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The uses of vital statistics in the work of the United Nations Population Division

By United Nations Population Division¹

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A. Introduction

1. The work of the United Nations Population Division encompasses a broad range of research in population dynamics, including analytical studies of fertility, mortality and international migration; the preparation of world population estimates and projections of the biennial *World Population Prospects*, which includes the estimation of levels and trends for several fertility and mortality indicators; analysis of urbanization; the monitoring of population policies; the analysis of the interrelations between population and development; and the monitoring and dissemination of population information. To carry out its activities, the Division crucially requires reliable data on vital statistics from each country.

2. This paper reviews the use of vital statistics in various aspects of the Division's work. It discusses the use of vital statistics to estimate and analyze the different components of population change, and reviews how those components are combined for the production of population estimates and projections by the cohort-component method. It considers the implications of poor data quality for the reliability and cross-national comparability of population indicators, and highlights the challenges that arise when multiple sources of data produce inconsistent estimates of demographic indicators.

3. The use of specialized questions on fertility or mortality in censuses, which is one source of vital statistics in many countries, will be touched upon in the sections of the paper pertaining to those topics. The paper will not deal at length with other uses of census data, but it bears emphasis that an accurate census population count is the fundamental basis of sound population analysis in most countries. Census counts by age and sex provide the denominators for fertility and mortality rates calculated from civil registration data. Even in cases where sample surveys are used to derive fertility or mortality statistics, census data are essential for valid sampling frames for the surveys.

B. Fertility

4. The Population Division monitors levels and trends in fertility for all countries of the world. Ideally, estimates of fertility are based on births recorded in a civil registration system, tabulated according to the age of the mother. Birth data are combined with population data to generate estimates of age-specific fertility (ASFR), generally for 5-year age groups. The ASFR are typically combined into a total fertility rate (TFR) that describes the hypothetical number of children a woman would bear, if she experienced that year's ASFR throughout her reproductive life. The TFR is an age-standardized indicator that is comparable across populations with differing age structures.

5. Fertility data can also be derived from sources other than civil registration, including questions on births posed to female respondents in sample surveys or censuses. In particular, full birth histories such as those collected in the Demographic and Health Surveys, can provide estimates of trends in age-specific and total fertility.

However, estimates from surveys are subject to both sampling errors, and also to biases that can affect the accurate reporting of births. For example, it has been found that in many surveys, there is evidence of omission or displacement in time of births, particularly in the period immediately preceding the survey, by interviewers or respondents who wish to avoid a lengthy questionnaire module on child health. Nevertheless, the collection of birth history data has become quite common, with over 100 countries collecting such data since 2000, covering 80.7 per cent of the world's population and 98.4 per cent of the population of Africa (tables 1 and 2²).

6. Estimates of fertility can also be obtained by asking about the date of a woman's last live birth, or about births in a defined period preceding the census or survey (often 12 months). However, in practice it has been found that such questions are subject to substantial under-reporting. Demographic methods are available to assess the extent of such under-reporting but these methods may give differing estimates of corrected fertility rates.

7. For the purposes of monitoring fertility levels and their determinants in publications such as the *World Fertility Report*, the Population Division preferentially uses estimates from civil registration systems that have been reported as complete in the United Nations Demographic Yearbook. In all, seven indicators in the *World Fertility Report* are taken from civil registration data: the number of marriages, number of divorces, mean age at first marriage, number of births, age-specific fertility rates (total fertility and mean age at childbearing), mean age at first birth, and the percentage of extra-marital births among all births. Fertility estimates from civil registration, even those reported as complete, are assessed against survey data where available, and the survey estimates are preferred if they are appreciably higher.

8. Accurate fertility data are also important for the monitoring of the Millennium Development Goals (MDGs). The Population Division produces estimates of adolescent fertility (that is, the age-specific birth rate at ages 15-19) to monitor progress on MDG 5 on maternal health, specifically for *Target 5.B, Achieving universal access to reproductive health*. Figure I, showing estimates of the adolescent birth rate for Albania, illustrates the challenges of identifying the trend in adolescent fertility when conflicting estimates arise from different sources. In general, the continuous time series from civil registration are the preferred source, but they must be carefully considered against data from surveys.

9. The time series of five-year fertility estimates for 1950-1955 to the present published in the *World Population Prospects* are constructed after careful evaluation of available data on fertility for a given country from civil registration, surveys or censuses. Reconciling inconsistent estimates from many sources has become a major challenge in the Division's work to generate time trends in fertility. Past estimates often must be adjusted in light of newly available data. Table 3 gives the distribution of countries according to the most recent source of fertility data that was used in the

² Tables 1 and 2 focus primarily on data collected for purposes of estimating mortality. Birth history data can be used to estimate both mortality and fertility, and the tabulations in tables 1 and 2 include the surveys known to the Population Division that have collected birth histories. However, the tables do not reflect the reporting of birth data from civil registration systems, nor do they include data on recent births from censuses or surveys.

2008 Revision of *World Population Prospects*³. The population estimation process provides a check on the available fertility data: when combined with estimates of the female population of reproductive age, fertility estimates should produce birth cohorts that are consistent with the cohorts counted in successive censuses. For the reasons just mentioned, the fertility estimates from *World Population Prospects* may differ from those in national sources.

C. Mortality

10. Trends in mortality give important, albeit incomplete insights into the development, health and well-being of populations. For instance, the life expectancy indicator estimated by the Population Division is a key component of the Human Development Index. Child mortality is another indicator closely watched by the United Nations system in the context of the Millennium Development Goals and other internationally agreed development goals, such as those of the 1994 International Conference on Population and Development and the 1990 World Summit for Children. The Population Division participates in the Inter-agency Group for Child Mortality Estimation (IGME) that produces estimates of infant and under-five mortality for MDG monitoring. The Division also monitors indicators of mortality among adults and convenes periodic Coordination Meetings on the Estimation of Adult Mortality, bringing together experts from the United Nations system and academia to discuss data and methods for adult mortality estimation.

11. The preferred standard for estimating mortality levels and trends for a given population is complete registration of deaths in a civil registration system, with accurate recording of age, sex and cause of death of the decedent. Most countries in the more developed regions and some countries in the less developed regions have attained a high level of completeness in the recording of occurrences of deaths (cause of death recording is generally less complete but will not be considered at length in this paper).

12. Even when registration data are incomplete, they may be amenable to adjustment. Demographic methods are available for assessing the completeness of death reporting in civil registration systems, although these pertain mainly to the assessment of death registration for adults. However, there is no widely accepted standard methodology, and the resulting correction factors can vary based on the age groups used for evaluation, assumptions about net migration, and other factors. For this reason, determinations of completeness levels and the corresponding adjustments to computed mortality rates still require a large element of judgment by the analyst. Assessments of the registration of infant or child deaths are generally done on an ad-hoc basis, for example by comparing civil registration records to health records or by comparing mortality rates for infant age groups to patterns from countries with complete registration systems. When estimates of child mortality from surveys or censuses exceed those from civil registration, the estimates from surveys are generally regarded as more accurate by United Nations analysts.

13. It is important to note that the situation regarding the reporting of mortality data from civil registration to international agencies has changed little since the

³ An updated version of this table for the 2010 Revision is under preparation.

1970s. Figure II shows the percentage of regional and world population for which any data from civil registration systems on age- and sex-specific deaths were reported to the United Nations *Demographic Yearbook* or to the World Health Organization, regardless of the quality of the data. Although the number of countries reporting any age-specific civil registration mortality data increased between the 1950s and the 1990s (table 1), the percentage of world population comprised by these countries remained constant at around 40 per cent. This total does not take into account the three large countries (China, India and Bangladesh) with sample registration systems that produce some data on mortality.

14. A number of alternative strategies for mortality estimation have been developed to cope with situations where civil registration coverage is incomplete or lacking. Tables 1 and 2 present summaries of the data sources available for the analysis of adult and child mortality, respectively, from 1950 until 2010 for countries with populations of 100,000 or greater in 2010. In particular, the estimation of infant and under-five mortality via collection of full or summary birth histories in sample surveys, or summary birth histories in census, has become quite widespread (tables 1 and 2). However, due to sampling error and various biases that can arise in the collection of full or summary birth history data, it is common for different sources from the same country to produce widely varying estimates (an example is shown in figure III, comparing under-five mortality estimates from civil registration, surveys, and census for Azerbaijan). Thus the same difficulties that arise in reconciling discrepant estimates of fertility are equally challenging to the estimation and analysis of mortality trends.

15. Various methods have also been developed to estimate adult mortality via surveys or censuses. One method involves asking about deaths that have occurred in the household in a recent period (often 12 months). Such data can be evaluated using the same methods that were described above for civil registration data. A major alternative source of data in the past two decades is the collection of “sibling histories” in the DHS and some other surveys. In the sibling history, the respondent essentially reports a birth history of his or her own mother, allowing a direct calculation of mortality rates from the age and survival status of the reported siblings. This provides a larger sample for estimating death rates, but research on selection biases and appropriate corrections is still ongoing. Thus, estimates of mortality levels based on sibling histories may give some broad insights into levels or trends of mortality, but must be taken in comparison with data from other sources. Nevertheless, this method of data collection has become widespread. Since 2000, sibling histories have been collected in surveys in 72 countries (table 1), covering 69 per cent of the world’s population (table 2), mainly through the Demographic and Health Surveys and the World Health Surveys. Additional methods of adult mortality estimation based on the survival of relatives include the orphanhood method, in which respondents report on the survival of their parents, and the widowhood method, in which respondents report on the survival status of their first spouse. These methods have largely fallen out of favour, although orphanhood data were still collected in 28 countries since 2000, mainly in Africa (data not shown in tables 1 and 2; tabulations are available from the Population Division upon request).

16. In producing the estimates of mortality referring to five-year periods that are incorporated into *World Population Prospects*, the Population Division evaluates

available estimates of mortality for a given country from civil registration, surveys or census. Often, estimates of child and adult mortality must be evaluated separately. The estimates are compared for consistency between sources, and also for the plausibility of the relationship between child and adult mortality. Estimates are adjusted as necessary, and in cases where the available data do not support construction of a life table for the entire age range, model patterns of mortality are adopted. Because of such considerations, the estimates of indicators such as life expectancy, infant mortality and under-five mortality from *World Population Prospects* may differ from those in national sources.

17. Table 3 shows the distribution of countries by the most recent data sources used in the *2008 Revision* to estimate child and adult mortality. Notably, there are far more countries that have recent data supporting the estimation of child mortality than of adult mortality. The use of adult mortality data shown in table 3 may appear to be somewhat at odds with the expansion of data collection on household deaths and sibling survival that was shown in tables 1 and 2. However, due to issues of data quality and methodological limitations, the mortality estimates derived from those sources are often reported as summary measures, such as the probability of dying between ages 15 and 50 (denoted ${}_{35}q_{15}$), and are not systematically used to construct abridged life tables by 5-year age groups. Thus, model mortality patterns are still used to produce some of the life tables incorporated in the population estimates and projections of *World Population Prospects*. In contrast, the estimates of infant and under-five mortality generated from survey data can be used more directly to estimate mortality patterns for the under-five population.

18. The importance of model patterns in the estimation and analysis of mortality in settings where data are deficient highlights another important use of high-quality mortality data in the Population Division, the further development of mortality models. Mortality models capitalize on observed regularities in the age patterns of mortality in different settings. For example, model life tables are frequently used to estimate levels of adult mortality in populations for which only child mortality estimates are available. Models are also used to guide the projection of future mortality. Key to successfully updating models is the continued incorporation of high-quality mortality data from civil registration. Unfortunately, the dearth of reliable registration data from developing countries means that the mortality experience of those countries is not necessarily reflected in the prevailing models. For this reason, other sources of continuous data, such as demographic surveillance sites have been exploited for development of new model life tables and for the modelling of special circumstances such as mortality from HIV/AIDS.

D. Other topics

19. The work of the Population Division encompasses a number of areas beyond the monitoring of those population aspects that are directly measured by vital statistics.

(a) Migration

20. With the exception of countries having population registers, migration is generally not captured through the same administrative systems as vital events.

However, accurate civil registration estimates of births and deaths, combined with census counts of population, can be used in the population balancing equation to indirectly compute estimates of net migration.

21. There is also one important note of caution to be sounded when computing estimates of fertility or mortality in the face of high migration levels. If annual population estimates do not properly account for migration, then fertility and mortality estimates may become biased especially as the time since the last census increases. Such biases may be corrected and time series retrospectively revised when a new census reveals the scope of inter-censal migration.

(b) Population and development

22. The population estimates and projections enabled by vital statistics are an essential input to the analysis of the relationships between population and various aspects of development. A particular emphasis has been on analysis of the implications for development of ageing populations. The Population Division contributes to the production and analysis of internationally comparable information on population ageing and intergenerational transfers. Additionally the Division periodically assesses the relationship between population and environment factors

(c) Population policies

23. Accurate data on population size and population change is essential to formulating policy, both in population-related matters and for social policy more broadly. The Population Division focuses in particular on the monitoring of national policies related to population growth, fertility, health and mortality, international migration and spatial distribution.

E. Conclusion

24. The Population Division highlights the critical importance of accurate vital statistics to the measurement and analysis of population trends. The efforts of national statistical offices in this regard are gratefully acknowledged. The Division encourages countries to rededicate themselves to improvement of the collection, processing and dissemination of civil registration data on births, deaths, and other vital events. Furthermore countries are encouraged to report even incomplete data to international statistical collections such as the United Nations *Demographic Yearbook*, as incomplete data can provide important insights when incorporated with other sources.

25. The Division recognizes that sample surveys and censuses will continue to be an important source of vital statistics in many countries for years to come, and emphasizes the complementary roles of different data collection processes. The maintenance of survey systems and regular censuses in concert with efforts to improve civil registration can offer a quality check on the development of registration systems, as well as scope for socioeconomic and other analyses that cannot be done with registration data alone.

TABLE 1. NUMBER OF COUNTRIES FOR WHICH SELECTED TYPES OF INFORMATION ARE AVAILABLE FOR ESTIMATING MORTALITY, BY TYPE OF INFORMATION AND PERIOD

Period	Type of Information	Africa	Asia	Europe and Northern America	Latin America and the Caribbean	Oceania	Total
	<i>Total number of countries^a</i>	55	50	42	37	12	196
		Number of countries with available data					
2000 or later	Civil registration	11	31	42	35	8	127
	Sample registration	–	3	–	–	–	3
	CEB/CS ^b	45	36	5	23	6	115
	Birth histories	46	35	11	15	2	109
	Household deaths	29	20	–	11	3	63
	Survival of siblings	37	19	7	9	–	72
1990-1999	Civil registration	13	33	42	36	10	134
	Sample registration	–	3	–	–	–	3
	CEB/CS	41	28	4	20	7	100
	Birth histories	36	33	4	17	1	91
	Household deaths	21	16	–	5	2	44
	Survival of siblings	23	7	–	5	–	35
1980-1989	Civil registration	10	30	42	35	9	126
	Sample registration	–	3	–	–	–	3
	CEB/CS	33	34	9	25	9	110
	Birth histories	22	14	–	15	–	51
	Household deaths	22	10	–	4	–	36
	Survival of siblings	1	1	–	–	–	2
1970-1979	Civil registration	14	19	36	36	7	112
	Sample registration	–	1	–	–	–	1
	CEB/CS	27	23	6	18	7	81
	Birth histories	10	12	1	13	1	37
	Household deaths	19	15	–	8	2	44
	Survival of siblings	–	–	–	–	–	0
1960-1969	Civil registration	15	16	37	35	8	111
	Sample registration	–	–	–	–	–	–
	CEB/CS	23	7	4	1	5	40
	Birth histories	–	1	–	1	–	2
	Household deaths	16	5	–	–	–	21
	Survival of siblings	–	–	–	–	–	0
1950-1959	Civil registration	11	13	36	34	7	101
	Sample registration	–	–	–	–	–	–
	CEB/CS	5	1	–	1	1	8
	Birth histories	–	–	–	–	–	0
	Household deaths	5	–	–	–	–	5
	Survival of siblings	–	–	–	–	–	0

^a Countries with 100,000 or more population in 2010.

^b CEB/CS: Children ever born/children surviving. Refers to countries that collected summary birth history data in a census or in a survey that did not include a full birth history.

Source: Tabulations based on United Nations, Department of Economic and Social Affairs, Population Division (2010). *World Mortality Report 2009* (CD-ROM Edition, POP/DB/WMR/Rev.2009/2).

TABLE 2. PERCENTAGE OF POPULATION FOR WHICH SELECTED TYPES OF INFORMATION ARE AVAILABLE FOR ESTIMATING MORTALITY, BY TYPE OF INFORMATION AND PERIOD

Period	Type of Information	Population covered (percentage)					Total
		Africa	Asia	Europe and Northern America	Latin America and the Caribbean	Oceania	
	<i>Total number of countries^a</i>	55	50	42	37	12	196
		<i>Population covered (percentage)</i>					
2000 or later	Civil registration	27.1	17.4	100.0	97.1	78.8	39.4
	Sample registration	–	65.6	–	–	–	39.8
	CEB/CS ^b	87.8	88.0	6.9	96.2	23.5	75.2
	Maternity histories	98.4	92.0	26.4	79.9	1.9	80.7
	Household deaths	48.9	80.6	–	35.7	2.6	58.8
	Survival of siblings	78.4	85.6	20.1	35.4	–	69.2
	Total population in 2005 (millions)	911.1	3 945.0	1 060.0	557.0	33.5	6 506.6
1990-1999	Civil registration	29.9	17.7	100.0	99.9	97.6	41.3
	Sample registration	–	66.2	–	–	–	40.1
	CEB/CS	94.9	91.1	18.6	92.9	22.0	78.4
	Maternity histories	86.8	89.6	22.2	84.0	16.2	76.4
	Household deaths	31.2	77.1	–	7.4	1.8	51.3
	Survival of siblings	44.3	9.5	–	43.7	–	15.0
	Total population in 1995 (millions)	720.9	3 470.4	1 023.2	482.6	29.0	5 726.2
1980-1989	Civil registration	25.4	16.8	100.0	98.4	96.7	41.6
	Sample registration	–	66.5	–	–	–	39.8
	CEB/CS	56.8	92.7	24.2	91.6	84.6	74.8
	Maternity histories	60.1	56.5	–	80.3	–	47.3
	Household deaths	36.0	52.1	–	37.4	–	38.3
	Survival of siblings	9.1	1.7	–	–	–	2.1
	Total population in 1985 (millions)	555.3	2 906.9	973.9	402.4	24.9	4 863.3
1970-1979	Civil registration	29.6	13.4	98.0	99.9	96.5	41.4
	Sample registration	–	26.0	–	–	–	15.3
	CEB/CS	39.7	49.0	9.2	91.6	7.0	42.2
	Maternity histories	26.0	20.1	1.0	43.2	2.7	18.1
	Household deaths	28.3	21.4	–	70.2	13.5	21.1
	Survival of siblings	–	–	–	–	–	0.0
	Total population in 1975 (millions)	420.3	2 393.1	918.5	323.1	21.5	4 076.4
1960-1969	Civil registration	34.4	11.9	98.3	66.5	85.3	40.7
	Sample registration	–	–	–	–	–	–
	CEB/CS	37.4	30.2	5.5	33.4	16.6	24.8
	Maternity histories	–	1.7	–	7.3	–	1.5
	Household deaths	28.1	9.8	–	–	–	8.3
	Survival of siblings	–	–	–	–	–	0.0
	Total population in 1965 (millions)	323.9	1 886.2	852.8	252.6	17.5	3 333.0
1950-1959	Civil registration	21.0	11.5	98.3	67.0	84.4	40.4
	Sample registration	–	–	–	–	–	–
	CEB/CS	6.7	0.0	–	32.8	0.7	2.9
	Maternity histories	–	–	–	–	–	0.0
	Household deaths	9.7	–	–	–	–	0.9
	Survival of siblings	–	–	–	–	–	0.0
	Total population in 1955 (millions)	255.5	1 549.3	762.2	191.7	14.2	2 772.9

^a Countries with 100,000 or more population in 2010. Regional total populations include smaller countries.

^b CEB/CS: Children ever born/children surviving. Refers to countries that collected summary birth history data in a census or in a survey that did not include a full birth history.

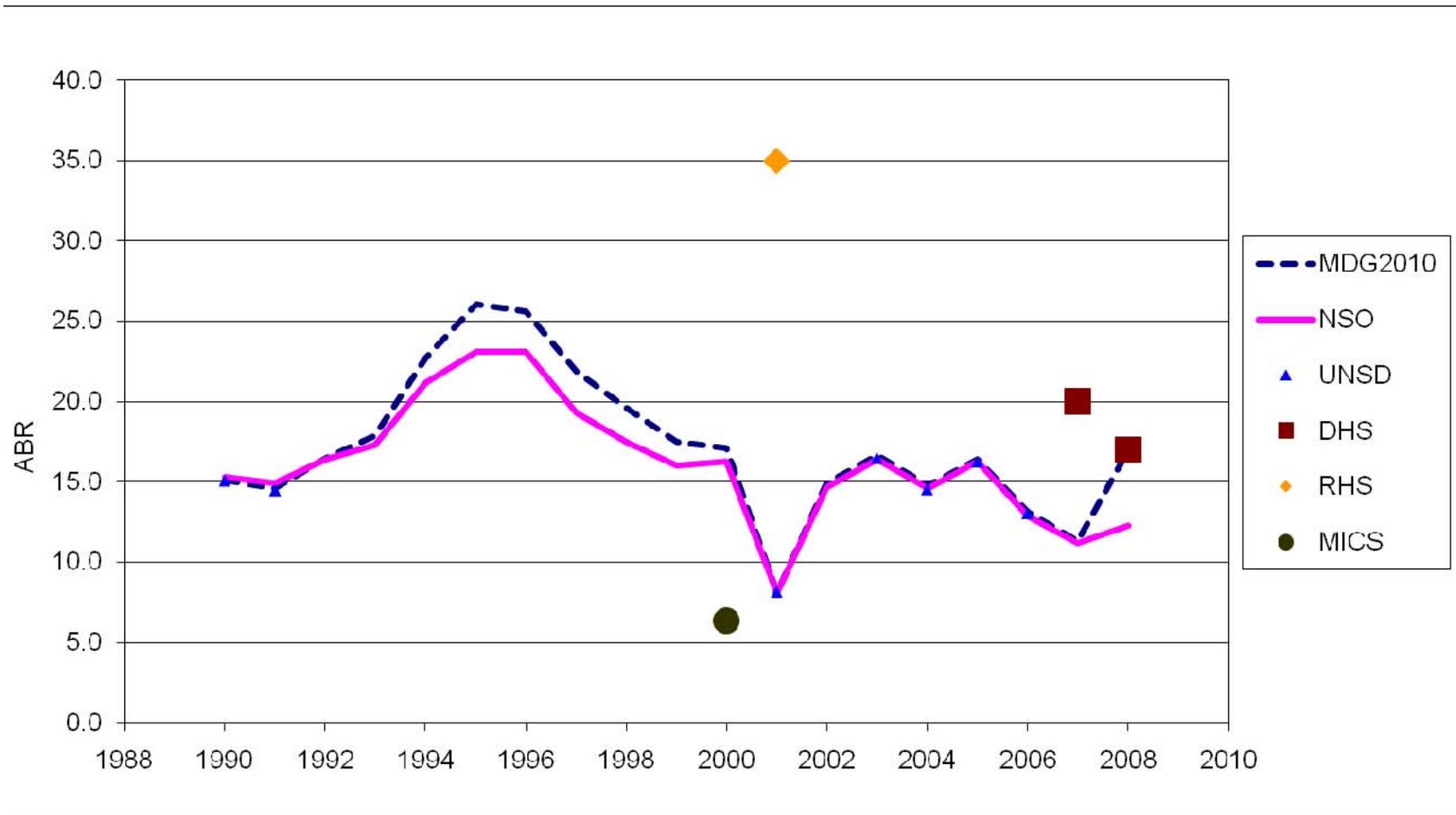
Source: Tabulations based on United Nations, Department of Economic and Social Affairs, Population Division (2010). *World Mortality Report 2009* (CD-ROM Edition, POP/DB/WMR/Rev.2009/2).

TABLE 3. DISTRIBUTION OF COUNTRIES ACCORDING TO THE MOST RECENT DATA USED FOR THE ESTIMATIONS OF FERTILITY, CHILD MORTALITY AND ADULT MORTALITY IN THE 2008 REVISION OF WORLD POPULATION PROSPECTS

<i>Reference date</i>	<i>Africa</i>	<i>Asia</i>	<i>Europe and Northern America</i>	<i>Latin America and the Caribbean</i>	<i>Oceania</i>	<i>Total</i>
<i>Fertility</i>						
No information	–	–	–	–	–	–
Before 1990	–	–	–	–	–	–
1990-1994	–	1	–	1	–	2
1995-1999	5	–	1	1	2	9
2000-2004	19	14	–	20	6	59
2005 and later	31	35	41	15	4	126
<i>Child mortality</i>						
No information	1	–	–	–	–	1
Before 1990	–	–	–	–	–	–
1990-1994	–	–	–	–	–	–
1995-1999	4	2	1	2	3	12
2000-2004	21	19	6	22	2	70
2005 and later	29	29	35	13	7	113
<i>Adult mortality</i>						
No information	50	17	–	7	4	78
Before 1990	2	2	–	5	1	10
1990-1994	1	7	2	8	1	19
1995-1999	1	6	8	3	4	22
2000-2004	1	13	15	12	1	42
2005 and later	–	5	17	2	1	25
Total countries	55	50	42	37	12	196

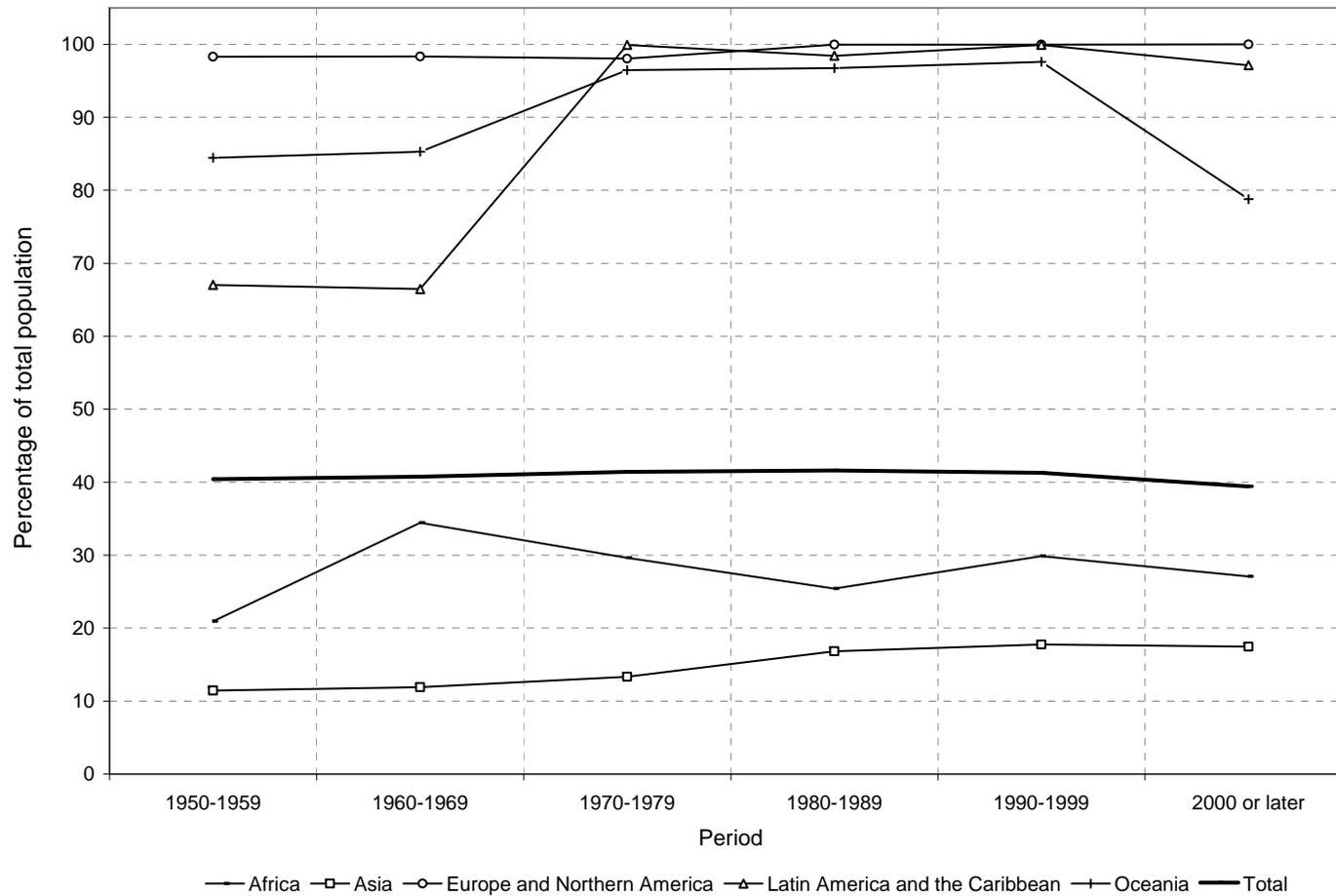
Source: United Nations, Department of Economic and Social Affairs, Population Division.

Figure I. Data available for estimating the adolescent birth rate, Albania



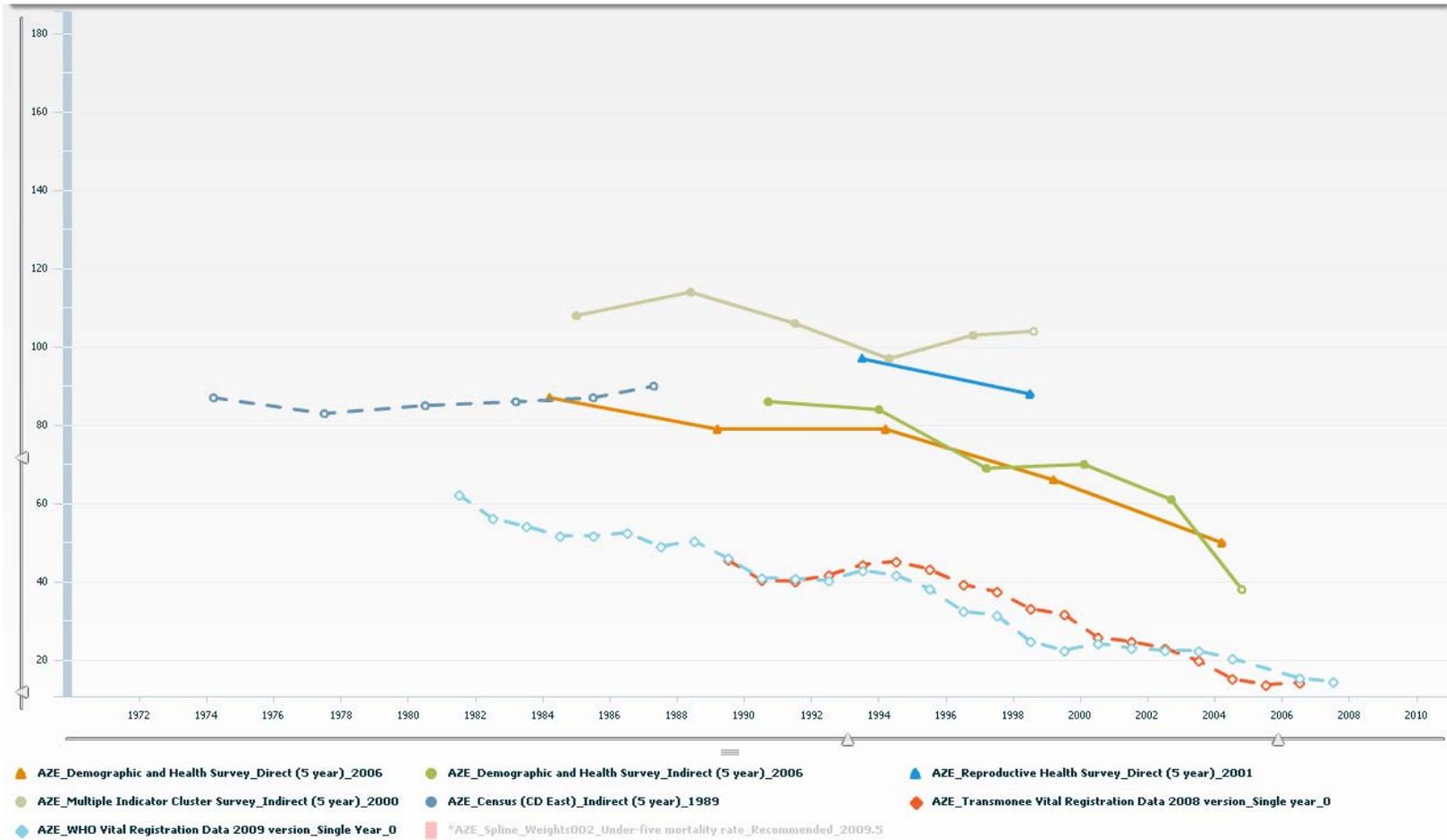
Source: United Nations, Department of Economic and Social Affairs, Population Division (2010). *2010 Update for the MDG Database: Adolescent Birth Rate* (POP/DB/Fert/A/MDG2010).

Figure II. Percentage of regional and world population for which civil registration data on deaths by age and sex were submitted to international agencies, by decade.



Source: Tabulations based on United Nations, Department of Economic and Social Affairs, Population Division (2010). *World Mortality Report 2009* (CD-ROM Edition, POP/DB/WMR/Rev.2009/2/F1-1).

Figure III. Under-five mortality estimates for Azerbaijan



Source: CME Info Database, <http://childmortality.org/cmeMain.html>, accessed 15 June 2010