnosing the problems affecting the coverage and quality of information derived from their vital registration systems and promoted the exchange of know-how and best practices with countries whose vital registration systems were functioning well. Mr. Silvi mentioned that the Member States of PAHO included several small island States in the Caribbean and noted that the Population Division did not publish population estimates by age and sex for some of those countries because their populations were below 100,000 inhabitants. Consequently, although PAHO tried to use population data provided by the Population Division whenever it needed those data, it could not use Population Division data for these smaller countries. Mr. Silvi added that PAHO was also involved in compiling and analysing data on causes of death at the subnational level.

World Bank

The representative of the World Bank, Mr. Eduard Bos, reported that the World Bank compiled and published indicators derived from those prepared by WHO and the Population Division. The World Bank also sponsored and published studies related to mortality. The Bank's most recent publication on the sub-

ject was entitled *Disease and Mortality in Sub-Saharan Africa.*[3] The Bank was participating in the Disease Control Priorities Project and the Health Metrics Network.

UNICEF

The representative of UNICEF, Mr. Neff Walker, reported that the main focus of UNICEF was the estimation and analysis of child mortality. With regard to adult mortality, UNICEF was primarily an end-user of estimates produced by others, although it was a partner with UNFPA, WHO, the World Bank and other institutions in the preparation of maternal mortality estimates. UNICEF was particularly interested in cause-specific mortality at young adult ages.

UNICEF continued to sponsor the Multiple Indicator Cluster Survey (MICS) programme and planned to increase the frequency of these surveys to a three-year cycle. Some indicators, however, would be measured only in every other cycle but it could be possible to add questions to gather information allowing the indirect estimation of adult mortality. UNICEF was also active in advocating the registration of children at birth as part of a human-rights approach to the issue, but it had not focused on the processing or dissemination of the data generated by such registration.

United Nations Statistics Division

The representative of the Statistics Division of the Department of Economic and Social Affairs, Mr. Srdjan Mrkic, said that the Division had the mandate of compiling the data on deaths by age and sex produced by countries, but did not produce mortality estimates derived from those data. The Division gathered the relevant data by sending questionnaires to national statistical offices and the information compiled was published in the United Nations Demographic Yearbook. National statistical capacity determined the ability of national statistical offices to provide the data requested. According to the data compiled by the Statistics Division, only about half the Member States of the United Nations, accounting for between 35 per cent and 38 per cent of the world population, had reliable civil registration systems capable of producing reasonably reliable vital statistics.

The Statistics Division had a programme for improvement of vital statistics that included the preparation of manuals and handbooks. The Statistics Division worked closely with UNICEF to ensure that the promotion of birth registration by UNICEF was expanded to include the registration of vital events other than births and the processing of the information collected. The Statistics Division had conducted workshops in Africa with the aim of building the capacity needed to process and publish the vital statistics data. A number of countries had shown improvement in the coverage of their vital statistics, including Colombia, the Philippines and Thailand. These improvements required cooperation from various government units as well as government commitment. It often took 10 or 15 years for efforts geared to improve vital registration systems to yield results. Unfortunately, during the 1990s the quality of vital statistics had deteriorated in some countries.

Countries lacking adequate civil registration had been using censuses or surveys to collect information allowing the estimation of fertility or mortality. In some contexts, where cultural barriers to the mention of deaths existed, censuses might not produce adequate data on adult mortality. Nevertheless, more countries were using censuses to gather the required information. Mr. Mrkic noted that the Statistics Divi-

[3] D. T. Jamison, R.G. Feachem, M.W. Makgoba, E.R. Bos, F.K. Baingana, K.J. Hofman, K.O. Rogo, eds. (2006). *Disease and Mortality in Sub-Saharan Africa*. Second edition. Washington, D.C.: The World Bank.

sion was developing a database of the types of questions included in population censuses that would permit the identification of potential sources of data on mortality.

In response to questions, Mr. Mrkic stated that, on average, 110 to 115 countries submitted completed questionnaires annually to the Statistics Division. Regarding the assessment of the completeness of vital registration statistics published in the Demographic Yearbook, he said it was obtained directly from reports made by national statistical offices to the Statistics Division. The Division checked the data for consistency but mostly accepted the assessments provided by national statistical offices. The handbooks on vital registration prepared by the Statistics Division focused on systems aimed at reaching universal coverage. They did not cover or suggest the possibility of instituting a sample registration system. He added that there were not many examples of successful sample registration systems and systems based on samples generally could not provide the data needed to assess trends at the sub-national level, especially for small areas. One participant commented that scaling-up vital statistics systems took too long and that the production of mortality estimates could not afford to wait for adequate data to be available in all cases.

United Nations Population Division

Representing the Population Division, Mr. François Pelletier provided an overview of the work carried out by the Population Estimates and Projections Section of the Population Division to assess empirical data and available estimates of child and adult mortality and to incorporate them in the process of estimating and projecting the populations of each country or area of the world. He provided concrete examples of the challenges faced by analysts when confronted with estimates for the same indicator derived from different sources or from the same source by different analysts and differing significantly from one another. Decisions on which values to incorporate in the preparation of population estimates were based on an assessment of the robustness of each estimate and the consistency of the resulting population accounting. Ms. Zlotnik noted that by reconciling estimates of the different components of population change so as to reconstruct the population as enumerated in the past, the estimates selected were subjected to a useful test of consistency.

Institut national d'études démographiques (INED)

Ms. France Meslé, Director of Research on Mortality at INED, presented the work of the INED unit focusing on mortality trends. A major part of the work of the unit was the analysis of trends in the causes of death in France. This work had started over 30 years ago. More recently, the unit had been studying mortality trends in Eastern Europe particularly in the former Soviet Union. It had collaborated in establishing a clean and validated time series of data on deaths by cause starting in the 1960s for the 15 successor States of the former Soviet Union. Studies of the European successor States, including the Baltic States, were completed. Studies of the Caucasian and Central Asian States were under way, although the trends implied by the data for the latter were proving to be more problematic to ascertain and interpret. INED had produced databases with time series of mortality indicators for France and for the former Soviet Union. INED, together with the Max Planck Institute and the University of California at Berkeley, had been one of the collaborators developing the Human Life-Table Database. INED also maintained demographic surveillance sites in Mali and Senegal and was developing a new site in Burkina Faso.

INDEPTH Network

Mr. Ayaga Bawah, Senior Research Associate of the INDEPTH Network, reported that the Network included 39 demographic surveillance sites located in 21 countries, all of which produced demographic indicators for the small areas covered by the sites. Surveillance at each site included the collection of longitudinal data at intervals varying from three months to a year. Data collection started with an initial cen-

sus of the population living in the site. Some of the surveillance sites had been operational for a long time, such as Matlab in Bangladesh, which had been in operation for 40 years. The INDEPTH network was established in 1998.

It was possible to pool data from multiple sites to make estimates of mortality. In 2002, the Network had published a monograph on mortality and was in the process of updating that work. It had also produced a monograph that presented new model life tables derived from the experience in the surveillance sites and a journal article on causes of death in Africa. Mr. Bawah recognized that the estimates based on surveillance data were not nationally representative and said that INDEPTH was starting to work with the national statistical offices of some countries to try and explore ways of obtaining better information at the national level. Countries having several surveillance sites might obtain reasonably good national estimates from their pooled data, although whether the sites in existence were adequately representative of the whole population would remain an issue.

INDEPTH was also collaborating with the Health Metrics Network and with WHO on a new programme to study adult mortality. Based on the voluntary collaboration of sites run by different institutions whose objectives differed, INDEPTH was facing the problem of ensuring that all sites made their data available to the network.

University of California at Berkeley

Ms. Dana Glei, Research Demographer of the University of California at Berkeley, reported that the Human Mortality Database, a joint project of the University of Berkeley and the Max Planck Institute for Demographic Research, contained time series data on mortality for 28 national populations with high-quality data. The project was funded by the U.S. National Institute on Aging until 2009. The guiding principles in developing the database were to ensure the comparability of the data across countries and over time; to maintain flexibility by allowing the data to be retrieved in a variety of formats; to ensure accessibility to both the estimates derived from the data and to the basic data themselves; and to ensure that the results obtained could be reproduced by any independent researcher. In obtaining, assessing and cleaning the basic data, the project relied on national expertise. While the database did not include any developing country, the project had provided some support to another University of California project focusing on Adult Mortality in Developing Countries and was supporting a researcher at Rockefeller University who was focusing on the analysis of data for developing countries.

Harvard University

Mr. Ken Hill, Professor at the Harvard Center for Population and Development Studies, reported that the Center was testing data collection instruments, including a number of new questions on mortality and cause of death, in four field sites. One objective was to develop a standard method to conduct verbal autopsies. The Center was engaged in carrying out several studies of programme evaluation of health operations in a number of countries and a new project had been initiated in Mexico. There was also interest to continue work in testing the performance of indirect methods for the estimation of adult mortality. A proposal to continue the project on Adult Mortality in Developing Countries was under review. Lastly, the Center would collaborate in revising the Global Burden of Disease estimates which, aside from estimates for the major world regions would also include country-specific estimates for about 15 countries.

D. CURRENT ESTIMATES OF ADULT AND OVERALL MORTALITY

Ms. Mie Inoue, Statistician at WHO, presented WHO current practice regarding data and methods to construct life tables. Empirical data were compiled from vital registration, sample registration systems, demographic and health surveys, and population censuses. WHO requested that its Member States annually submit data on deaths classified by age, sex and cause. The completeness of death registration was assessed by using demographic techniques such as the general growth balance equation method, the Preston-Coale method or the Bennett-Horiuchi method.

Countries were classified into five categories according to the source and type of data available for estimating mortality. The first category consisted of countries with complete vital registration data and with sufficiently lengthy time series to establish trends in age-specific mortality rates (50 countries). The second included countries with incomplete vital registration data requiring adjustment, but having also data for sufficient years to allow the assessment of trends (48 countries). The third category encompassed two groups of countries: those with some usable vital registration data but with too short a time series for trend evaluation, and those with survey or census data permitting the estimation of both child and adult mortality (33 countries). The fourth category covered countries with survey or census data allowing only the estimation of child mortality (59 countries), while the fifth category included two countries with no available data on mortality.

Extrapolation of trends was necessary to obtain current mortality estimates for most countries, since the most recent data available for the majority of countries referred to a few years back. Child mortality was projected through a collaborative effort among United Nations entities. For the 50 countries with complete vital registration data for sufficient years, WHO was the source of estimates of current child mortality. For other countries, UNICEF was the source of estimates based on all available information on child mortality, whether from surveys or censuses, derived directly or using indirect methods. All child mortality estimates were reviewed by the Inter-Agency Group for Mortality Estimation.

Adult mortality indicators were projected using the annual rate of change from an empirical source, if available; otherwise, a trend was derived from the annual rate of change in age-specific mortality based on the Population Division's *World Population Prospects*.[4]

For all countries, the modified logit system was used to produce life tables. The inputs to the modified logit system could be a time series of probabilities of dying in childhood and during adulthood; projected child and adult probabilities of dying; or just projected probabilities of dying in childhood. For countries where the proportion of deaths due to AIDS was higher than 5 per cent, AIDS deaths were subtracted from the inputs so that the probabilities of dying in childhood or in adulthood did not reflect the impact of AIDS. Then, deaths caused by AIDS were added to those resulting from the fitted life table. AIDS deaths by age and sex were obtained from UNAIDS. Thus, the modified logit model was used by WHO to construct non-AIDS mortality only.

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[4] See, for instance, United Nations, Department of Economic and Social Affairs, Population Division, *World Population Prospects: The 2004 Revision, Datasets in Excel and PDF Formats,* United Nations publication, Sales No. E.05.XIII.11, 2005.

Ms. Inoue suggested that, in order to harmonize WHO estimates of life expectancy at birth with those prepared by the United Nations Population Division, one would need to focus first on using similar estimates of the completeness of death registration and the same version of UNAIDS estimates. She welcomed the idea of convening meetings such as this one to discuss adult mortality estimation and facilitate data sharing and the assessment of completeness of vital registration.

Ms. Cheryl Sawyer, Population Affairs Officer at the Population Division, presented the data and methods used by the United Nations Population Division to estimate mortality in preparing the revisions of *World Population Prospects*, the Division's biennial assessment of past population trends and future prospects. The Population Division's projection software, Abacus, had been in use since the 1970s but had been modified in significant ways, particularly with respect to the procedures used to project mortality. Abacus projected populations classified by five-year age groups with an open-ended interval of 100+ over five-year periods. Calculations started at a base year, that could range from 1950 to 1995 in the *2004 Revision*. Empirical information on the components of population change was used to project the population forward from the base year until 2005 and, from there on, models were used to project the population in the future.

Regarding mortality, the empirical information examined by the Population Division in developing its estimates included some combination of the following: (*a*) life expectancy at birth; (*b*) under-five and infant mortality rates (derived in collaboration with the Inter-Agency Group for Mortality Estimation); (*c*) age-specific mortality rates derived from vital registration data adjusted as necessary; (*d*) life tables calculated by other institutions or researchers; (*e*) indirect estimates of various kinds, and (*f*) estimates of HIV prevalence obtained from UNAIDS. The mortality inputs for the projection program could be provided in the form of a set of survival ratios by sex (s_x) for each period, that is, the proportion of individuals in a five-year age group ($_5L_x$) who would be alive five years later ($_5L_{x+5}$) according to the age-specific mortality rates of that period; or the level of life expectancy by sex and the selection of a family of model life tables from which the necessary survivorship ratios would be derived. There was also the option of providing the survival ratios by sex for the base or initial period, and levels of life expectancy by sex for subsequent periods (the so called "modified method"). This option was used for most countries with adequate empirical data on mortality by age and sex because it permitted the automatic generation of appropriate survivorship ratios consistent with the expectation of life provided as input for each period and with the age pattern of mortality in the initial survivorship ratios modified, over time, according to the rates of change of the survivorship ratios in an underlying family of model life tables.

For countries lacking information on age-specific mortality, input took the form of estimates of life expectancy by sex and a model life-table family selected to provide the age pattern of mortality. When only the level of child mortality was known, the estimated life expectancy was derived using a family of model life tables.

Ms. Sawyer noted that the mortality estimates used in estimating population trends for past periods were an integral part of a comprehensive and consistent set of population estimates and the need to ensure consistency with enumerated populations was sometimes the cause of discrepancies between the estimates produced by the Population Division and those obtained while focusing only on mortality data. If a new system to generate life tables and survivorship ratios from existing evidence were to be developed, it would have to be added to the options available to project mortality in Abacus and would likely take some time to become operational.

Mr. Kirill Andreev, Population Affairs Officer at the Population Division, presented comparisons of current mortality estimates made by WHO and the Population Division. For half the countries, the estimated life expectancy at birth in the two sources differed by a year or less, but for a quarter it differed by at least two years. Regarding adult mortality or, more specifically, the probability of dying between exact

ages 15 and 60, ${}_{45}q_{15}$, the difference amounted to 50 deaths per 1000 or more in 40 countries for males and in 27 countries for females. The main reasons identified for such differences were: (*a*) different adjustments made to data on deaths by age in countries with incomplete registration of deaths; (*b*) the use of the South family of the Coale-Demeny model life tables in deriving the estimates of adult mortality used by the Population Division, since those models had lower adult mortality for a given level of child mortality than other models, and (*c*) differences stemming from the different "production cycles" of WHO and the Population Division, since each set incorporated estimates related to HIV/AIDS prepared by UNAIDS at different times.

During the discussion, Ms. Inoue clarified that for countries with incomplete data on registered deaths, age-specific mortality rates were used if trends in those rates could be estimated reliably. If data were insufficient to estimate trends, the probability of survival in adulthood, ${}_{45}q_{15,}$ was used and projected according to the rate of mortality change estimated by the Population Division.

Also during the discussion, Ms. Sawyer indicated that in reconstructing a population using projection methods, use was made of any empirical information available on the age patterns of mortality. However, unless survivorships ratios were calculated independently of Abacus for all five-year periods over which the population was being reconstructed, the use of models either to extrapolate a set of initial empirically-based survival ratios or the outright use of model life tables to calculate the necessary survival ratios limited the capacity of matching the age patterns of mortality derived from empirical data over the period concerned. Furthermore, because the period over which the population was reconstructed could start anywhere between 1950 and 1995 (depending on where the base year was set), there was no guarantee that the age-specific parameters available for the five-year periods prior to the base year were internally consistent. For all periods, however, the population increment equalled the number of births minus the number of deaths plus the net number of migrants. Regarding the discrepancies noted between the age-specific mortality estimates for the Russian Federation and actual data, they were primarily due to the use of a mortality model in reconstructing the population of that country. An effort to avoid such discrepancies in future revisions of the United Nations population projections would be made since, as participants noted, the results in such cases were misleading.

E. MORTALITY MODELS TO GENERATE LIFE TABLES

Ms. Inoue presented the WHO modified logit system for estimating life tables. WHO had developed this system in response to evidence that existing model life table systems did not adequately capture observed mortality patterns. A significant increase in the availability of data on mortality for countries with complete registration provided the basis for developing an improved model system. To add flexibility to the model, it was based on a modified Brass logit equation whose parameters were estimated on the basis of 1,802 life tables derived from data for 64 countries. The mean of those tables was used as the standard age pattern of mortality for the model.

The advantages of the WHO model were the flexibility it allowed by being a parametric model (two-parameters were used) and the fact that it was based on a wider range of empirical data than previous models. However, as other models, it did not reflect the impact of HIV/AIDS. Ms. Inoue remarked that, in terms of approach, the WHO model was similar to the relational model proposed by the Population Division and both had a similar level of flexibility, being based on the same number of parameters.

Mr. Wilmoth presented the mortality modelling strategy proposed by the Population Division (called henceforth, the United Nations model). As background for the strategy proposed, he noted that countries could be classified, in a manner similar to that used by WHO, according to the type and quality of data available for the derivation of mortality estimates. Five categories of countries were proposed and in all

but one, the information available was deficient or incomplete. However, most countries had sufficient information for the estimation of at least mortality in childhood and a high proportion also had information allowing the estimation of some indicator of adult mortality. Hence, the aim was to provide a means of generating life tables from information on either child mortality alone or child mortality and adult mortality (measured as the probability of dying between exact ages 15 and 60, ${}_{45}q_{15}$).

To do so, a model was fitted to the historical set of life tables contained in the Human Mortality Database. The model had as independent variable, for each age, the logarithm of the central death rate, $\log({}_5m_x)$, and two parameters: child mortality, as measured by ${}_5q_0$, and a factor *k* that can be used to adjust the fit so that it matches a particular level of adult mortality, usually measured in terms of ${}_{45}q_{15}$. A one-parameter version of the model was also fitted where, for each age group, the logarithm of the central death rate, $\log({}_5m_x)$, was modelled as a linear function of $\log({}_5q_0)$. Mr. Wilmoth suggested that this approach was more straightforward than that used in deriving the WHO model because, by focusing on the central mortality rates rather than on the logits of survival probabilities, it was easier to assess the effects of variations in each parameter. Furthermore, if the level of adult mortality produced by using the single-parameter model differed from a reliable empirical estimate, the second parameter *k*, which essentially moved the mortality curve below age 75 up or down, could be used to adjust the fit in order to reach the desired level.

Mr. Vladimir Canudas-Romo, Researcher at the Department of Demography of the University of Berkeley, presented the results of his assessment of the performance of the two models using different collections of life tables. The first comparison tested the performance of the two models when their parameters were fitted to the same set of life tables (those contained in the Human Mortality Database). According to this comparison, the United Nations model performed better than the WHO model fitted to the Human Mortality Database. A second comparison checked how well the models fit two different sets of empirical life tables, the Human Life-Table Database and the INDEPTH database. Because these databases contained only life tables presented separately by sex, the original WHO model could be used since it was sex-specific. According to this second comparison, the original WHO model estimated life expectancy or ${}_{45}q_{15}$ more accurately than the United Nations model and the latter produced better approximations than the WHO model fitted to the Human Mortality Database. On the basis of this analysis, Mr. Canudas-Romo concluded that: (*a*) it would be desirable to derive the United Nations model by sex; and (*b*) the goodness of fit of the different models should be assessed not only on the basis of aggregate measures but also in terms of their capacity to reproduce observed age-specific mortality patterns.

During the discussion, concern was expressed that the United Nations model might be mixing the effects of changes in a country over time with geographic diversity at one time. Questions were asked about whether the United Nations model might be fit by sex, by regional groupings of countries, or to sub-national data. One participant inquired whether the size of the population had been considered in fitting the model. Mr. Wilmoth noted that the data used to fit the model were not weighted by population size. He added that, in developing the WHO modified logit model, different choices regarding which tables to include or exclude did not make much difference in the resulting parameters. To the suggestion that mortality patterns had changed markedly after 1950 owing to the widespread use of antibiotics, Mr. Wilmoth replied that, for developed countries, which were the main sources of the life tables used to fit the models, sanitation and social factors were more influential in shaping age patterns of mortality than medical factors.

Some participants suggested that the approach taken in building the United Nations model was similar to that underlying the construction of the Coale-Demeny model life tables or the Lee-Carter approach. In this regard, the WHO relational model, just as the original Brass relational model, modelled a relation between two mortality schedules, while the proposed United Nations model, modelled a relation between indicators in a single mortality schedule.

There was interest in knowing to what extent the parameter *k* could be used to reflect the special situation in a country, even if a reliable estimate of adult mortality were not available. For instance, could *k* be used to reflect the impact of HIV/AIDS? There was also interest in exploring ways of incorporating some measure of uncertainty when using the model to generate mortality schedules.

Regarding the assessment made by Mr. Canudas-Romo, it was observed that it was not very revealing to analyse the fit to e_0 and ${}_{45}q_{15}$ separately, since e_0 depended on the value of ${}_{45}q_{15}$.

F. ESTIMATING ADULT MORTALITY USING INCOMPLETE VITAL REGISTRATION DATA

Mr. Ken Hill presented an evaluation of Death Distribution Methods (DDM) for the estimation of the completeness of death registration. The General Growth Balance (GGB) method used the deaths registered between two censuses and the enumerated population at those censuses to estimate the completeness of death registration relative to the completeness of census enumeration. It compared the death rate at age x or over with estimates of the same death rate calculated as the difference between the entry rate to the age group (birth rate at age *x*) and the growth rate of that age group, for every age *x* multiple of five. If the assumptions of the method were met, a plot of one set of estimates against the other would be approximately linear and the estimated slope would be the inverse of the adjustment factor for number of registered deaths.

In the second method examined, called the Synthetic Extinct Generations (SEG) method, age-specific growth rates for the population aged *x* or over were used to convert registered deaths above age *x* to an estimate of the population aged *x*. The average ratio of the estimated to the observed population over age *x* over the range of variation of *x* provided an estimate of the adjustment factor for deaths.

Both the GGB and the SEG methods assessed completeness of death registration relative to that of population enumeration. Both methods assumed that the population was closed to international migration and that the completeness of death registration was constant by age and so was the completeness of enumeration for the population of different ages. The SEG method further assumed that the completeness of enumeration was the same for the censuses used to estimate population growth rates.

Mr. Hill noted that the analysis presented was an evaluation rather than a validation of these methods. Validation would require knowing the true mortality schedules to which a population was subject and, for most developing countries, lack of reliable information made it impossible to obtain such schedules. The evaluation was carried out applying the two methods to 29 countries or areas with data referring to parts of the 1960-2000 period and obtained from the Human Mortality Database. The data used were considered to be of the highest possible quality. The methods were applied to the age range 5+ to 65+. The results of the evaluation were not reassuring. In the absence of major reporting errors, coefficients of variation in the estimates obtained were still 5 per cent or higher. Furthermore, estimates of completeness of death registration that were off by more than 10 per cent were not uncommon. The existence of non-zero net migration was one the factors biasing the estimates obtained. Mr. Hill reported that further experimentation would be undertaken, probably applying the methods to a more restricted age range, such as 40+ to 80+, to see of the biases related to non-zero net migration could be reduced.

Ms. Danzhen You, from the Department of Demography of the University of California at Berkeley, reported the results of a sensitivity analysis of the performance of death distribution methods. She reiterated the key assumptions behind the methods: (*a*) the completeness of death reporting and of the enumeration of the population was assumed to be constant with age; (*b*) the population was assumed to be closed and therefore not affected by migration, and (*c*) for the SEG method, the completeness of enumeration was assumed to be the same for the two censuses considered. To conduct sensitivity analysis, simu-

lated data affected by different types of errors were used in the application of the two methods. Four different types of errors were simulated: (*a*) a completeness of enumeration that varied with age; (*b*) a completeness of death registration that varied with age; (*c*) age misreporting, and (*d*) non-zero net migration.

According to the tests performed, age misreporting did not have a serious effect on the estimates yielded by either of the two methods. Non-zero net migration, in contrast, had a noticeable effect on the results produced by both methods and the effect was more marked the larger the magnitude of net migration, with the results of the SEG method being more affected than those of the GGB method. Regarding a completeness of enumeration that varied with age, it had a larger effect on the estimates produced by the GGB method than on those yielded by the SEG method, with the size of the effect related to the variance of completeness of enumeration by age. A completeness of death registration that varied with age had effects that varied from modest to substantial. In addition, the results of the SEG method were sensitive to changes in the completeness of enumeration from one census to the next. In view of these results, it was suggested that using both methods in combination could yield better estimates than using either of them separately. The best strategy was to use the GGB method to derive an adjustment for changes in the completeness of enumeration from one census to the next, adjust the second census on that basis and then use the adjusted results in the application of the SEG method to obtain an estimate of the completeness of death registration.

Ms. Lioudmila Andreeva, Research Specialist at Rockefeller University, reported on work she was carrying out to update the data for developed countries contained in the Human Mortality Database and to check the consistency of data on population and deaths by age for developing countries as contained in various secondary sources, including the United Nations Demographic Yearbook database, the WHO mortality database, and the data compiled for the Adult Mortality in Developing Countries project of the University of California at Berkeley. In checking the information available in these sources, she had found many inconsistencies among data that were supposed to originate from the same source but whose versions in the different secondary sources considered did not always coincide. Consistency among the different secondary sources improved the more recent the data considered. Because the secondary sources used did not have adequate information on the original sources from which the data had been obtained, it was not always possible to establish the reason for the inconsistencies detected. Ms. Andreeva noted that, in planning a database containing the basic data for mortality estimation, attention had to be given to the type of meta-information that it would be useful to include regarding the original data sources used and the types of adjustments that the data compiled in the database had been subject to. She was sharing the results of her work with the Population Division.

Mr. Wilmoth discussed a strategy to develop a protocol for compiling, organizing and analysing the data required for the application of death distribution methods. The protocol would include a description of the various formats in which the original data appeared; means of transforming the original data into standardized formats; details of how the estimation methods would be applied; and the types of checks, including diagnostic plots, to which the results of the estimation methods would be subject. Examples of what he considered format issues included: how to treat vital registration series with missing data for a year or a number of years; how to treat residual categories, such as those labelled “unknown” or “not stated”; how to handle non-standard age groups; or how to deal with differences in the open-ended age group. Developing a comprehensive protocol on how to deal with any of these contingencies would ensure consistent preparation of the data for use with the death distribution methods and would facilitate their consistent application across populations and over time, thus permitting a fair comparison of the results obtained. It would also facilitate developing appropriate software to automate the updating of mortality indicators. Mr. Wilmoth considered that the preparation of such a protocol was a necessary and useful basis for inter-agency collaboration in sharing information and data for the estimation of adult mortality.

The discussion considered first whether the death distribution methods could be adapted to include explicit allowance for international migration. If reliable independent estimates of net migration by age were available, adjustment was possible. Unfortunately, very often the best estimates of net migration were themselves obtained as the residual of population change plus deaths minus births. Therefore, both adjusted census counts and adjusted numbers of deaths were necessary to obtain a reliable estimate of net migration. Nevertheless, it was worth noting that non-zero net migration had opposite effects on the results of GGB and those of the SEG method, thus providing a means of its detection.

Participants focused on possible alternatives to the death distribution methods when these methods did not work. One possible but costly alternative was to match civil registration records on deaths with data from other administrative sources that also reflected mortality. Another option was to use a restricted age range in the application of the GGB and SEG methods, as suggested by Mr. Hill. This option, however, remained to be tested.

It was noted that the data yielded by the INDEPTH network could not be used for the application of the death distribution methods because the longitudinal collection of data in each site did not normally include a second enumeration of the population. In addition, since the Human Mortality Database contained both the original data and, in many cases, also adjusted data, it was important to make clear whether in testing the methods the original data had been used or not.

Data quality and the availability of meta-information were discussed in relation to the presentations made by Ms. Andreeva and Mr. Wilmoth. Participants noted that censuses often produced different population counts including preliminary, final and adjusted ones, often based on surveys of census coverage. The inconsistencies detected by Ms. Andreeva among the data included in the different secondary sources she used could stem from the fact that one source included one type of count and another included another type. Furthermore, even if the data associated with a particular census or from the registration of deaths for a particular period were always the same in the secondary sources examined, there was no guarantee that their quality in terms of completeness of coverage or age reporting was good. It was reassuring, nevertheless, that consistency in the contents of the different secondary sources increased for data with more recent reference dates, indicating an improvement in the way national statistical offices released information.

The need to include appropriate meta-information on the source of the data contained in databases was acknowledged and underscored. National statistical offices often retrospectively issued revised time series of population or mortality data and if those data were included in a database, they should be adequately labelled or qualified. For example, in France, the statistical office revised the time series of population estimates annually on the basis of a yearly population survey. Hence, in planning a comprehensive database, either allowance would have to be made to include several versions of the same type of data or the data would have to be revised regularly. In either case, it was necessary to make sure that the unadjusted, primary or raw data could be distinguished from adjusted or revised data. It was suggested that databases should record sufficient meta-information to indicate the data-collection source that produced each data set; the publication, website or type of special tabulation from which the data were copied; and any information available on whether the data had been adjusted or not.

G. DATABASE DEVELOPMENT

Mr. Kirill Andreev and Ms. Cheryl Sawyer, Population Affairs Officers at the Population Division, presented plans for developing a data system to underpin mortality estimation at the Population Division.

Mr. Andreev said that all incoming data would be archived in their original format and listed in a reference database. The data would be evaluated and reformatted, as necessary, to be stored in a database, tentatively being called "Database of Demographic Quantities" which would be a repository for all demographic data useful for mortality estimation. The database would also be used for the dissemination of mortality estimates and it would be developed in a relational model compatible with existing databases in the Population Division.

Mr. Andreev presented an overview of the relational database model proposed. Demographic quantities, including deaths by age and sex, population by age and sex, data on children ever born and surviving, and official life tables, would be input and each of the data items would be qualified in terms of a reference date (calendar time), age, sex, Lexis shape and other relevant variables. To implement the different methods of mortality estimation, appropriate software would be developed as a library in Matlab. To ensure quality control, checking programs would be developed.

Ms. Sawyer described the inventory of all available primary data for mortality estimation that was being carried out in preparation for the development of the database. A database on data availability had been set up and had been tested. It allowed the production of reports on the availability of data by country or data type. This database would eventually be part of the Database on Demographic Quantities and would guide the development of the latter. To populate the inventory database, the census questionnaires from the 1990 and 2000 rounds of population censuses had been reviewed for all content relevant to the estimation of mortality. The Population Division's data files on child mortality estimation had been consolidated and updated to produce a comprehensive list of population surveys and censuses that contained information allowing the estimation of child mortality. Work on compiling the sources and the type of data relevant for the estimation of adult mortality was starting. The collaboration of partners in identifying all possible data sources would be appreciated. Mr. Andreev presented an Excel worksheet that collaborators could use to submit the required information.

Mr. Wilmoth proposed a path for collaboration in developing the mortality database. The main steps in carrying out this task included: (*a*) designing the database; (*b*) constructing the database; (*c*) populating the database, and (*d*) maintaining the database. Along the way, it was important to ensure access to all collaborators, to maintain quality control, and to develop the necessary analytical features or capabilities. It was part of the work programme of the Population Division to improve mortality estimation and the database was a key instrument to do so. Hence, the Population Division was in the process of developing the database but, because other institutions already had considerable experience with similar databases, it was seeking their collaboration. Such collaboration would reduce duplication of work and potentiate available resources. To facilitate collaboration, the plan was to develop a web-based interface to allow interested partners to contribute by populating the database and to have access to its contents. During the development phase, access would be restricted to collaborating institutions but it was expected that, eventually, most of the contents of the database would be publicly available. Regarding the development of analytical tools for use in connection with the database, the first set would likely include tools to assess data quality and make data comparisons. During a second stage, tools allowing the application of estimation methods or the evaluation of their results would be developed. He then outlined some of the future steps: (*a*) complete the database design and develop the database; (*b*) define a collaborative strategy to populate the database; (*c*) develop the necessary queries and analytical features for the web-based use of the database, and (*d*) open the database for use by the collaborating institutions.

During the discussion, participants offered suggestions about the type of data that should be gathered. With respect to data relevant for the estimation of child mortality, for instance, it was suggested that, in addition to the number of children ever born and surviving by age of mother, the full tabulations of women classified by number of children ever born and women by number of children surviving (or dead) should also be included because they allowed additional checks of data quality. It was noted that to

gather more detailed data than those generally published, it would be necessary to obtain special tabulations from certain sources. One example involved data by sex on children ever born and surviving, which were not normally published in the reports of the Demographic and Health Surveys but could be obtained from the survey data themselves.

Participants suggested that, to the extent possible, it would be useful to automate the input of data into the database, especially when the primary data were already available in electronic form. Once more, the need to record the necessary meta-information on all data was underscored. Allowance could be made, for instance, to record the notes accompanying published tables. Regarding the treatment of missing data, it was suggested that allowance be made for the recording of any information available on whether and what type of imputation had been made. It might also be useful to code the results of the qualitative analysis of each data set to make them transparent to users. In preparing the United Nations Demographic Yearbook, for instance, substantial effort was required to ensure that data were properly annotated (via footnotes).

Participants noted that data on population and births would also have to be included to serve as denominators in calculating mortality rates. To make full use of time series of recorded deaths, projected populations would be needed as denominators. The database should make allowance for their inclusion. Meta-information on how such data or other population estimates were obtained would need to be recorded and made available to users. Recalling the activities of UNICEF to make child mortality estimates available, it was suggested that when the Population Division's database went public it should make explicit how United Nations entities collaborated in sharing data.

Participants expressed support for the proposal to collaborate in both developing and populating the database. A pilot database could be developed at the Population Division and shared with collaborators to test the design. It was decided that a working group including the Population and the Statistics Divisions of the United Nations, WHO and the University of California at Berkeley would collaborate in getting the first phases of this project started.

Participants agreed that a web interface would be the best way to share access to the database. Several institutions offered to collaborate in adding data to the database. The World Bank could contribute data derived from its household surveys. WHO would share the data it gathered on mortality statistics.

H. FOCUS ON SELECTED REGIONS AND COUNTRIES

a. Sub-Saharan Africa

Mr. Ayaga Bawah talked about the mortality patterns derived from the INDEPTH data obtained from the longitudinal surveillance of sites in sub-Saharan Africa. The data collection procedures used in each site included an initial population census and periodic rounds, carried out every three or four months, to record the births, deaths, migration movements and other demographic events occurring in each site since the previous round. The recording protocol included noting which women were pregnant to ensure that the outcome of each pregnancy was recorded in subsequent rounds.

The data collected provided a useful set to study mortality levels and patterns in Africa, where alternative data sources on adult mortality were scarce. Because of such scarcity, existing model life table systems had not been based on data from Africa and it was possible that the patterns they reflected did not adequately match those actually present in the continent. For that reason, a set of model life tables had been derived from the data gathered in the African sites of the INDEPTH Network, which produced 17 life tables by sex based on the data for sites in 11 African countries. These life tables were grouped into

two major categories with similar patterns of mortality by age and sex. Group 1 reflected mortality in populations with low levels of HIV/AIDS whereas Group 2 included populations with high levels of HIV/AIDS. The average mortality schedules for these two groups were used as standards in a Brass logit relational model to generate model life tables. For each group, derivation of a model implicitly assumed that the populations used to generate the standard were homogeneous.

Mr. Bawah used the examples of Ethiopia and Guinea to show how the models could be used to estimate life tables for national populations. The models provided a means of smoothing estimates derived from observed data and could be used to project mortality by establishing a trend from time-series data obtained from the Demographic and Health Surveys. Given the diversity of levels of HIV prevalence in African countries and differences with regard to the stage the epidemic had reached in each of those countries, more work was needed to make sure that the models could reflect appropriately the effects of HIV/AIDS on mortality patterns in Africa.

The discussion focused first on the effect of HIV/AIDS. It was noted that the mortality patterns generated using the standard of Group 1 produced mortality models similar to those already in existence, whereas those generated by the standard derived from Group 2 incorporated the average effect of high HIV prevalence.

Participants noted that there were very few countries with high HIV prevalence and with reasonably adequate vital registration data to allow an assessment of the impact of AIDS mortality. They included South Africa and Zimbabwe in Africa and Thailand in Asia. However, in all of these countries, under-registration of deaths was still a serious problem and the quality of data on cause of death was deficient. In Kenya, the African Population Health Centre was working with the Government to produce statistics based on registered deaths. In addition, several of the INDEPTH sites were starting to conduct HIV testing on a regular basis. Currently, the main and most reliable sources of information on deaths caused by AIDS were longitudinal studies that had followed relatively small cohorts of persons for 10 to 15 years.

b. Former USSR and Eastern Europe

Ms. France Meslé presented an overview of adult mortality in the former USSR and Eastern Europe. She noted that researchers at INED had been using vital registration data from the successor States of the former Soviet Union to reconstruct mortality levels and trends in those countries. To do so, especially during the 1990s, population estimates had to be derived taking into account the large migration movements occurring after the break-up of the Soviet Union. The last census of the Soviet Union as a whole dated from 1989. Although most successor States had conducted a census around 2000, the completeness of enumeration was still being debated in some countries. In addition, intercensal population estimates had not been updated in some of the successor States.

There was also evidence of significant under-registration of deaths in some of the successor States. Data quality for the successor States in Europe was generally good except perhaps for minor under-registration of child deaths related to the definition of live births. The completeness of registration had been falling in the other successor States, particularly in those located in the Caucasus. In Georgia, for instance, there were major discrepancies between the statistics published by the Central Statistical Agency and those produced by the Ministry of Health. The situation in the successor States located in Central Asia was particularly problematic. Civil registration was known to be incomplete, partly as a result of the registration fees levied by some countries. Yet, the results of demographic surveys showing high infant and child mortality had been questioned by the national statistical offices of some countries and it was difficult to estimate the level of under-registration at other ages. However, Ms. Meslé and colleagues had produced a time series of adjusted mortality estimates for Armenia and Georgia and were working to produce similar time series for other successor States.

Ms. Meslé focused next on causes of death. Life expectancy in Eastern Europe and the former USSR had largely stagnated since the mid-1960s owing to increasing adult mortality caused mainly by cardiovascular disease and violent deaths. During the 1990s, most Central European countries and the Baltic States had begun to see a reduction of mortality due to cardiovascular disease, but the situation in the Russian Federation and Ukraine was still worsening. It was therefore not easy to foresee what future trends in mortality would be like: a continuation of stagnation or the start of a sustained decline in mortality?

In discussing these findings, participants noted that the causes of the recent improvement in life expectancy in some countries of Central and Eastern Europe were complex. Both improving trends in healthy behaviour and better medical care were contributing to such a trend. Changes in mortality trends in the former German Democratic Republic provided an interesting example of a turnaround driven mostly by improved medical care and access to modern treatments.

Participants agreed that there was considerable uncertainty in projecting mortality for the countries of Central and Eastern Europe because it was not clear whether mortality trends would change in those countries where mortality had largely stagnated or whether the countries whose mortality levels had been declining could sustain that decline over the coming decades. In many of the countries concerned, levels of adult mortality were unusually high relative to levels of child mortality, yielding an atypical age pattern of mortality. Trends in mortality due to cardiovascular disease or in mortality due to violence were expected to determine future changes in overall mortality in many Central and Eastern European countries.

c. Other case studies

Ms. Sawyer presented the cases of three countries—China, Mexico and Zimbabwe—to illustrate the challenges of producing a best estimate of adult mortality on the basis of multiple but imperfect data sets. She noted that estimates derived from different types of data were not always in agreement and that estimates based on the same data but derived using different methods could differ from one another.

Ms. Sawyer noted that, regarding child mortality, a spline was fitted to all available direct and indirect estimates of child mortality to produce the estimates adopted by the Inter-Agency Group for Mortality Estimation. In fitting the spline, analysts assessed the quality and reliability of the various estimates available and reflected that assessment in terms of weights applied to each estimate during the fitting procedure. With regard to the estimation of adult mortality, where the number of estimates over time was less dense, Ms. Sawyer remarked that fitting procedures to derive trends over time were not being systematically used as yet. To compare the consistency of child mortality estimates with those relative to adult mortality, Ms. Sawyer derived a value of ${}_{45}q_{15}$ from the United Nations one-parameter model life tables using as input the estimated ${}_{5}q_{0}$ as reported by UNICEF and transformed into child mortality by sex by assuming a differential between the sexes.

China had an expanding system of disease surveillance points and a sample vital registration, but both were believed to suffer from serious under-registration. Therefore, estimates of ${}_{45}q_{15}$ for the country were based on adjusted numbers of deaths recorded in censuses and surveys. Estimates of ${}_{45}q_{15}$, obtained from various sources based on different methods, were fairly consistent.

In Mexico, the completeness of registered deaths was relatively high, as confirmed by multiple analyses. Therefore, data from Mexico could be used to derive a country-specific age pattern of mortality directly from vital registration data.

Zimbabwe had a number of data sources yielding the number of deaths by age and sex, including the vital registration system, censuses and one survey. In addition, the Demographic and Health Surveys pro-

gramme (DHS) had collected information on sibling survival and censuses and surveys had recorded data on parental survival. The estimates derived from those sources indicated without doubt that adult mortality had been increasing since the late 1980s. However, estimates of ${}_{45}q_{15}$ derived from different sources for the same period differed by wide margins.

During the discussion, participants remarked that the procedure used to transform child mortality estimates into an indicator of adult mortality was useful in exploring the quality and consistency of the estimates at hand. In that respect, lack of a consistent and validated time series of child mortality estimates by sex for each country was a drawback. Noting that sex differentials in childhood mortality varied across countries and over time, participants underscored the need to derive consistent time series of child mortality estimates by sex.

I. APPROACHES TO MODELLING AIDS MORTALITY

Mr. Thomas Buettner, Chief of the Population Studies Branch of the Population Division, described the simulation model implemented in AbacusDIM and used by the Population Division for the estimation and projection of the demographic impact of HIV/AIDS. In AbacusDIM, the simulation was driven by the changing incidence of HIV over time. The dynamic model used to represent the spread of the epidemic was that developed by the UNAIDS Reference Group on Estimates, Modelling and Projections[5] and was consistent with the implementation made in the software known as Estimation and Projection Package (EPP) used by UNAIDS. The model included three parameters that determined the course of the epidemic, namely, the starting time of the epidemic, a parameter reflecting the rate of recruitment of new individuals into the high-risk or susceptible group and another representing the force of infection. AbacusDIM was used to fit the estimated trends in HIV prevalence supplied by UNAIDS. Past trends in HIV prevalence were generally fitted by assuming that the parameters of the model remained constant since the start of the epidemic. However, projections were made by changing the value of the fitted parameters in a systematic way in all countries. The changes projected were consistent with assuming that, over time, behavioural change would reduce the rate of recruitment into the population susceptible to infection and that better prevention methods would reduce the force of infection.

The UNAIDS epidemiological model yielded the overall number of new infections among adults occurring each year. These were distributed by age and sex using distributions based on empirical data. As more data became available, the distributions used were modified. The set of model distributions were being updated in preparing the *2006 Revision* of *World Population Prospects*. To estimate the number of deaths caused by AIDS, AbacusDIM projected the infected population using a multi-state approach that reflected the competing mortality risks between "background mortality" (that is, mortality without HIV/AIDS) and mortality caused by AIDS. The probability schedules used to reflect the chances of developing full-blown AIDS according to time elapsed since infection were assumed to follow a Weibull distribution. In the *2006 Revision,* the effect of anti-retroviral therapy was incorporated by assuming that a proportion of infected individuals would receive treatment one year before their expected progression to full-blown AIDS.

Mr. Buettner observed that in a population highly affected by the HIV/AIDS epidemic, HIV-negative persons might be subject to higher risks of death than they would have been subject to in the absence of the HIV/AIDS epidemic because of the effects the epidemic had in overtaxing health services or in increasing the prevalence of other infectious diseases, such as tuberculosis. Hence, the "background mortal-

[5] Improved methods and assumptions for estimation of the HIV/AIDS epidemic and its impact: Recommendations of the UNAIDS Reference Group on Estimates, Modelling and Projections. AIDS, vol. 16, pp. W1-W14 (UNAIDS Reference Group on Estimates, Modelling and Projections, 2002).

ity" used in AbacusDIM should not be interpreted as the level mortality would have had in the absence of the epidemic. In an actual application, the estimation of background mortality often involved an iterative process whereby the mortality resulting from the model was compared with overall mortality estimates and, if inconsistencies were evident, a revised background mortality was used to generate a closer fit.

Mr. Wilmoth discussed whether AIDS mortality could be modelled using a relational model. Model life table systems were based on the observation that age patterns of mortality were similar across populations. Therefore, on the basis of such models, child mortality alone could predict age-specific mortality at other ages reasonably well. However, with the advent of AIDS and the changes it induced in mortality at relatively young adult ages, the relationship between child and adult mortality was altered in such a way that the former became a poor predictor of the latter. Mr. Wilmoth remarked that other causes of high excess mortality in adulthood, including war, conflict or social and political crises, produced age patterns of mortality similar to those observed in AIDS-affected countries. He wondered if the effects of such "shocks", which caused excess adult mortality, could be captured by a model such as that proposed by the United Nations by varying parameter *k*, which controlled the level of mortality over the adult age range.

During the discussion, the difficulties involved in modelling the impact of AIDS on mortality were elaborated further. Participants agreed that it was easier to separate or remove the effect of AIDS from empirical mortality estimates for the purposes of evaluation or adjustment of those estimates and then add AIDS mortality back, than to try and figure out a way of considering AIDS and non-AIDS mortality together. It was noted that, in the case of South Africa, researchers had produced a time series of non-AIDS mortality.

It was observed that current HIV prevalence was an important element in modelling future mortality, though the time of death of those infected could not be established with certainty. It was suggested that, in order to incorporate the impact of AIDS in models of mortality, age and time might have to be incorporated in the model simultaneously. Some participants argued that to model AIDS mortality properly it was necessary to begin at the start of the epidemic. Others considered that simulation models which incorporated explicit parameters capturing the effects of behavioural change and other factors, such as the one used by the Population Estimates and Projections Section of the Population Division, were better at capturing the likely effects of the epidemic than parametric models of the shape and level of mortality, such as the United Nations model being proposed by the Mortality Section of the Population Division. The models incorporating parameters that could be interpreted epidemiologically were also more appropriate for the preparation of simulations to inform policy makers. It was recognized, however, that the evidence base on which to estimate such parameters was weak. Evidence being gathered at the INDEPTH sites could potentially be useful in improving future applications of the epidemiological model of the epidemic.

J. CONCLUDING REMARKS AND FUTURE DIRECTIONS

Mr. Vallin offered some concluding remarks. He said that levels, trends and future prospects for mortality were all vitally important. In deriving them, it was essential to make use of all possible empirical information available but, given existing lacunae in the availability of mortality data, recourse to models was also necessary. However, it was important that those producing estimates make clear to what extent those estimates were based on empirical evidence. In this regard, it would be useful to distinguish estimates based on observed or adjusted data from those derived by extrapolating from past trends.

Mr. Vallin expressed support for the proposal of compiling all available information and promoting the sharing of such information. He encouraged the development of new methods of mortality estimation and the further refinement of older methods. Demographic models had to be tested against reality. He suggested that sub-national data could be used to that end. Mr. Vallin commended the work of the different entities producing estimates of mortality and underscored the usefulness of sharing results and cooperating in comparing data and methods to ascertain the causes of any discrepancies that might arise. If absolute consistency among the sets of estimates produced by different entities could not be reached, a useful approach might be to find ways of communicating systematically the degree of uncertainty to which different estimates were subject.

To conclude, Mr. Wilmoth summarized the expected follow-up to the proposals made at the meeting by focusing on three main issues:

Database development. Mr. Wilmoth underscored the importance of this activity to set the basis for the systematic derivation and assessment of mortality estimates. He recalled that a sub-group constituted by the United Nations Population Division, the United Nations Statistics Division, WHO and the University of California at Berkeley would collaborate to develop a pilot version of the database, test it and develop a protocol for data exchange. This pilot version would be presented and discussed at the next coordination meeting on mortality.

Further development and testing of estimation methods. Mr. Wilmoth emphasized the need for further work on evaluating or developing indirect methods to estimate adult mortality, noting that there was mixed evidence about the reliability of some methods when their underlying assumptions were violated. The next coordination meeting on adult mortality might address those issues more systematically, including by comparing estimates derived from death distribution methods to those derived from data on survival of relatives.

Collaborative programme of adult mortality estimation. Despite uncertainties about the quality of the estimates available and the reliability of existing estimation methods when the assumptions on which they were based were not upheld, Mr. Wilmoth thought that a coordinated effort to develop a comprehensive and consistent set of estimates of adult mortality was worth undertaking. He reiterated his proposal of building on the model set by the meetings convened by UNICEF to coordinate the estimation of child mortality. The Population Division would continue convening meetings focusing on adult mortality with a view to fostering the exchange of information, the development of partnerships and the discussion of ways to improve the assessment of mortality levels and trends worldwide.

Mr. Wilmoth thanked participants for their cooperation and active engagement in the meeting and closed the proceedings.

UN/POP/MORT-EGM/2006/INF.1

26 October 2006

English only

UNITED NATIONS EXPERT MEETING ON CURRENT ISSUES
IN THE ESTIMATION OF ADULT MORTALITY
United Nations Secretariat
Department of Economic and Social Affairs
Population Division*
New York, 26-27 October 2006

ORGANIZATION OF WORK

Thursday, 26 October 2006

Afternoon session: *13:30-17:30*

1. **OPENING OF THE MEETING:** Ms. Hania Zlotnik

2. **OVERVIEW OF THE PROJECT:** Mr. John Wilmoth

3. **BRIEF SUMMARY OF MORTALITY ESTIMATION ACTIVITIES**
   Participants (one per institution) are asked to provide a brief overview of work and a statement of priorities in the area of mortality estimation from the perspective of their home institutions.

Afternoon break: *15:30-15:45*

4. **CURRENT ESTIMATES OF ADULT OR OVERALL MORTALITY**

   a) Summary of data and methods
      i. World Health Organization: Ms. Mie Inoue
      ii. UN Population Division: Ms. Cheryl Sawyer
   b) Comparison of estimates: Mr. Kirill Andreev, Ms. Cheryl Sawyer

5. **UN AND WHO RELATIONAL MORTALITY MODELS:**

   a) Presentation of WHO model: Ms. Mie Inoue
   b) Presentation of UN model: Mr. John Wilmoth
   c) Comparison of two models: Mr. Vladimir Canudas-Romo

* This expert group meeting was organized by the United Nations Population Division in collaboration with the Inter-Agency Group for Mortality Estimation.

ORGANIZATION OF WORK *(CONTINUED)*

Friday, 27 October 2006

Morning session: *8:30-12:00*

6. ESTIMATING ADULT MORTALITY USING INCOMPLETE VITAL REGISTRATION DATA

a) Evaluating the validity of indirect estimates of adult mortality: Mr. Ken Hill
b) Simulation analysis of death distribution methods (DDM): Ms. Danzhen You
c) Comparison of data sources for DDM estimation: Ms. Mila Andreeva
d) Toward a methods protocol for DDM estimation: Mr. John Wilmoth

Morning break: *10:30-10:45*

7. DATABASE DEVELOPMENT

a) Database design and data processing: Mr. Kirill Andreev, Ms. Cheryl Sawyer
b) Collaboration and implementation: Mr. John Wilmoth

Lunch break: *12:00-13:30*

Afternoon session: *13:30-17:00*

8. FOCUS ON SELECTED REGIONS AND COUNTRIES

a) Sub-Saharan Africa: Mr. Ayaga Bawah
b) Former USSR and Eastern Europe: Ms. France Meslé
c) Other examples: Ms. Cheryl Sawyer

Afternoon break: *15:00-15:15*

9. APPROACHES TO MODELLING AIDS MORTALITY

a) Epidemiological models and simulation: Mr. Thomas Buettner
b) Model life tables and relational models: Mr. Ayaga Bawah, Mr. John Wilmoth

10. CONCLUDING REMARKS AND FUTURE DIRECTIONS: Mr. Jacques Vallin

UN/POP/MORT-EGM/2006/INF.2

1 November 2006

English only

UNITED NATIONS EXPERT GROUP MEETING ON
CURRENT ISSUES IN THE ESTIMATION OF ADULT MORTALITY
United Nations Secretariat
Department of Economic and Social Affairs
Population Division
New York, 26-27 October 2006

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