CHAPTER 5

Demography of Aging

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In the 1960s, the demographic phenomenon that received a great deal of both scholarly and popular attention was rapid population growth, popularly referred to as the population explosion. By the end of the 20th century, global population aging—the graying of the world (Peterson 1999)—was the demographic phenomenon receiving a great deal of attention. These demographic trends generated widespread alarm regarding the threat that each posed to the future social and economic well-being of societies. Interestingly, both are produced by the modernization of demographic behavior, or the demographic transition. Rapid population growth occurred as death rates declined rapidly, resulting in birth rates exceeding death rates. As birth rates subsequently declined around the world, population growth slowed and population aging began. In other words, population aging is the price paid for solving the challenge of population growth. There is, however, an important contrast between the issues of rapid population growth and population aging. Rapid population growth appears to be a short-term phenomenon, whereas the marked change in age composition resulting from population aging is unlikely to be reversed in the future.

This chapter begins by discussing the demographic determinants and global patterns of population aging and then explores a series of important issues related to population aging: How does migration affect population age composition? What are the implications of population aging for pension systems? How does population aging affect population health and health care? How does population aging affect kinship structures? Finally, it reviews methodological issues related to studying population aging and future research directions.

SUBSTANTIVE ISSUES

Demographic Determinants of Population Aging

Population aging is a basic demographic phenomenon, determined by a population's fertility, mortality, and migration patterns. Indeed, the age distribution of a population at any time is uniquely determined by its history of births and age-specific death and migration rates. Demographers have been able to carefully explicate how population aging occurs. Two approaches are especially useful in this type of demographic analysis: the stable population model and population projections.

THE STABLE POPULATION MODEL. The use of the stable population model to examine population aging has been developed in several books on mathematical demography (Coale 1972; Keyfitz 1968; Preston, Heuveline, and Guillot 2001; also see chapter 22 in this *Handbook*). Discussions of the stable population model for population analysis begin by establishing that the age distribution of a closed population is determined by past fertility and mortality schedules. If age-specific fertility and mortality rates remain unchanged for a long time (a century is generally long enough), and no migration occurs, the population will have a unique and unchanging age distribution. That is, under these conditions the proportion of the population in any age category does not change from one year to the next. Because the age distribution is mathematically determined by age-specific birth and death rates in a stable population, it is possible to determine the effect of a change in the age-specific fertility and/or mortality rates on the age distributions of a stable population. This approach is called "comparative statics," indicating that it does not deal with the dynamics of the transition from one stable population to another but only with the comparison of a stable population after a change in vital rates to the initial stable population.

Using the stable population model, the effect of a change in fertility on the age composition of a population is found to be straightforward. A permanent shift to a lower fertility level, with no change in mortality rates, leads to an aging of the population. This result is not surprising, because it seems obvious that under similar mortality conditions, a population with lower fertility will have proportionately fewer children, and hence an older population, than one with higher fertility. Comparing stable populations with different fertility levels and similar levels of life expectancy shows the magnitude of the effect of a fertility decline. For example, in a stable population with life expectancy of 80 years, 11.9% of the population will be over age 65 if the gross reproduction rate (GRR) is 1.5, but 25.9% if the GRR is 0.8. Other comparisons of stable population age composition under differing fertility and mortality conditions can be made from data in Table 5.1. The effect of decreasing fertility can be seen by looking down columns in this table. Clearly, under any particular mortality condition, sustained low fertility leads to an older population than sustained high fertility.

Analyzing the stable population model shows that the effect of mortality change on population aging is not straightforward. The effect of a change in mortality depends on the specific ages at which mortality changes. Contrary to what most nondemographers assume, an increase in life expectancy (average years lived by a cohort) does *not* necessarily result in an aging of the population and may actually produce a younger population. The variable effect of changing mortality levels for the age distribution of a

TABLE 5.1. Percent over Age 65 in Stable Populations with Various Combinations of Fertility and Mortality.

	Expectation of Life (in years)					
Gross Reproduction Rate	30	40	50	60	70	80
4.0	1.8	1.8	1.7	1.7	1.7	2.1
3.0	3.1	3.0	3.0	2.9	3.0	3.6
2.0	5.8	5.9	5.9	5.9	6.1	7.5
1.0	14.5	14.9	15.5	15.7	16.5	20.2
0.8	17.8	18.9	19.7	20.1	21.2	25.9

Source: Coale and Demeny 1983.

stable population can be seen by exploring several different causes of increasing life expectancy. For example, an increase in life expectancy that occurs only because of a decrease in infant mortality results in a younger population. Indeed, increasing the proportion of babies who survive would have the same long-term effect on population age composition as would an increase in the birth rate. On the other hand, an increase in life expectancy caused only by decreasing death rates in later life (among those over age 50 years, for example) would increase only the size of the older population and hence lead to population aging. A third scenario is one in which there is an equal absolute decline in death rates at all ages. Stable population analysis shows that this particular mortality decline has no effect on population age composition. Thus it turns out that, depending on the ages at which mortality declines, increasing life expectancy can lead to population aging, population "younging," or no change in age composition. Examples of these different possible outcomes can be seen by looking across rows in Table 5.1. Increasing life expectancy from 40 to 60 with a GRR of 3.0 decreases the proportion over age 65 in a population, but increasing life expectancy from 60 to 80 with a GRR of 1.0 produces a significant aging of the population. As discussed later, the actual effect of declining mortality on the age composition of a population depends primarily on what life expectancy is when the decline occurs.

POPULATION PROJECTIONS. Basically, a population projection begins with a baseline population and then, using some method, determines what size that population would be at some future date under a particular set of assumptions. Some methods make it possible to project not only the size but also the composition (age, sex, race, etc.) of a population into the future. Unless a calculation error is made, a projection is accurate—that is, under the given set of assumptions, the baseline population will change as expected. Of course, when a projection is used to forecast the future size and composition of a population, it may be totally wrong if the assumptions are not an accurate description of actual future demographic behavior. Population projections used as population forecasts are discussed below; here the interest is in using population projections to examine the determinants of population aging. What are the effects of alternative patterns of mortality, fertility, and migration on future population age composition?

A series of alternative projections of the United States population by the Census Bureau (Day 1996) can be used to illustrate how population projections aid our understanding of the determinants of population aging. The baseline for these particular projections is 1995, when 12.8% of the population was aged 65 years and over, the total fertility rate was 2.055, life expectancy was 75.9, and yearly net immigration was 820,000. Using various assumptions regarding fertility, mortality, and migration over the ensuing 55 years, the Census Bureau calculates what the size and age composition of the population would be in 2050. The alternative assumptions used for these calculations are shown in Table 5.2. Projections of the percent of the United States population over age 65 years in 2050 under differing sets of assumptions are shown in Table 5.3.

Following the middle series for all three demographic variables would lead to a population with 20.0% over age 65 in the year 2050. The other entries in Table 5.3 show the projected proportion of the old population (age 65 and over) when one of the variables follows either a higher or lower trajectory while the other two follow the middle series. This allows us to isolate the effect of alternative fertility, mortality, or migration scenarios on population aging. As expected from the discussion of the stable population model, a pattern of higher fertility would produce a younger population (17.6% over age 65 years) and a pattern of lower fertility would produce an older population (22.8% over age 65 years). The alternative mortality assumptions have an even larger consequence for population aging over this period than the alternative fertility assumptions. A large reduction in mortality results in the largest proportion over age 65 years of any of these scenarios (23.3%), while a slight increase in mortality results in the smallest proportion of the old of any scenario (16.5%).

Perhaps the most interesting finding revealed in these alternative projections is the relatively small effect of differing assumptions about future immigration levels on the future age distribution. Either increasing or decreasing the annual net flow of immigrants to the United States by half a million would change the proportion over age 65 years in the population by less than 1% from the middle series. Indeed, a projection

Table 5.2. Census Bureau Assumptions of Fertility, Mortality, and Migration for 2050.

Item	1995	2050 Level Assumption: Low	Middle	High
Fertility (GRR)	2.055	1.910	2.245	2.580
Life expectation (yrs)	75.9	74.8	82.0	89.4
Net immigration (000's)	820	300	820	1,370

Table 5.3. Percent of the United States Population Projected to be Over Age 65 years in 2050 Under Alternative Assumptions.

Assumptions*	% 65+
Middle series for fertility, mortality, and migration	20.0
Low fertility, middle mortality, and migration	22.8
High fertility, middle mortality, and migration	17.6
Low mortality, middle fertility, and migration	23.3
High mortality, middle fertility, and migration	16.5
High immigration, middle mortality, and fertility	19.4
Low immigration, middle mortality, and fertility	20.8
Zero immigration, middle mortality, and fertility	22.3

Source: Day 1996.
*See text for description of assumptions.

using the extreme assumption of zero future immigration results in an only a slightly older population (22.3% over age 65 years) in 2050 than the middle series with 820,000 net immigrants per year. The ineffectiveness of using immigration to slow population aging is discussed more fully below. A more thorough use of population projections to study determinants of population aging is possible by using various starting populations and a wider range of alternative assumptions about future fertility, mortality, and migration patterns.

Using either the stable population model or experimenting with alternative assumptions in making population projections leads to the same basic conclusions regarding the demographic determinants of population aging. A decline in fertility leads to population aging. A decline in mortality spread across all ages has little effect on the age composition of a population, but a decrease in mortality concentrated in later life can significantly increase population aging. And, within typical boundaries actually observed, immigration has only a small effect on population aging. Using this information helps us understand past trends in population aging and provides a basis for anticipating future trends.

Trajectories of Population Aging

From the perspective of the early 21st century one can see an amazing revolution of demographic behavior that began slowly in Europe in the 18th century and accelerated around the world in the 20th century. All populations before the demographic transition, as the revolution is generally called, had to contend with high death rates. When half or fewer of all babies survived to adulthood, fertility was necessarily high or a population would not survive. Under these conditions of high fertility and high mortality, all populations were young by contemporary standards, with no more than 3% or 4% of any population being over age 65 years. Without entering into the discussion (and debates) about the causal mechanisms involved (Casterline 2003; Chesnais 1992), the basic description of what happened can be simply noted. Death rates and birth rates in Europe, North America, and Australia declined drastically between 1850 and 2000. During this transition, populations in these areas grew significantly larger and became much older. Almost all other countries experienced significant declines in mortality and fertility rates beginning sometime in the 20th century, and consequently experienced rapid population growth and some population aging. But because the pattern and timing of the demographic transition has varied widely across countries, some countries are still at an early stage of the demographic transition and have yet to experience any population aging. Thus, as a consequence of differences in demographic behavior over the past century, in 2000 there were enormous variations across countries in the age composition of their populations.

The dimensions of global population aging, and issues related to it, received a great deal of attention at the beginning of the 21st century. Major reports on this topic were published by the Population Division of the United Nations (United Nations 2002), the United States Census Bureau (Kinsella and Velkoff 2001), and the National Academy of Sciences (National Research Council 2001). Each of these reports notes that societies around the world are now in the midst of a profound change in the age distribution of their populations. There is interest both in changes that have occurred, as well as those anticipated in coming decades. To describe these patterns of global population aging, it is useful to focus on the period 1950 to 2050. Data in Table 5.4 show percent over age 65 years and over age 80 for a variety of populations in 1950, 2000, and 2050. The data for 1950 and 2000 are based upon estimates from national censuses and surveys, and data for 2050 are projections based on certain assumptions regarding future demographic behavior. These particular populations are selected to illustrate the diversity in patterns of population aging, but there is also a degree of arbitrariness. The percent over age 80 years is included in this table because of the growing interest of social and health policy researchers in the "oldest-old" portion of the population.

The first comparison in Table 5.4 is between the more developed regions (Europe, Northern America, Japan, and Australia and New Zealand) and the less developed regions (Africa, Latin America, and Asia excluding Japan). In general, countries included in the "more developed" regions have had higher levels of income, higher life expectancy, and lower birth rates since 1950 than countries in the "less developed" category. Although this is a crude division of world societies, it is clear that it captures large differences in population aging. Between 1950 and 2000, population aging progressed much more rapidly in more developed areas, and the difference between more and less developed was marked in 2000 (14.3% over age 65 years in more developed, compared to 5.1% in less developed). Between 2000 and 2050 it is anticipated that the proportion of old will nearly double in developed regions (to 26.8%) and triple in less developed regions (to 14.0%). In 2050 the less developed regions will have populations as old as developed regions had in 2000, and developed regions will have historically unprecedented proportions of their populations over age 65 years. But, as shown by the next comparison, there is great variation within both more and less developed regions.

AFRICA, ASIA, AND LATIN AMERICA. The pattern of population aging is very similar in Asia and Latin America over the 100 years between 1950 and 2050. In both regions, modest population aging occurred prior to 2000, but extremely rapid aging will occur

TABLE 5.4. Percent of Population Over Age 65 years and 80 years for the World and Selected Areas, 1950, 2000, and 2050.

	65 +			80 +		
Area	1950	2000	2050*	1950	2000	2050*
World	5.2	6.9	15.6	0.5	1.1	4.1
More developed countries	7.9	14.3	26.8	1.0	3.1	9.6
Less developed countries	3.9	5.1	14.0	0.3	0.7	3.3
Least developed countries	3.3	3.1	6.3	0.3	0.4	1.0
Africa	3.2	3.3	6.9	0.3	0.4	1.1
Asia	4.1	5.9	16.7	0.3	0.8	4.2
Europe	8.2	14.7	29.2	1.1	3.0	10.0
Latin America	3.7	5.4	16.9	0.4	0.9	4.1
Northern America	8.2	12.3	21.4	1.1	3.2	7.7
United States	8.3	12.3	21.1	1.1	3.2	7.6
China	4.5	6.9	22.7	0.3	0.9	6.8
France	11.4	16.0	26.7	1.7	3.7	10.4
Italy	8.3	18.1	35.9	1.1	3.9	14.1
Uganda	3.0	2.5	3.6	0.3	0.3	0.5

Source: United Nations 2002.
*"Medium projection" by The United Nations.

over the subsequent 50 years as the proportion of the population over age 65 years triples. The primary reason for anticipating rapid aging after 2000 is the sharp decline in birth rates that began in the last three decades of the 20th century in these regions. Before 1970 the total fertility rate in both Asia and Latin America was above 5.5, but by 1995 to 2000 it had fallen to just 2.7. Africa, in contrast, has yet to experience population aging, and only 3.3% of the population of Africa was over age 65 years in 2000. Birth rates in most of Africa remained high by world standards throughout the 20th century (the total fertility rate in Africa was 5.2 in 1995 to 2000), and life expectancy increased slowly compared to patterns in Asia and Latin America. With the HIV/AIDS epidemic in the 1990s, some African countries experienced large declines in life expectancy, and for the continent as a whole life expectancy was lower in 2000 than in 1990. Nevertheless, the United Nations population projections anticipate that Africa will experience a demographic transition in the 21st century, the total fertility declining to 2.4 by 2050. Under this scenario, the proportion of old in Africa's population will double between 2000 and 2050. However, the population of Africa in 2050 would still be younger than the population of the more developed regions was in 1950.

EUROPE AND NORTHERN AMERICA. In both Europe and Northern America the proportion of old in 1950 (8.2% over age 65 years) was about double what it had been in 1900. Significant population aging continued in both areas in the second half of the 20th century as fertility declined to replacement level or below and mortality declines among the elderly persisted. Because fertility in Europe was consistently lower than in any other continent over this time period, Europe had the oldest population of any region in 2000. Rapid population aging in both Northern America and Europe is expected to continue for some decades into the 21st century, with Europe becoming even more distinctive as having the oldest population of any region. By 2050, almost 30% of the population of Europe is expected to be older than 65 years.

SELECTED COUNTRY COMPARISONS. Table 5.4 contains data for five countries that are following distinctive patterns of population aging. France was characterized by relatively low fertility in the 19th century, and 7% of its population was over age 65 in 1865—the first time any country reached this level. Compared to countries where population aging started later, the process occurred slowly in France. It took 115 years, until 1980, for the proportion old in France to double to 14%. In Italy and Spain, where fertility decline began much later and then proceeded more rapidly than in France, it took only 45 years for the proportion old to double from 7% to 14%. An even more dramatic drop in fertility occurred in China, where the transition from 7% to 14% old is expected to take only 27 years (from 2000 to 2027).

Italy provides an example not only of a country with very rapid population aging, but also a country where fertility fell far below replacement level. The total fertility rate in Italy fell below 2.0 in the late 1970s, and then continued to decline to only 1.2 by 2000. As a result of this sustained low fertility, Italy had the oldest population of any country in 2000, with 18.1% over age 65 years. By 2050, the United Nations population shows about 36% of the population old in Italy, and this result depends on fertility increasing by 50% between 2000 and 2050. Should a fertility increase not occur in Italy, Italy's population would become even older than this United Nations projection.

If Italy has the oldest population of any country, the East African country of Uganda represents one of the youngest with only 2.5% over age 65 years in 2000. In fact, the proportion old in Uganda's population declined between 1950 and 2000. This "younging" of the population occurred because fertility remained at the same high level (total fertility rate over 7.0) over this time period, while the infant death rate declined by about 40% (from 160 to 90 per 1,000). Although the United Nations anticipates a significant decline in fertility and increase in life expectancy before 2050, the proportion old in Uganda is projected to increase to only 3.6% by 2050. The small number of older people expected in 2050 in Uganda is partially explained by the devastating effect of the AIDs epidemic on cohorts that will occupy the older age categories at that time (the cohorts in the young adult stage of life in the late 20th and early 21st centuries).

China had a larger absolute number of people over age 65 years in 2000 than any other country, and its lead in this category is expected to continue through 2050. At both dates, United Nations data show over one-fifth of the world's older population living in China. More significant for China than its absolute number of older people, however, is the extremely rapid pace of population aging that it will experience in the 21st century. In just 40 years, between 2000 and 2040, the proportion of the population over age 65 is expected to more than triple—from 6.8% to 21.8%. This dramatic shift in age composition is the result of the total fertility rate dropping from above 6 prior to 1970 to only 2.6 by the end of the 1970s, and then continuing to decline to below replacement level by 1990. In addition, declining mortality after 1965 is enabling most members of the large cohorts born in the two decades before 1970 to survive to old age. The demographic transition responsible for rapid population aging in China will also produce a marked shift in family composition, so that the older population in the future will have very few adult children compared to the historical situation (Zeng and George 2001).

UNITED STATES. The long-term trend of population aging in the United States (from 4% over age 65 years in 1900 to 20% by 2030), as in other countries, is a consequence of the long-term trend from high fertility and mortality to low fertility and mortality. But the pathway to an older population is not smooth in the United States. Because the older population grew more rapidly than the nonold population over most of the 20th century, the proportion of the population over age 65 years increased steadily. But this trend was reversed between 1990 and 2000, as the proportion over age 65 years declined slightly—from 12.6% to 12.4% (United States Bureau of the Census 2001b). Census Bureau projections show slight population aging occurring again between 2005 and 2010, followed by very rapid aging between 2010 and 2030, with the percent over age 65 years growing from 13.2% to 20.0% over these two decades (Day 1996). The explanation for this irregular pattern of population aging can be traced to the postwar baby boom that lasted from the mid-1940s to the mid-1960s, and the baby bust of the late 1960s and 1970s. The large fluctuations in the total fertility rate, from 2.1 in 1936 to 3.7 in 1957 to 1.7 in 1976, resulted in cohorts differing widely in size. As the relatively small cohorts born in the 1930s entered old age around 2000, population aging briefly ceased. Then, as the baby boom cohorts enter old age between 2010 and 2030, rapid population aging will occur. Finally, as the baby bust cohorts enter old age after 2030, population aging will again almost cease for several decades.

THEORETICAL ISSUES

Migration and Population Aging

In-migration and out-migration do not necessarily alter the age distribution of a population. If migration rates did not vary by age, and if migrants experienced the same fertility and mortality levels as the population of interest, then migration would affect the size of the population but not the age composition. However, migration rates almost always do vary with age. Out-migration from an area is predictably higher for young people than for older people. Although some exceptions may be found, the tendency of young adults to migrate at higher rates than older people generally has been true across time and across cultures (Bean et al. 1994; also see chapter 11 in this *Handbook*). Despite the age selectivity of migrants, both analytic and empirical studies of the effect of migration on population aging have shown that migration generally has only a small effect on the age composition of a population. Further insight into the link between migration and population aging is gained through examination of two situations: internal migration in the United States as it affects regional differences in age composition and "replacement migration" as a solution to population aging in developed countries.

MIGRATION AND POPULATION AGING IN THE UNITED STATES. At the state level, the proportion of the population over age 65 years in 2000 varied from a low of 5.7% in Alaska to a high of 17.6% in Florida. For the United States as a whole, 12.4% of the population was over age 65 in 2000. The extreme positions of these two states reflect their exceptional in-migration patterns—a disproportionate number of migrants to Alaska have been young and a disproportionate number to Florida have been old. Excluding the extremes, the proportion old in state populations ranged from 8.5% to 15.6%, and relatively clear patterns can be seen. All 14 states in which older people comprised less than 12% of the population were in the West and the South. Seven of the 10 oldest states were in the Northeast or Midwest. Why is it that although more old people move from colder to warmer climates than vice versa, the oldest regions are the Northeast and Midwest, and the youngest regions are the West and South?

The answer is that direction of migration is generally similar for older and younger people, and that the young are much more likely to move than the old. For example, between March of 1999 and March of 2000 someone aged 20 to 24 was eight times as likely to change place of residence as someone aged 65+ (35.2% versus 4.4%) (United States Bureau of the Census 2001a). Because of this age pattern of migration, states (or counties) in which out-migration exceeds in-migration over a sustained period of time have relatively old populations. Older people in these areas tend to "age in place," while a disproportionate number of younger people move out. In recent decades, the areas that have experienced substantial net out-migration have been concentrated in the farm states of the Midwest and the declining industrial states of the Northeast. These two regions, as noted above, are the regions with the highest concentration of older people. Using this reasoning, one should anticipate that areas with substantial net in-migration would tend to have relatively young populations. This is the general pattern and accounts for the below-average proportion old in the Sunbelt (which has gained population through migration in recent decades). Florida is simply an exception to this pattern—it has been such a magnet for older retirees moving out of the Northeast that its in-migration rate for older people has exceeded that of younger people.

Moving to areas smaller than states, even greater variations in age composition can be observed. Some counties might be classified as "gerontic enclaves." In two counties (one in Florida and one in North Dakota), over one-third of the population was over age 65 in 2000, and there were 57 counties in which over one-fourth of the population is old. Half of these very old counties were in Florida (reflecting a large in-migration of retirees) and in South Dakota and North Dakota (reflecting the large out-migration of young adults).

REPLACEMENT MIGRATION. It was noted above that, within usual boundaries, immigration tends to have only a small long-term effect on a population's age distribution. It is useful, nevertheless, to see what volume of migration would be required to counter the population aging anticipated in developed countries. The United Nations (2000) provides this type of information for several countries and regions in a report titled *Replacement Migration: Is it a Solution to Declining and Ageing Populations*. Because the motivating concern for this report is the increased future burden on the working population to support the growing older, dependent population, the population indicator of interest in this report is the potential support ratio (PSR). The PSR is defined simply as the population aged 15 to 64 years divided by the population aged 65+ years. The basic question involves the relationship between PSRs in 2050 and alternative scenarios regarding the annual number of net migrants entering each population between 1995 and 2050. The analysis involves a straightforward comparison of the age distribution (PSR) resulting from projecting various populations using alternative assumptions regarding net immigration.

The results of this study are summarized in Table 5.5, where outcomes of several alternative population projections are reported for Japan, the European Union, and the United States (results for France, Germany, Italy, Republic of Korea, Russian Federation, United Kingdom, and Europe are also included in the United Nations report). For each country there is baseline information about the PSR in 1950 and 1995; then selected outcomes in 2050 are shown for each of four alternative projections. Each projection uses the medium variant fertility and mortality assumptions used in the standard United Nations population projections. The four migration alternatives are as follow: (1) migration as assumed in the medium variant projection, (2) zero migration, (3) migration required to keep PSR from falling below 3.0 before 2050, (4) migration required to keep PSR at the 2000 level. The outcomes for each projection are PSR in 2050, average annual number of migrants between 2000 and 2050, percent of the 2050 population that is comprised of post-2000 immigrants and their descendants, and the ratio of the population size in 2050 to that in 2000.

The PSR in Japan declined from 12 to 4 between 1950 and 2000 and is projected to decline further to 1.7 in 2050 under the medium assumptions of future demographic behavior. For Japan, where it is assumed that no migration will occur, the medium projection results in a population in 2050 that is almost 20% smaller than the population in 2000 and is unaffected by non-Japanese immigrants. If immigration were used to prevent the PSR from falling below 3.0, Japan would need to admit an average of nearly two million immigrants per year, and by 2050, 30% of the population would be of non-Japanese origin. The fourth scenario, maintaining the same PSR as 1995, shows that a

TABLE 5.5. Population Indicator for Japan, European Union, and the United States in 2050 Under Alternative Demographic Scenarios

Country & Indictor	1950	2000	2050[5]			
			Proj.1	Proj.2	Proj.3	Proj.4
Japan						
1. PSR[1]	12.1	4.0	1.7	1.7	3.0	4.8
2. Ave. Immig.[2]			0	0	1,897	10,471
3. % Immig.[3]			0	0	54.2	87.2
4. Pop. Incr.[4]			0.83	0.83	1.81	6.46
Unites States						
1. PSR[1]	7.8	5.3	2.8	2.6	3.0	5.2
2. Ave. immig.[2]			760	0	816	10,777
3. % immig.[3]			16.8	0	17.4	72.7
4. Pop. incr.[4]			1.25	1.04	1.26	3.83
European Union						
1. PSR[1]	7.0	4.1	2.0	1.9	3.0	4.3
2. Ave. immig.[2]			270	0	3,073	13,480
3. % immig.[3]			6.2	0	40.2	74.7
4. Pop. incr.[4]			0.88	0.83	1.39	3.27

Source: United Nations 2000.
[1] PSR = Potential Support Ratio ($^{\text{pop. 15-64}}/_{\text{pop. 65+}}$)
[2] Ave. immig. = Average annual volume of immigration in 1,000s, 2000–2050.
[3] % Immig. = Percent of population composed of post-2000 immigrants and their descendants.
[4] Pop. incr. = Ratio of total population to total population in 2000.
[5] Proj. 1 – Median variant
Proj. 2 – Median variant, except zero migration
Proj. 3 – Maintain PSR of 3.0
Proj. 4 – Maintain PSR existing in 1995

strategy for eliminating population aging through immigration is totally unrealistic. Preventing further population aging after 1995 through replacement migration would lead to a population in 2050 that was eight times larger than the 1995 population, and one in which 80% were non-Japanese.

Results of similar analyses for the European Union and the United States are shown in Table 5.5. In both cases, it is surprising how little difference the effect of anticipated migration has on population aging compared to a scenario of zero immigration. Also, in both cases the level of future immigration required to prevent any population aging after 1995 is wholly unrealistic, as was the case for Japan. The cost of trying to stop population aging via immigration would be a tremendous increase in population density and a transformation of the culture as most residents would be first- or second-generation immigrants. And, because populations cannot indefinitely grow at a rapid pace, this "solution" would only postpone the ultimate need to adapt to an older population. Because the United States is expected to maintain near-replacement-level fertility over the 21st century, the medium projection shows a PSR only slightly below 3.0 in 2050, so maintaining a PSR of 3.0 would require an average immigration level only 20% greater than the expected one. In contrast, the European Union would need an annual level of immigration three times greater than that occurring around 2000 to prevent the PSR from slipping below 3.0.

Efforts to use replacement migration to prevent population aging are not likely to gain significant political support. Greatly increasing the volume of immigration to developed countries would generate concerns about environmental consequences of population growth and cultural challenges of large immigrant populations (Grant 2001; Meyerson 2001). Furthermore, as shown by the study of replacement migration, the magnitude of immigration required to significantly alter future patterns of population aging is staggering. It seems that any country with low fertility and mortality must anticipate a future population that will be far older than any that have existed previously. This is not, of course, equivalent to saying that the social and economic challenges of an older population constitute a crisis. For perspective, it should be noted that the well-being of the older population increased remarkably between 1950 and 2000 as PSRs declined to unprecedented lows in developed countries (see Table 5.5).

Public Pension Programs

Almost all industrialized countries have established public pension programs that collect taxes from the current working population, often levied as a payroll tax, to provide benefits to the current retired population. An example of this approach is the Social Security program in the United States. This type of pension system is referred to as an unfunded pay-as-you-go (PAYG) pension, reflecting the fact that the contributions of current workers are not being invested in assets to be used to finance their own retirement. Rather, the current generation of workers is supporting current retirees, and the current generation will be dependent on contributions of future generations to support them in their old age. As currently designed, PAYG public pension programs in Europe, North America, and Japan will need to be altered significantly in order to achieve fiscal sustainability in coming decades (Disney 2000; World Bank 1994). An important reason why projections show that PAYG public pensions are headed toward fiscal imbalance is population aging.

The effect of population aging on PAYG pension systems is rather obvious, as can be seen by looking at the ratio of workers to pension beneficiaries. As a population ages, there is a decline in the relative number of workers available to support the expanding proportion of the population that is retired. The projected decrease in the support ratio over the first several decades of the 21st century is large for every developed country (see Table 5.5), creating fiscal imbalances in almost every public pension system. The challenge is greatest for nations that have the lowest projected support ratios (countries such as Japan and Italy), but is also substantial for the United States.

Problems in the long-term stability of PAYG pension systems as the demographic transition reached maturity might have been anticipated in their initial formulations (Disney 2000), but other developments have complicated the situation. First, across all developed countries the labor force participation rate of older men declined in the second half of the 20th century. Of course a major explanation for men leaving the labor force at younger ages over this time period was the growing availability of pensions (Wise 1997). The result, nevertheless, was to further reduce support ratios. Second, population forecasts available to those designing the major national pension schemes seriously underestimated the future decline in both death rates among the old and fertility rates among women. Consequently the pension programs as initially formulated did not anticipate the speed and extent of subsequent population aging. Third, for political reasons the generosity of pension benefits increased over time. Thus it is population aging, in combination with these other factors, that is forcing policy makers to decide among alternative reform options to stabilize public pensions in the near future.

Two basically different approaches to reforming public pensions are being debated (Disney 2000). The less radical approach, referred to as "parametric" reform (Chand and Jaeger 1996), argues that unfunded PAYG schemes can be brought into equilibrium by making changes in a few parameters. More money available for paying pension benefits could come from either increasing taxes on the workers or by increasing the proportion of the working age population that participates in the labor force. Pension expenditures could be reduced by decreasing benefits, either by directly cutting benefits or by increasing age for pension eligibility. The approach of increasing normal retirement age has received support from some demographers who point out that that increasing life expectancy and improving health of cohorts entering old age make a fixed retirement age (such as 60 or 65) increasingly obsolete (Chen 1994; Uhlenberg 1988). The general view of those favoring parametric reform is that by making moderate changes in several of the parameters (payroll tax, eligibility age, cost of living adjustment, means testing), existing public pension systems could be maintained as unfunded PAYG programs despite population aging (Kingson and Williamson 2001; Williamson 1997).

The alternative proposal argues that rather than "fixing" the existing programs, the required long-term solution is to move from unfunded to funded pensions. This approach is referred to as "paradigmatic" reform because it calls for a fundamental change away from the PAYG system. In a funded pension program the money collected from current workers and/or employers is invested in private sector equity markets (stocks, bonds), and these investment accounts are used to pay retiree benefits. This capital reserve–financing system could be operated as a public pension program. In the United States, for example, this would mean that the balance of funds in the Social Security Trust Fund would be invested in capital markets rather than in government bonds. Most often, however, plans for moving to funded pension plans expect that the transition would involve privatizing social security with a system of individual–based accounts. The most cited example of a country moving to a privatized social security plan is Chile (Edwards 1998), but there also are examples of partial privatization in several European countries (Feldstein and Siebert 2002).

The key difference between the two pension plans is that in a PAYG program retirees are dependent on current workers to support them, whereas in a funded program each generation funds its own retirement by accumulating capital. The relevance of this debate to population aging is obvious: population aging does not threaten the fiscal sustainability of funded pension plans. Other potential advantages of reforming public pension programs by moving to funded systems are often noted, such as the higher expected real rate of return on contributions and the contribution to development of financial markets (World Bank 1994). On the other hand, there are strong critics of paradigmatic pension reform who argue that this solution involves unfair transition costs, creates increasing inequality and greater individual risk, and threatens the viability of intergenerational solidarity in society (Walker 1999; Williamson 1997). Not surprisingly, many analysts suggest that a compromise of partial privatization of social security is a reasonable way to achieve the reform of public pensions required by population aging (Boldrin et al.1999).

Health and Health Care

Over the past two centuries all developed countries have experienced an epidemiological transition characterized by declining death rates and shifting cause-of-death patterns.

Before this transition most people died of infectious diseases (smallpox, scarlet fever, tuberculosis, influenza, and pneumonia, etc.), which affected all ages. The young were especially vulnerable, and most people did not survive to old age (Caldwell 2001; Riley 2001). With the conquest of infectious diseases, mortality is concentrated in the older ages, and the primary causes of death are chronic degenerative diseases (heart disease, cardiovascular disease, and cancer). Therefore, population aging may have significant implications for population health, as a growing proportion of the total population is comprised of older people with chronic diseases. Growth in the prevalence of chronic disease in a population raises concerns about declining vitality of its members, the overall burden of care for those with physical and cognitive limitations, and the health care costs to society. For example, the health care cost per capita is three to five times greater for the population over age 65 than for the population under age 65 in developed countries (CDC 2003).

In addition to possible effects of population aging on the burden of disease, it is also important to consider the impact of the aging of the older population. Aging of the older population can be measured as changes in the proportion of its members over age 80 or 85. At the global level around year 2000, the average annual growth rate of persons aged 80 and older was three times greater than the growth rate of the total population, and twice as high as the growth rate of the population over age 60 (United Nations 2001). Consequently, in the late 20th and early 21st centuries an increasing proportion of the total population and of the older population is in the "very old" category. The proportion of the elderly population in Europe that is 80 years and older is expected to grow from 20% in 2000 to over 35% by 2050, and 40% of Japan's elderly population is projected to be 80 years and older by 2030 (National Research Council 2001). In the United States, the proportion of the older population aged 85 and older is expected to double between 2000 and 2050, increasing from 12.6% to 23.6% (Federal Interagency Forum on Aging Related Statistics 2000).

The aging of the older population is significant for the health burden in a population because rates of disability and dependency increase rapidly at very old ages. Examples of differences in health problems and health costs for different segments of the older population in the United States are shown in Table 5.6. The contrast between the "youngest-old" (65 to 69) and the "oldest-old" (85+) tend to be striking. For example, compared to the youngest-old, the oldest-old are 16 times more likely to reside in nursing homes and 12 times more likely to have severe memory loss. Average per capita health care expenditures in 1999 increased from $6,711 for those aged 65 to 69 to $16,596 for those aged 85 or older. Thus one might anticipate that the challenge to provide adequate health care would grow in societies that are experiencing both population aging and aging of their older population. Indeed, assuming no future changes in age-specific rates of Alzheimer's disease and functional disabilities leads to alarming conclusions about the burden of disease and suggests that societies may become "global nursing homes" (Eberstadt 1997), where severe age-based health care rationing is inevitable (Peterson 1999).

In discussing the future of population health and health care expenditures, however, some writers argue that "demography is not destiny" (National Academy on an Aging Society 1999) and warn against alarmist forecasts based simply on demographic forces (Gee and Gutman 2000). The point of these arguments is that as a population ages, the composition and characteristics of the elderly population also are likely to change and the social policies and technology affecting the delivery of health care can change. Therefore,

Table 5.6. Health Indicators for the United States Older Population Around Year 2000, by Age.

Indicator	Age 65–69	70–74	75–79	80–84	85 +
Average per capita health expenditures (1998 $)	6,711	8,099	9,241	10,683	16,596
Nursing home	1.1*			4.3**	18.3
Severe memory impairment (%)	1.1	2.5	4.5	6.4**	12.9
Needing assistance (%)	8.1	10.5	16.9	34.9***	

Sources: Federal Interagency Forum on Aging Related Statistics 2000.
*Age category is 65–74.
**Age category is 75–84.
***Age category is 80+.

one cannot accurately forecast future health conditions and costs by assuming that the only thing that will change over time is the population age composition. One important source of support for this position is research in the United States that has found significant changes in age-specific disability rates among the elderly since 1990.

A widely debated research question related to increasing life expectancy has been whether the years added to life past age 65 are years lived with or without major disabilities. If extending life increases the burden of disease in a population by lengthening the time between onset of chronic disease and death, then population aging is likely to entail large increases in health expenditures. On the other hand, if the added years of life are disability-free years, population aging does not necessarily have a negative effect population health. An analysis of the empirical research on this topic conducted since 1990 finds strong support for the conclusion that there was a decline in prevalence of age-specific functional limitations among older Americans after 1982 (when reliable data were first collected) (Freedman, Martin, and Schoeni 2002). The most ambitious of these studies reports that rates of disability declined by 1.7% annually between 1982 and 1999 (Manton and Gu 2001). There is also evidence that severe cognitive impairments have been declining (Freedman, Aykan, and Martin 2001). Part of the explanation for these positive trends is that educational levels of older adults have been improving, and higher levels of education are associated with better physical and cognitive health (Freedman and Martin 1999). Further, it is clear that there remain significant aspects of lifestyle associated with disease and disability (smoking, obesity, exercise) where substantial improvement is possible for those who will reach old age in the future. In other words, it is possible that the potential increase in burden of disease associated with population aging could be averted, or partially averted, if trends toward increasing duration of disability-free aging past age 65 years continue.

Although it seems common sense to expect that population aging will result in higher societal per capita expenditures on health care, two types of research suggest that age structure is not an important determinant of health care spending. First, comparing per capita health care spending across a number of developed countries fails to find a statistically significant effect of demographic factors. Despite wide variations in both per capita health care spending and proportion old in the population across the 30 countries in the Organization for Economic Cooperation and Development (OECD), there is little relationship between the two (Reinhardt et al. 2002). Most striking is the United States, where the proportion of the population above age 65 is small relative to the OECD average, but per capita health spending was 134% higher than the OECD median in 2000 (Anderson et al. 2003). Despite the relatively high cost of health care in the United States, there is no evidence that Americans have better health or even utilize more health care services than the OECD median (Anderson et al. 2003). Second, population aging is estimated to contribute little to the projected growth of total spending on personal health in the United States or Canada in coming decades (Burner, Waldo, and McKusick 1992; Gee and Gutman 2000; Reinhardt 2003). These studies conclude that health care spending in the future is likely to be determined more by medical technology, health policy, and the organization of health care services than by population age structure.

Population Aging and Kinship Structure

The demographic forces responsible for population aging (declining fertility and declining mortality at older ages) have significant implications for the structure of kinship networks. Particularly relevant for the well-being of both older and younger people are changes in the structure of intergenerational relationships associated with an aging society. The basic relationship among fertility, mortality, and supply of intergenerational kin can be seen by thinking about extreme situations. In a society where everyone has a large number of children and few people survive to very old ages, grandparents would be in short supply for children, but individuals who survive to old age would tend to have many grandchildren. Similarly, most middle-aged adults would not have surviving parents, but individuals who survive to old age would typically have multiple children. This type of kinship structure is quite similar to the one existing in China before 1900. At the opposite extreme is the ideal expressed in contemporary Chinese society, where women would have only one child each and most adults survive past age 70 years. Under these conditions, children would have no siblings or cousins and would have the undivided attention of two sets of grandparents. Older people, however, would have a short supply of grandchildren, being forced to share their one grandchild with a competing set of grandparents. The parent-child relationship in later life in a low-mortality, one-child family society would be characterized by middle-aged adults having surviving parents who have no other child to depend upon for support. Although the above scenario is idealized, it correctly identifies the direction of change in intergenerational relationships that occurs as populations age.

The family and kinship implications of rapid population aging in Japan, China, and South Korea have received some attention (Jiang 1995; Martin 1990; Zeng and George 2001). In these countries, as well as in other Asian countries, the long tradition of elderly people coresiding with an adult child is being challenged by population aging. In Japan, for example, the proportion of people over age 65 who live with a child declined from 77% in 1970 to 52% in 1991 (Brown et al. 2002; Martin 1990). In countries where adult children have provided most of the care for dependent older people, the changing supply of children challenges existing caregiving arrangements. The average number of children available to provide care for parents aged 65 to 69 in urban areas of China will decline from 3.1 in 1990 to only 1.1 in 2030 (Jiang 1995). Changing intergenerational relationships related to population aging are also occurring in the United States and Europe.

PARENT-CHILD RELATIONSHIPS. An aspect of the parent-child relationship that has received a great deal of research attention is the care that adult children provide for their aging parents who experience disabilities. It is now well established that adult children, especially daughters, provide a substantial proportion of the care required by older people with functional limitations (Rein and Salzman 1995; Stone 2000). Data from the 1993 study of Assets and Health Dynamics show that the largest category of caregivers for older people with limitations in activities of daily living in the United States is adult children, who comprise 42% of the total (spouses provide 25%) (Shirey and Summer 2000). The economic value of informal caregiving in the United States in 1997 was estimated to be 1.7 times the total national spending for paid home care and nursing home care (Arno, Levine, and Memmott 1999). This pattern of adult children providing much of the care required by their elderly parents is found across many, if not all, societies currently experiencing rapid population aging (Pickard et al. 2000; Schofield and Bloch 1998; Traphagan and Knight 2003). Thus changes in the supply of adult children available to provide informal care for the disabled older population have potentially significant social and economic implications for aging societies.

From the perspective of older people, the average number of living adult children was substantially smaller in 2000 than in 1900. For example, women around age 70 years in the United States had an average of more than five children each in 1900, compared to three in 2000 (Downs 2003; United States Bureau of the Census 1976). In terms of risk of not receiving caregiving from adult children, however, changes in average number of children is not as significant as changes in the proportion of old people who are childless or have only one child (Uhlenberg 1993). By this indicator, older people in the early 21st century are relatively advantaged, but conditions will be much less favorable by 2030. In the United States the average number of living children for people aged 70 to 85 years will fall below two by 2030 and the proportion who are childless will nearly double (Downs 2003; Wachter 1997). In Italy, microsimulation projections show mean number of children for women aged 75 to 84 years falling from 2.1 in 1994 to only 1.4 in 2050, and one-fourth of the older women in 2050 are expected to be childless (Tomassini and Wolf 2000). Similar decreases in the supply of adult children will occur in all aging societies, suggesting that informal care may play a smaller part in meeting the health care needs of the elderly in the future.

Wachter (1997) suggests that a growth in number of stepchildren might partially reduce the consequences of a declining number of biological children for older people. However, evidence thus far does not indicate that stepchildren provide the same level of care as biological children, and presence of a stepparent may have a negative effect on the child-parent relationship (Lye et al.1995; White 1994). One study finds partial empirical support for Wachter's hypothesis that remarriage, by generating more diverse kin ties, expands perceptions of total kinship support among the elderly, but it concludes:

> Since more people in the population are not marrying (or marrying later), and since more people divorce than remarry, it is hard to imagine that the next several cohorts of elderly people will be better off than the current cohort in terms of perceived social support from extended kin. The marital status changes are especially problematic for women... (Curran et al. 2003:188).

Concern over future shifts in the ratio of adult daughters to older people does not focus only on the needs of older people. There is also a large literature on the burden that caring for parents places on middle-aged women (Schulz et al. 1990). Decreasing death rates among adults lead to an increasing likelihood over time that middle-aged women will have parents who are still living. Under fertility and mortality conditions existing in the late 20th century, a person could expect to spend more years living with parents over age 65 than with dependent children under age 18 (Watkins, Menken, and Bongaarts 1987). A trend toward an increasing number of years lived with a cosurviving old parent will continue if, as expected, death rates at older ages continue to decline. But when women born after the baby boom reach age 50 years, beginning around 2020, they will have significantly fewer siblings to share the task of caring for their parents, who will be living longer. Other social changes are expected to further increase the burden of caregiving for these women. A growing proportion of middle-aged women are expected to have careers that compete with caregiving for their time and energy (Doty, Jackson, and Crown 1998; Pavalko and Artis 1997), and a growing proportion will be divorced (Uhlenberg 1994). Also, a growing proportion of their older parents will be divorced and consequently will not have access to caregiving that a spouse might provide (Evandrou and Falkingham 2000). If current patterns of children providing informal care for their aging parents continue, the burden of caregiving among middle-aged women might be expected to increase significantly.

GRANDPARENT-GRANDCHILD RELATIONSHIPS. Changes in the structure of grandparent-grandchild relationships in the United States associated with population aging over the 20th century have been studied (Uhlenberg and Kirby 1998; Uhlenberg 2005). In examining the effects of demographic change on this relationship, it is important to be clear regarding whose perspective is being taken. Declining adult mortality increased the supply of grandparents for children and young adults, while declining infant and child mortality affected the supply of grandchildren for older people. Decreasing fertility reduced the number of grandchildren for older people, while for young people it reduced the number of siblings and cousins who might compete for a grandparent's attention. Although the direction of these changes is obvious, the magnitude and timing of structural changes in grandparent-grandchild relations requires empirical investigation.

The declining death rates occurring throughout the 20th century meant that an ever-increasing proportion of those who bore children would survive long enough to experience the birth of grandchildren and great grandchildren. For example, the proportion of women that would survive from age 25 years to age 80 years under mortality conditions existing in 1900 was only 19%, compared to 59% under conditions existing in 2000. The proportion surviving between these ages is expected to continue to increase over the 21st century, reaching 70% by 2050 (Bell and Miller 2002). This remarkable mortality revolution produces large changes over time in the supply of grandparents. For example, the proportion of 10-year-olds with all four grandparents alive increased from about 6% in 1900 to 41% in 2000 and is projected to be 48% by 2020 (Uhlenberg 2005). Even more impressive was the increase in number of living grandparents among young adults. Based on estimates using life tables, the proportion of 30-year-olds with a grandparent alive more than tripled between 1900 and 2000—from 21% to 75%, and should grow to 82% by 2020 (Uhlenberg 2005). Thus, in an aging population, children grow up with access to an increasing number of grandparents, and most young adults will have grandparents living when they bear children.

The number of sets of grandchildren that an older person has is equal to the number of his or her children who have produced children. Thus in a society where low fertility has persisted over several generations, old people will have far fewer sets of grandchildren than in a high-fertility society. The transition to older people typically having few sets of grandchildren is not necessarily monotonic, however, as changes in the distribution of women in the United States aged 60 to 64 years by number of grandchild sets shows (Uhlenberg 2005). The baby boom and subsequent baby bust greatly affected the supply of grandchildren for people in different cohorts as they approached old age. Women aged 60 to 64 in 2000, who became mothers during the baby boom, had low rates (around 13%) of grandchildlessness, and 38% had three or more sets of grandchildren. Thus in the United States there was an increasing supply of grandchildren between 1950 and 2000, despite the aging of the population. By 2020, however, the proportion of older adults who are grandchildless will increase to 22%, and the proportion with more than two sets of grandchildren will be cut in half. After this date, the proportion of older people with more than two sets of grandchildren will remain low and probably decline further, unless there is a future increase in fertility. In Europe and Japan, where fertility has been much lower than in the United States, the supply of grandchildren for older people will be considerably smaller than in the United States. Unless there is drastic future decrease in the amount of time and energy that grandparents invest in grandchildren, children in aging societies will receive increasing attention from grandparents.

MEASURES AND METHODS

Measures

There are three basic approaches to measuring the age structure of a population. The most common measure, and the one most used in this chapter, is simply proportion of the total population that is over a fixed chronological age, usually 60 or 65 years. Although there is no chronological age that marks a universal transition in physical or social condition, social programs often use age 60 or 65 years as a criterion for entitlement. This measure provides a straightforward way to compare the relative number of older people in populations across time or across societies.

A second commonly used measure is the median age of a population—the age that divides the population into equal numbers of younger and older people. This measure does not focus specifically on the older population, but rather tracks broad patterns of population aging. In general, the indicators *percent old* and *median age* tell the same story about population aging, but they do not always move in the same direction over a short time period. For example, the aging of particularly small or large cohorts across certain age markers may produce unusually small or large changes in percent old over a short time period, while median age is changing quite smoothly. A good example of this is the aging of baby boom cohorts in the United States, in combination with the aging of the smaller cohorts that preceded and followed them. Between 1990 and 2000 the median age of the U.S. population increased from 32.8 to 35.3 years, but the percent over 65 declined slightly, from 12.6% to 12.4%. Over this time period the large baby boom cohorts grew older, but it was the relatively small cohorts born before the baby boom that entered old age. Between 2010 and 2030 the median will continue its gradual upward movement, going from 37.4 to 39.0 years, but the percent old will increase dramatically, from 13.2% to 20.0%, as baby boomers pass age 65 years.

The third measure of age distribution is the ratio of the size of two age categories. Measures of this type are used to focus on shifts in the age composition that are considered to have particular economic or social significance. Examples of these measures include the old age dependency ratio, the potential support ratio, and the aging index. The old age dependency ratio (population aged 65+ years/population aged 20 to 64 years) provides a rough index of the relative size of the retired population to the working-age population. Obviously this is only a crude indicator of the relative size of these two categories, because not all adults below age 65 years are in the labor force and not all over age 65 years are retired. The same issue of dependency of older people sometimes is discussed using the potential support ratio, which is simply the inverse of the old-age dependency ratio. The potential support ratio is useful to provide general audiences with a sense of the change that population aging produces in the number of workers available to support each older person. For example, this measure can be used to show the dramatic implications of population aging in Japan, where the potential support ratio is expected to drop from 12.1 in 1950 to 1.7 in 2050 (see Table 5.5). The aging index—(population aged 65+ years/population aged 0 to 14 years) X 100—is used to dramatize the shifting balance of young and old in populations that are aging. South Korea, where the aging index goes from 32 to 125 between 2000 and 2030, illustrates a country rapidly changing from one where children greatly outnumber old people to one where old outnumber young (Kinsella and Velkoff 2001).

PROJECTION UNCERTAINTIES. The basic methods used to study determinants of population aging—the stable population model and population projections—are discussed at the beginning of this chapter. However, there is an issue related to the uncertainty of forecasts based on population projections that merits closer attention. A great deal of interest in the future financing of pensions and health care concerns the anticipated changes in the old-age dependency ratio. But how much confidence should be placed in the forecasts provided by the United Nations or the United States Census Bureau regarding future trends in population aging?

Demographers have given a great deal of attention in recent years to the accuracy of past population forecasts and to ways of improving forecasts (e.g., Lutz, Vaupel, and Ahlburg 1998; National Research Council 2000). These studies find that forecasting errors of 15% or more are common when predicting the size of the very old population in industrialized countries 15 years into the future (Keilman 1997). One thing learned from reviewing the errors in past forecasts, particularly with respect to the size of the older population, has been a tendency of demographers to underestimate future declines in adult mortality. Based on the argument that past gains in life expectancy could not be sustained once the unrepeatable transition to low infant and child mortality occurred, conventional wisdom suggested that life expectancy in the future would grow slowly as it approached a biological maximum (Olshansky and Carnes 2001). But an important study shows that maximum life expectancy in developed countries has been increasing at a steady rate of about 2.4 years per decade since 1840 (Oeppen and Vaupel 2002), and another study found a quite steady average increase of 2.1 years per decade for 21 industrialized countries between 1955 and 1995 (White 2002). Although past trends do not necessarily predict future trends, these findings suggest the possibility of life expectancy exceeding 100 by 2100. Should this level of mortality decline persist, populations in the future could be far older than any of the scenarios offered by existing official forecasts.

But it is not only future mortality trends that will determine future population age distributions. There is uncertainty regarding future fertility rates. The extremely low fertility experienced in Spain, Italy, and Japan at the beginning of the 21st century could rebound to replacement level or above, stay steady, or decline further (Vallin 2002). Future levels of international migration, dependent on economic, social, and political factors, are certainly unknown. Thus the future of population aging is really not known. The problem of uncertainty in forecasts is not large in the short-term but becomes greater the further the horizon of the forecast. Over 20 or 30 years, scenarios based on different plausible assumptions of vital rates do not differ greatly. However, when forecasts are made of conditions 50 or 100 years into the future, the results diverge so much that they are useless for planning. For example, using a probabilistic projection technique, one study provided confidence intervals for its projection of the proportion of Western Europe's population that would be over age 80 years in the future. It concluded, with 95% confidence, that between 3% and 43% would be aged 80+ years in 2100 (O'Neill and Lutz 2003). This level of uncertainty indicates that demographers do not have methods that provide meaningful answers to questions about long-term population patterns. Population experts may consider some scenarios as highly unlikely, but their past record of anticipating large changes is weak. Demographers did not predict the baby boom, nor did they predict that total fertility rates in some countries would fall below 1.2.

FUTURE RESEARCH DIRECTIONS

The ways in which fertility, mortality, and migration determine the pattern of population aging are well understood by demographers, but there are many opportunities for researchers to expand understanding of the social, economic, political, and health implications of population aging. A growing number of researchers from multiple disciplines and many countries are engaged in exploring diverse aspects of global population aging. Recognizing the value of coordinating some of the research on this topic, the National Research Council of the National Academy of Sciences commissioned a panel to examine existing data and knowledge regarding global population aging with the goal of identifying critical areas for future research. Results of this study were published in 2001 (National Research Council 2001), and these results guide much of the discussion on future research directions that follows.

First, there is an opportunity to expand multidisciplinary work that examines connections across domains. Currently there is a tendency for demographers to focus on population projections, sociologists to focus on family and kin ties, economists to focus on pension and work issues, and epidemiologists to focus on health and disability issues. But each of these domains is linked to the others, and none can adequately be understood in isolation from the others. By working together on research design, investigators from these various disciplines can develop measures and coordinate data collection so that linkages across domains can be studied. One goal would be that policy recommendations could reflect a more complete understanding of population aging that comes from recognizing that the experience of aging is multifaceted.

Second, there is growing recognition in the social sciences of the need to collect longitudinal microdata to improve our understanding of causal mechanisms. Nowhere is the need for these types of data greater than in the field of aging. Cross-sectional data are notoriously weak for drawing conclusions about aging because different age categories at a point in time represent different cohorts. A panel study with repeated observations over time is more useful for studying the dynamics of aging over the life course. But to be most useful, a panel study needs to continuously add new cohorts at the bottom in order to track how the experience of aging changes over time. This approach to data collection is both expensive and necessary for advances in research to match advances in conceptualization.

Third, the harmonization of research across countries has the potential of greatly expanding our understanding of aging. There is substantial variation across countries in population aging, welfare policies, family systems, health care organization, economic conditions, etc. These cross-country variations in societal and population conditions provide the possibility for exploring the consequences of aging in different macro contexts. For this possibility to be realized, multinational research teams might be assembled to standardize, or at least harmonize, data collected in multiple countries.

Fourth, existing computer technology is making it increasingly possible to create databases that link information from multiple sources. For example, data from administrative health records and social security files can be linked with survey information to provide a wealth of longitudinal information on individuals. In addition, geographical information on neighborhood and regional context could be added to individual records to allow cross-level analyses. It is clear that individuals do not age in isolation, but as members of households, communities, regions, and countries. Ethical concerns about assembling large and complex data files on individuals are obviously significant, but the potential availability of these types of data excites the research imagination.

A final note on directions of research concerns theoretical advances. If population aging progresses as expected, more than 30% of the population in some countries (Japan and Italy, for example) will be older than 65 years by 2050, and all developed countries will have an unprecedented proportion of old people. Assuming no changes in technology and social organization, one must conclude that this dramatic population aging would produce huge problems. Using the same logic, alarmists in the 1960s made forecasts of impending disasters that would result from rapid population growth. The point is, of course, that ‘‘other things’’ do not remain constant. Social organization changes in response to challenges. New technology alters the relationship between humans and the environment. Demographic behavior of people changes over time in response to changing social conditions. A challenge for researchers is to develop a better theoretical understanding of how societies adapt to changing social and demographic conditions. In particular, in what ways might societies change as their populations grow increasingly old?

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