

APPENDIX B.
POPULATION PROJECTIONS AND
AVAILABILITY OF DATA



Making Population Projections

Making a cohort-component population projection is a multi-step process whose complexity lies not in the calculations — computer programs now handle this quickly and painlessly — but, rather, in deriving the projection inputs, or assumptions. Gathering the base data, assessing their quality, adjusting them as necessary using demographic techniques, and assessing their comparability among countries are all necessary to ensure the success of the projection process. Once the base estimates are derived, the researcher also must make reasonable and consistent assumptions about the future course of fertility, mortality, and international migration. Regional and world populations are obtained by first projecting each country's population separately and then combining the results to derive aggregated totals.

This section (adapted from Arriaga and Associates, 1994) briefly summarizes the process of preparing population projections by the cohort component method at the International Programs Center of the U.S. Census Bureau. Further details and complete references for specific methods mentioned can also be found in Arriaga and Associates (1994).

The Cohort Component Method

Cohort-component population projection follows each group of people of the same age and gender throughout its lifetime, exposing it to assumed mortality, fertility, and migration. An initial, or base year, population disaggregated by age and sex is exposed to estimated age-sex-specific chances of dying as determined by projected mortality levels and age patterns. Once deaths are estimated, they are subtracted from each age group,

yielding the next older age group in the next time period. Fertility rates are projected and applied to the female population of childbearing age to estimate the number of births every year. Each cohort of children born is also followed through time and survivors are calculated after exposure to mortality. Finally, the component method takes into account in-migrants who are incorporated into the population and out-migrants who leave the population. Migrants are added to or subtracted from the population at each specific age. The whole procedure is repeated for each year of the projection period, resulting in the projected population by age and sex, as well as birth and death rates, rates of natural increase, rates of population growth, and other summary measures of fertility, mortality, and migration for each year.

Base Data on Population

For many developed countries, base data on population are taken from population registers or current official estimates prepared by the national statistical offices based on a census for an earlier year. For developing countries, the base population for a projection is based on census data. However, census enumerations are not perfect, and reported data on the population age and sex structure may be affected by age misreporting and by underenumeration of people of certain ages. If the projection starts with errors in the base year, such errors will be carried throughout the projection period and will have an impact on the projected number of births as well.

Consequently, before being accepted to serve as a base for the projections, a population must be evaluated to detect errors and adjusted as necessary to correct them. Various methods have been

developed to detect age misreporting, including analysis of digit preference, age ratios, and sex ratios. Techniques have been developed for making any needed corrections. Depending on the country-specific data problems, mild smoothing or strong smoothing techniques may be recommended.¹³ The base population age and sex structures for most developing countries in this report are at least slightly smoothed for the population ages 10 years and over.

Special attention is given to possible underenumeration of the youngest age groups, 0-4 years and 5-9 years, because errors in these ages may have a significant impact on the total projection. Suppose, for example, that children age 0-4 years were undercounted in the base population. In the projection, not only would the surviving cohorts of these children be smaller than they should be, but when the female cohorts reached reproductive ages, their number of births would also be underestimated. The completeness of enumeration of individuals in the youngest age groups is evaluated by checking for consistency between the number counted and the estimated levels of fertility and mortality during the 10-year period prior to the census date, as children of these ages represent the survivors of births during that period.

Base Data on Mortality

When vital registration data are available and complete (which is usually the case only in developed countries), it is easy to construct life tables using microcomputer programs, and thereby to derive both a level and an age pattern of mortality suitable for the projection

¹³ Arriaga and Associates (1994: 39-42).

process. For most developing countries, however, it is necessary to estimate mortality some other way. Data on deaths may be available from vital statistics registers, as well as from surveys or censuses that include questions concerning deaths during a specific period of time, for example, deaths of any household members during the past year. If registered deaths can be evaluated and adjusted for errors, they can be used to obtain valuable information about the level and pattern of mortality.

Several techniques have been developed for estimating underregistration of deaths.¹⁴ Some of them are based on the assumption that the population is “stable.” A stable population is one in which there has been no migration, and neither fertility nor mortality has changed in the past. Other techniques, developed more recently, do not require the assumption of stability. Some methods may be applied to estimate mortality during the first years of life.¹⁵ They are based on data on children ever born and children surviving, by age of mother.

Like mortality in infancy and childhood, mortality in adult ages can be estimated indirectly when reliable data are not available to measure it directly. Two principal techniques have been developed to estimate adult mortality based on information collected in censuses or surveys: the orphanhood technique, based on the number of people whose mother or father has died; and the widowhood technique, based on the number of people whose first spouse has died. Both provide an estimate of

¹⁴ For example, the Preston-Coale technique, the growth balance technique developed by Brass, and the Bennett-Horiuchi technique.

¹⁵ For example, the Brass technique and modifications developed by Trussell, Sullivan, and Feeney; the Palloni-Heligman technique, and the Johnson technique.

survivorship levels between two adult ages for a period of time prior to the year of data collection. However, these techniques are seldom used for the base mortality patterns of the projections in this report because the reference period to which the estimated mortality pertains is not well defined.

Base Data on Fertility

As in the case of mortality, procedures for estimating fertility depend on the availability of data and on the level and type of detail of the information. For cases where vital registration is complete, fertility can be measured directly using classical procedures. Most developing countries, however, do not have reliable vital statistics, so techniques have been developed to measure fertility indirectly based on census or survey information.

Using the age structure of the population, the crude birth rate is sometimes estimated by the rejuvenation technique, in which the population at the youngest ages is “reverse survived” to determine the number of births from which they are survivors. This technique is attractive because it does not require the collection of data related specifically to fertility. However, the reliability of the estimate depends on the quality of both the census data on age and the survival ratios used for the rejuvenation.

Under certain circumstances, census data by age can be used to obtain not only a crude birth rate but age-specific fertility rates as well. This is done by using the own-children technique based on information on children and women by single years of age. This technique requires data linking individual children to their natural mothers.

Other techniques, such as the Rele technique, use census data by age to calculate the net reproduction rate or total fertility rate based on the relationship of children of specified ages to the number of women in childbearing ages.

Finally, and most importantly for many developing countries, many censuses and surveys include questions related specifically to fertility, for example, the number of children women have had and whether they had a birth in the year preceding the inquiry. Responses to such questions can be used to estimate fertility indirectly. Some techniques to do this include the P/F (Parity/Fertility) ratio method developed by Brass, based on the average number of children ever born to women in 5-year age groups and women’s age pattern of fertility derived from births in the year preceding the census or survey; and the Arriaga technique, which is similar to the P/F ratio method but links data for more than one date. While the Brass P/F ratio method assumes constant fertility in the past, the Arriaga method does not. All of these methods can be used to estimate the age-specific fertility rates required for making component population projections.

Base Data on International Migration

Although migration is sometimes an important component of population change, it is not generally well recorded except in some European countries, such as Sweden and the Netherlands, that maintain complete and detailed population registers. Some countries collect information on arrivals and departures of passengers at the official borders of the national territory, but such data are seldom processed in a way that renders them useful for statistical

purposes. Even in countries with otherwise excellent statistical systems, information on international migration is often unreliable. The primary source of information on immigration for purposes of population projections is census data on place of birth of the foreign-born population. To detect emigration as well, in order to calculate the net movement in or out of a country, it is necessary to find data for the countries in which the emigrants have settled (since they are the foreign immigrants of that country). In addition, special migration flows, such as refugee movement, are incorporated by considering reported numbers of refugees from the United Nations High Commissioner on Refugees, country sources, and media reports. Thus, most data on international migration are educated guesses at best, especially since not only total numbers but also age and sex distributions of the migrants are required for the projection process.

Assumptions About the Future

Once levels of mortality, fertility, and migration have been determined for the base year of the projection, each component must be projected into the future. Although the procedure for doing this is mechanical, care must be taken in determining projected levels, trends, and patterns by age. Not only must the assumptions be appropriate for the particular country in question, but consistent assumptions must be made when projections are being carried out for more than one country.

An expected increase in contraceptive prevalence is implicit in the assumptions about future fertility declines for most developing countries. For many developed countries, future fertility levels are projected to experience only minor

change, either slight decreases or slight increases.

In general, mortality is expected to continue to decline in most countries, as economic development occurs and health care improves. A particular exception relates to the impact of acquired immune deficiency syndrome (AIDS) on the mortality of some countries, where mortality levels in the next decade are expected to increase. (For a description of the method used to incorporate the impact of AIDS mortality on selected populations, see Appendix C.) While there is no single "right" way to make assumptions about the future, the following procedures are those recommended and generally used by the Census Bureau for the projections presented in this report.

Projecting Mortality and Fertility

To project mortality and fertility, available data on past trends in life expectancy at birth and total fertility rate are considered. The trend in future levels of these indicators can be approximated using a logistic function.

Life expectancy at birth is projected by fitting a fixed-slope logistic curve to the most recent estimate of life expectancy at birth.¹⁶ If estimates of total fertility rates are available for more than one date in the past, a logistic function can be fitted to these data. The results of the logistic function must be carefully scrutinized, however, to ensure that they yield an acceptable future target for the individual country's circumstances.

¹⁶ The fixed-slope model of change in sex-specific life expectancy at birth in a population assumes that future change follows a fixed logistic curve from its initial level. The relationship is based on empirical research undertaken at the International Programs Center, U.S. Census Bureau, in 1998-1999.

In some instances, no data on past trends in fertility are available to which a logistic curve can be fitted. When trend data are not available for estimating future changes using a logistic function, the past experience of other countries serves as a guideline to determine the pace of future change.

Recent population and socioeconomic trends and policies of each country are taken into account to determine if the projected trends are plausible. For example, for mortality, information concerning programs of public health are considered in judging the results. For fertility, factors such as trends in age at marriage, the proportion of women using contraception, the strength of family planning programs, and any foreseen changes in women's educational attainment or in their labor force participation in the modern economic sector are considered.

The next task is to determine an age pattern of mortality and fertility for each of the projected values, since these patterns tend to vary as overall levels change. For each level of projected life expectancy at birth, a set of central death rates is estimated using an iterative interpolation process. The interpolation is logarithmic and uses a set of central death rates for the base year and a "limit" set of rates with very low mortality. Life tables constructed with the interpolated rates correspond to the life expectancies at birth projected previously. Age-specific fertility rates for each projected level of total fertility rate are interpolated between the set for the base year and an ultimate pattern of fertility derived at the International Programs Center using empirical data for countries with low fertility.

Once mortality and fertility have been tentatively projected for each

country according to its particular circumstances, the estimates are compared with projected values for other countries in the same region and with those for other regions. Differences are evaluated to make sure they exist for valid reasons that can be explained by known peculiarities of the particular countries.

Finally, in recent years the Census Bureau has concluded that distinctive mortality assumptions must be made for selected countries in this report because of the death risk due to AIDS. Using methodology that takes into account the effect of AIDS, country projections have been prepared that assess its impact on future populations in countries where the infection is significant (see Appendix C).

Projecting International Migration

Assumptions about future migration are generally much more speculative than assumptions about fertility and mortality. International migration may occur as a result of changing economic conditions, political unrest, persecutions, famines, and other extreme conditions in the countries of origin. Thus, individuals may be attracted by economic opportunities perceived to be available in more industrialized societies. And refugees may flee in large numbers looking for better or more stable lives elsewhere.

Due to the unpredictability of conditions such as crop failure, emerging violence, and war, migration forecasts are subject to large errors. If migration is known to have a negligible impact on a country's current growth rate, future migration is often assumed to be nil. If a country's migration is known to be significant, the estimated number of migrants during the past is frequently held constant in projecting

to the near future. The age and sex composition of international migrants depends on the situation in each country. If information is not available, model patterns by age and sex are sometimes used.

Regional and World Aggregations

As new data are obtained, world population projections are updated and published biennially in this profile series.¹⁷ The national projections presented in this report were updated for any country for which significant new information was received since the preparation of the previous profile. For most countries, the cutoff for receipt of new information was the end of calendar year 2001.

Due to the differing nature of the base data for each country, there is no standard starting date for each country's projection. The projection period for several countries started as recently as 1996, when the base information was current to that date. In contrast, the projection period for many African countries (and a few countries in other regions as well) started as long ago as the 1970s, or even before, although information for a later date on one or more of the variables may have been taken into account when deriving parameter estimates for the early years of a projection. "New" information for a country whose projection base year is in the 1970s may pertain to the 1980s or 1990s, superseding the 1970s data available for a previous round. Thus, total populations in the revised projections may change for any year in the past.

¹⁷ Projections are made by the cohort component method for all but 4 small countries or territories with a combined population in 1998 of about 400,000 people, or 0.01 percent of the world total. For these small countries, total populations and vital rates are projected, but not age and sex distributions.

When the projected population for any individual country changes, so does the aggregated total for the corresponding region and for the world. New aggregations are made for world regions and world totals, combining the latest projected data for all countries, and superseding previously projected world and regional totals given in previous reports.

The differing starting dates complicate aggregations not only of total population but of vital rates and other measures as well. For this reason, regional and global aggregations of crude birth and death rates, life expectancy at birth, infant mortality rates, and age-sex distributions of the population generally can be presented only for the latest and future years for which all countries have a projected estimate for each variable. In this report, such measures are always shown for 2002.

Recency of Base Data for the Projections

The first two sections of this appendix described methods for evaluating base data and making projections, without reference to the data situations actually encountered in the various countries. This section reviews the availability of data for the current round of projections as presented in this report.

Census Cycles, Ongoing Survey Programs, and Demographic Data Availability

This report presents population estimates and projections for 227 countries or areas of the world. These estimates and projections are based, in turn, on population data published in the wake of the 1990 round of censuses and, less frequently, the 2000 round of censuses. They are also based on published vital statistics and

survey results, which accounts for the greater recency of fertility and mortality data compared with population data.¹⁸

Of the 227 countries and areas covered, 154 have data on population size, 180 have information on fertility, and 165 have information on mortality pertaining to some date since 1990 (Tables B-1, B-2, and B-3). Data availability has continued to improve since the publication of the previous edition in this series (*World Population Profile: 1998* (WP98)). For example, fewer countries now have population data available only prior to 1990. The number of countries lacking more recent data has fallen from 87 (as reported in WP98) to 73 at mid-2002, when the analytical work for WPO2 was completed.

While the current round of projections draws on population data for 1995 or later for only about 1 in 6 countries, they incorporate new fertility data for half of all countries and new mortality data for about 40 percent of all countries. As tables B-2 and B-3 show, the proportion of more developed countries with relatively recent fertility and mortality data is substantially higher than that for less developed countries. This reflects the general availability of complete vital statistics data from registration systems for more developed countries and the lack of such data for many developing countries.

Differences in Recency of Data by Development Status

Perhaps more important than the number of countries with recent information on population size,

¹⁸ Data on fertility and mortality tend to be more recent than data on population size largely because of the wealth of information being generated by the Demographic and Health Surveys program, the Reproductive Health Surveys program, the Centers for Disease Control, and similar multi-country survey programs.

fertility, and mortality is the proportion of the world's population covered by such information.

Again, as tables B-1 through B-3 show, over 80 percent of the global population lives in countries with population data as recent as 1990; over half, in countries with fertility data since 1995; nearly half, in countries with mortality data since 1995. Ninety-nine percent of the populations of more developed countries live in countries for which the current round of estimates and projections incorporates data for 1995 or later. For less developed countries the corresponding figures are 47 percent for fertility data and 36 percent for mortality data. Tables B-1 through B-3 show how the recency of data varies by geographic region as well as by development status.

Recency of Information on Contraceptive Prevalence

In the population projections presented in this report, information on the prevalence of family planning is not used directly as input in the computer model. Nevertheless, knowledge of the extent of contraceptive use and the strength of national family planning programs are important considerations when projecting future levels and age patterns of fertility required for cohort-component projections.

Recent data on the current use of family planning methods are gathered primarily by surveys such as the DHS program of Macro International, Inc. and the various family health and contraceptive prevalence surveys of the U.S. Centers for Disease Control. There are also important regional survey programs in Europe and the Middle East. In addition, some countries conduct other national surveys, either for the specific purpose of gathering information on family planning or for other purposes,

such as the monitoring of maternal and child health. These surveys often include questions about contraceptive use.

Of the 172 countries in developing regions, 84 (49 percent) have gathered information on family planning for some date since 1995 (Table B-4). About 1 in 3 more developed countries has contraceptive data for this period.

It is primarily the larger countries that gather information on contraceptive use, as shown by the larger proportions of populations than of countries covered by available data. While 49 percent of less developed countries have contraceptive data available since 1995, these countries represent 65 percent of the LDC population globally. Similarly, the 31 percent of more developed countries with data since 1995 account for 59 percent of the world's MDC population.

Data for the United States

The estimates and projections presented in this report take into account the population count from Census 2000, vital statistics and immigration data made available after 2000, and include the Armed Forces overseas. However, the projections for the United States presented in this report are interim projections, prepared without undergoing a full and final Census Bureau review. These estimates and projections also feed into those for North America, more developed countries as a group, the Developed World (the grouping used in most of the figures of the report), and the world as a whole.

New U.S. projections will be released in 2004 and will be available through the Internet at www.census.gov/population/www/projections/

Table B-3.
Distribution of Countries and of Population by Region and Recency of Reliable Data on Mortality

Region	Year of latest data									
	Countries					Midyear population: 2002 (millions)				
	Total	1995-2002	1990-94	1980-89	Before 1980 or none	Total	1995-2002	1990-94	1980-89	Before 1980 or none
Absolute Numbers:										
WORLD	227	95	70	38	24	6,228	2,988	2,496	619	126
Less Developed.....	172	48	65	37	22	5,030	1,805	2,480	619	126
More Developed.....	55	47	5	1	2	1,199	1,183	16	(Z)	(Z)
AFRICA	57	5	23	20	9	839	49	275	492	22
Sub-Saharan Africa.....	51	5	21	18	7	687	49	192	428	17
North Africa.....	6	-	2	2	2	152	-	83	63	6
NEAR EAST	16	5	3	3	5	179	10	30	69	70
ASIA	28	12	12	2	2	3,518	1,760	1,705	23	30
LATIN AMERICA AND THE CARIBBEAN	45	20	15	8	2	539	112	389	35	3
EUROPE AND THE NEW INDEPENDENT STATES	55	40	13	-	2	803	713	90	-	(Z)
Western Europe.....	28	25	1	-	2	392	392	(Z)	-	(Z)
Eastern Europe.....	12	10	2	-	-	121	113	8	-	-
New Independent States.....	15	5	10	-	-	290	207	83	-	-
Baltics.....	3	2	1	-	-	7	4	4	-	-
Commonwealth of Independent States.....	12	3	9	-	-	283	204	79	-	-
NORTH AMERICA	5	4	-	1	-	320	320	-	(Z)	-
OCEANIA	21	9	4	4	4	32	25	5	1	(Z)
Percent distribution of:										
	Countries					Population				
WORLD	100	42	31	17	11	100	48	40	10	2
Less Developed.....	100	28	38	22	13	100	36	49	12	2
More Developed.....	100	85	9	2	4	100	99	1	(Z)	(Z)
AFRICA	100	9	40	35	16	100	6	33	59	3
Sub-Saharan Africa.....	100	10	41	35	14	100	7	28	62	2
North Africa.....	100	-	33	33	33	100	-	55	42	4
NEAR EAST	100	31	19	19	31	100	6	17	39	39
ASIA	100	43	43	7	7	100	50	48	1	1
LATIN AMERICA AND THE CARIBBEAN	100	44	33	18	4	100	21	72	6	1
EUROPE AND THE NEW INDEPENDENT STATES	100	73	24	-	4	100	89	11	-	(Z)
Western Europe.....	100	89	4	-	7	100	100	(Z)	-	(Z)
Eastern Europe.....	100	83	17	-	-	100	94	6	-	-
New Independent States.....	100	33	67	-	-	100	72	28	-	-
Baltics.....	100	67	33	-	-	100	51	49	-	-
Commonwealth of Independent States.....	100	25	75	-	-	100	72	28	-	-
NORTH AMERICA	100	80	-	20	-	100	100	-	(Z)	-
OCEANIA	100	43	19	19	19	100	79	17	3	1

- Represents zero.

Z Less than 500,000 or less than 0.5 percent.

Source: U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.

Table B-4.
Distribution of Countries and of Population by Region and Recency of Reliable Data on Contraceptive Prevalence

Region	Year of latest data									
	Total	1995-2002	1990-94	1980-89	Before 1980 or none	Total	1995-2002	1990-94	1980-89	Before 1980 or none
Countries					Midyear population: 2002 (millions)					
WORLD	227	101	31	24	71	6,228	3,969	1,963	110	185
Less Developed.....	172	84	21	17	50	5,030	3,257	1,562	55	155
More Developed.....	55	17	10	7	21	1,199	712	401	56	30
AFRICA	57	35	6	3	13	839	699	97	10	32
Sub-Saharan Africa.....	51	30	6	3	12	687	547	97	10	31
North Africa.....	6	5	-	-	1	152	152	-	-	(Z)
NEAR EAST	16	12	1	1	2	179	131	17	24	7
ASIA	28	13	9	1	5	3,518	2,054	1,429	4	30
LATIN AMERICA AND THE CARIBBEAN	45	16	3	10	16	539	434	4	16	84
EUROPE AND THE NEW INDEPENDENT STATES ..	55	19	12	6	18	803	322	415	36	30
Western Europe.....	28	5	5	5	13	392	124	229	34	5
Eastern Europe.....	12	3	3	1	5	121	69	26	2	25
New Independent States ..	15	11	4	-	-	290	129	161	-	-
Baltics.....	3	2	1	-	-	7	6	1	-	-
Commonwealth of Independent States..	12	9	3	-	-	283	123	159	-	-
NORTH AMERICA	5	2	-	-	3	320	320	-	-	(Z)
OCEANIA	21	4	-	3	14	32	9	-	20	3
	Percent distribution of:									
	Countries					Population				
WORLD	100	44	14	11	31	100	64	32	2	3
Less Developed.....	100	49	12	10	29	100	65	31	1	3
More Developed.....	100	31	18	13	38	100	59	33	5	3
AFRICA	100	61	11	5	23	100	83	12	1	4
Sub-Saharan Africa.....	100	59	12	6	24	100	80	14	2	5
North Africa.....	100	83	-	-	17	100	100	-	-	(Z)
NEAR EAST	100	75	6	6	13	100	73	10	13	4
ASIA	100	46	32	4	18	100	58	41	(Z)	1
LATIN AMERICA AND THE CARIBBEAN	100	36	7	22	36	100	81	1	3	16
EUROPE AND THE NEW INDEPENDENT STATES ..	100	35	22	11	33	100	40	52	4	4
Western Europe.....	100	18	18	18	46	100	32	58	9	1
Eastern Europe.....	100	25	25	8	42	100	57	21	2	20
New Independent States ..	100	73	27	-	-	100	45	55	-	-
Baltics.....	100	67	33	-	-	100	81	19	-	-
Commonwealth of Independent States..	100	75	25	-	-	100	44	56	-	-
NORTH AMERICA	100	40	-	-	60	100	100	-	-	(Z)
OCEANIA	100	19	-	14	67	100	29	-	62	8

- Represents zero.

Z Less than 500,000 or less than 0.5 percent.

Source: U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.

