VITAL AND HEALTH STATISTICS

Changing Mortality Patterns, Health Services Utilization, and Health Care Expenditures:
United States, 1978–2003

The projected effect of changes in mortality patterns on the future population size and population age distribution is examined. An assumption of declining mortality trends implies an increased aging of the population. The potential effects of an aging population on health care use and expenditures are examined.

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Foreword

This report is an outgrowth of a paper entitled "Projection and analysis of health status trends" presented by Dorothy P. Rice at the 1978 meeting of the American Public Health Association.

The purpose of this report is to examine in detail how two alternative mortality assumptions, projected to the year 2003, affect estimates of health care utilization and expenditures in the future. The first is that mortality levels by age, as of 1976, remain constant. The second is that recent declining trends, as experienced from 1966 to 1976, are sustained. These illustrative projections of mortality are based on historic trends and patterns, and they represent limits of what may be reasonably expected to occur in future years. It is unlikely that either projection will be realized. The future course, at least as it relates to demographic patterns, will probably lie somewhere within the bounds set by these projections. However, they do serve to illuminate the relationships among demographic trends, the use of health care, and medical care expenditures.

Significant long-term effects on the age distribution of the population will occur even if age-specific mortality rates remain constant between 1978 and 2003. More dramatic demographic changes will be evident if mortality declines at the rate experienced during the period 1966–76. In turn, these demographic changes will have a significant effect on the use of health services and expenditures for health care. These projections do not anticipate future trends in other factors that influence utilization of health services, such as changes in therapies. They do reveal, however, that, whatever else happens, the projected changes in the size and age distribution of the population alone would produce substantial increases in the number of people with chronic health problems and their above-average use of medical care.

Special thanks are extended to Bruce Sobus, Office of the Actuary, Social Security Administration, for providing life tables and population projections; to Professor Herbert Klarman, New York University, for reviewing and commenting on the content of the report; and to Dr. Jacob Feldman for valuable conceptual contributions to the paper.

Manning Feinleib
Director

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Symbols

- - -	Data not available
. . .	Category not applicable
-	Quantity zero
0.0	Quantity more than zero but less than 0.05
Z	Quantity more than zero but less than 500 where numbers are rounded to thousands
*	Figure does not meet standards of reliability or precision
#	Figure suppressed to comply with confidentiality requirements

Changing Mortality Patterns, Health Services Utilization, and Health Care Expenditures

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Chapter 1 Introduction

The future demographic composition of population in the Nation, State, or local area is of great concern to health planners, policy analysts, and individual institutions planning to serve their communities. In particular, the future size and age distribution has implications for the use of health services and related expenditures. This report provides projections of future population size and age distributions for the country as a whole and examines their possible effects on health care use and expenditures.

Predicting demographic change is, by its nature, an uncertain exercise. Much depends on whether past trends continue or whether future developments, both expected and unexpected, alter the components of population change that are the basis for population projections. Each of the three components of population change—births, migration, and deaths—respond to external or environmental factors. For births, some evidence of an association with economic conditions exists; for migration, unpredictable international events can often exert an impact; and for deaths, changes in personal habits such as diet, exercise, and smoking may ultimately affect mortality trends. Therefore, the results of projection processes should be used with caution.

Nevertheless, projections of the size and composition of the population, of health services use, and of health expenditures can be made and used to advantage. Although it is not possible to predict exactly what will happen, it is usually feasible to establish a range within which future developments are most likely to occur.

The complexity of the projection process and the range of uncertainty are directly related to the number of variables under consideration. Population projection usually involves the three demographic variables: births, migration, and deaths. Health sector models, however, incorporate additional health-related variables for which varying assumptions about future developments must be made. These may include utilization patterns, health manpower availabilities, and financial resources. This report is primarily concerned with demographic effects and, in particular, with the affect of changes in mortality patterns. Other variables—both demographic and health sector variables—are held constant in order to focus on the possible consequences of mortality change.

Marked reductions in mortality would have only a small effect on the total size of the U.S. population during the next quarter of a century. However, such reductions could have a substantial impact on the age distribution of the population—the proportionate shares of the population that are comprised of youth, the working age population, and the elderly. The projections in this report, even assuming no change in age-specific patterns of mortality, imply a future population with a relatively older age structure than exists at present. If recent reductions in age-specific death rates persist into the future, the population will be even older.

The demographic effects of two alternative assumptions of future mortality patterns on total population size and on selected features of the health sector are examined. The first is that mortality levels by age, as of 1976, remain constant. The second is that recent declining trends, as experienced from 1966 to 1976, are sustained.

The 1966–76 period was one of marked mortality decline in the United States. This trend has been essentially sustained through 1978.[1] Thus, by assuming that the rate of improvement during that 10-year period is maintained, an upper limit to the size and relative age of the population—as determined solely by mortality change—can be set. Because some mortality improvement is to be expected, the constant mortality assumption would set the lower limit. The actual mortality pattern will probably differ from either assumption, although it will most likely lie between the high and low limits. The purpose of this report is to examine the range of possible consequences for the health sector of an increasingly older American population.

The discussion of the projection process and the examination of the impact of the alternative mortality assumptions on future health care utilization and expenditures to the year 2003 are supplemented by tables and charts. Both the logic and the calculations of the projection process are explained. In chapter 2, an overall view of the projection model and the relationships among its components are provided. In chapter 3,

a detailed description of the alternative mortality assumptions is presented. In chapter 4, the projected populations determined by the alternative mortality assumptions are discussed. In chapter 5, these demographic projections are used as inputs to a health sector model. For that model, constant health sector parameters are assumed. This results in two sets of projections for each of four factors: (1) the population with limitation of activity, (2) aggregate utilization of health care services, (3) aggregate health care expenditures, and (4) per capita health care utilization and expenditures. In chapter 6, the possible impact of these projections on future health care concerns is discussed.

Chapter 2
Projection model

The overall logic of the projection model and the relationships among its major components (figure 1) are discussed in this chapter. The model is designed to focus on the effect of alternative assumptions of future mortality patterns. All other variables in the projection model are held constant. For the demographic component of the model, births and migration are held constant. For the health sector component of the model, age-specific per capita rates of health care utilization, expenditures, and limitation of activity are held constant.

Demographic projections

The population projections were prepared in collaboration with the Office of the Actuary of the Social Security Administration, which prepares such projections annually.[2] The projection method used was the standard cohort-component approach in which separate assumptions are made for future levels of the demographic components—births, migration, and deaths. For this projection method, each age group, or cohort, is followed through successive calendar years. Each age group is survived from one calendar year to the next by applying survival probabilities. These survival probabilities are determined by the alternative assumptions of future mortality patterns. The pattern of age-specific fertility is assumed to be consistent with a completed family size averaging 2.1 children per woman for each cohort of women born after 1970. Net immigration during the projection period is assumed to be 400,000 per year, with a constant age distribution each year as shown in table I. These assumptions of fertility and migration are the same as those used by the Office of the Actuary.

The mortality assumptions used in this report differ from those used by the Social Security Administration. They are based on data from the National Center for Health Statistics (NCHS) Division of Vital Statistics. The two alternatives are as follows: (1) a constant level of mortality in which age-specific rates remain unchanged at the 1976 level through the year 2003, and (2) declining level of mortality in which projected death rates for the year 2003 are based on a continuation of recent downward trends experienced during the period 1966–76.

Health sector projections

Age-specific rates of health services utilization are assumed to be constant throughout the projection period, so that changes in future utilization can be attributed solely to demo-

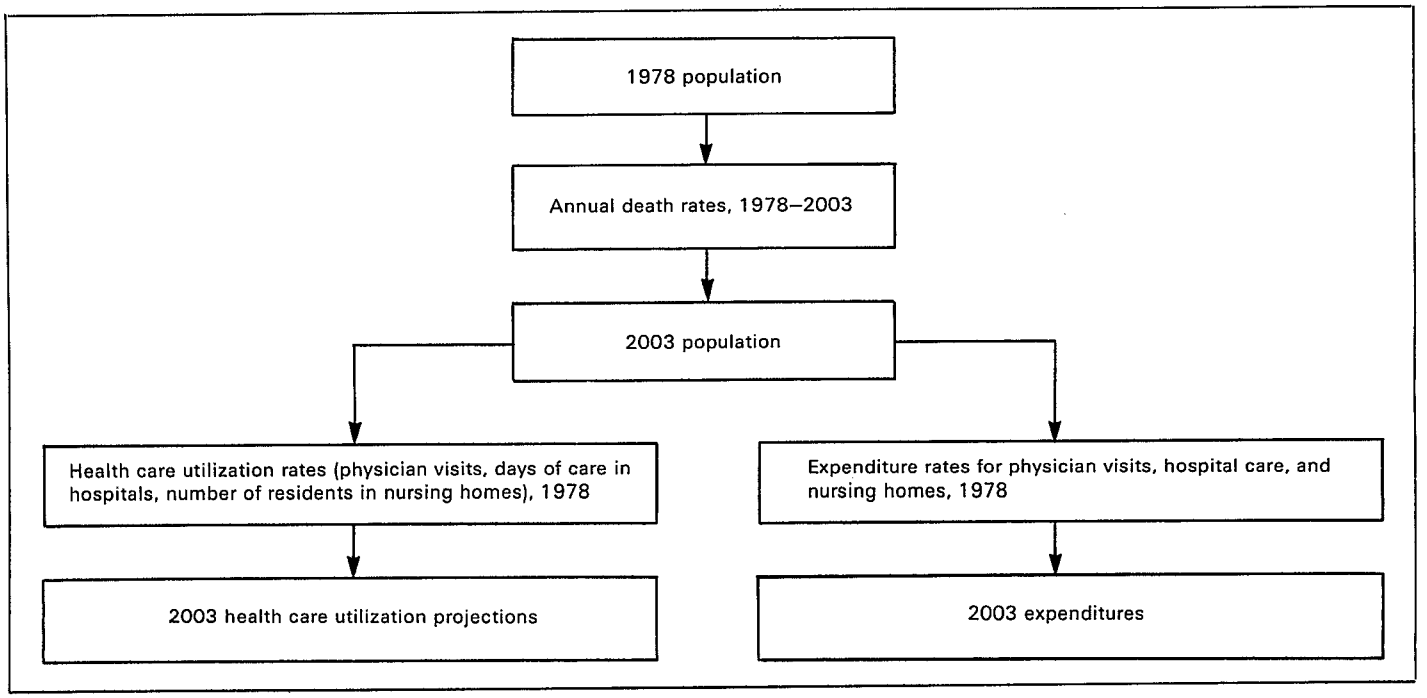


Figure 1. Schematic of the projection model for population, health services utilization, and health expenditures

graphic factors. These rates are based on data from NCHS sources, including the National Health Interview Survey, the National Hospital Discharge Survey, and the National Survey of Nursing Homes. Future utilization is derived by applying these age-specific rates to the population projections.

Medical care prices are also assumed to remain constant throughout the projection period. The Health Care Financing Administration (HCFA) annually estimates personal health care expenditures by type of expenditure for three age groups,[3] and HCFA provided figures for 1978. Adjusting these figures by increases in utilization because of population growth alone results in projected total expenditures for hospital care, physician visits, and nursing home care in 2003. For projected health care utilization, projected expenditure patterns by age reflect only population change because medical care prices are held constant throughout the projection period.

Under the assumptions of constant prices and age-specific patterns of health care utilization, the projected total expenditure figures show the differential effects between the assumptions of no change in mortality and continued and substantial decline in mortality.

Chapter 3
Mortality projections

The procedures used to project death rates for the alternative mortality assumptions and to derive survival rates are described in this chapter. Projections of death rates are made separately for men and women by 5-year age groups. These, in turn, are the basis for calculating life table survival rates.

Death rates

Description

Age-specific mortality rates are projected to the year 2003 from the base year 1976, the most recent year for which final data were available. While table 1 shows age-specific death rates for broad age groups in the total population, the projection methodology employed 5-year age-specific rates for men and women separately, as shown in table II.

Between 1953 and 1978, the U.S. death rate declined from 9.6 to 9.1 deaths per 1,000 population or by 5.2 percent (table 1). The highest reductions—52 percent—occurred among those under 20 years of age. Less dramatic reductions in mortality were experienced by people above that age, but every age group showed a decline. Even the elderly population 85 years of age and over showed important improvements in health status, as measured by their death rates, which declined by almost 20 percent.

From 1978 to 2003, the population will grow relatively older as greater numbers of people move into the advanced age groups. This will happen even under the assumption of constant mortality, when the risk of death at each age remains unchanged. As the larger number of people move into the advanced ages, they give increased weight to the age groups that have higher death rates. Therefore, the death rate for each broad age group, and for all age groups combined, can show an increase, despite the assumption of constant mortality.

Under the alternative mortality assumption, which is an extrapolation of the experience during 1966–76, age-specific death rates would continue to decline at a steady rate through 2003. The projected age-specific death rates for 2003 under the declining mortality assumption indicate substantial reductions for each age group in contrast to constant death rates under the other mortality assumption. Separate projections were made for men and women by 5-year age groups (table II).

The greater part of the decline in mortality between 1953 and 1978 occurred during the latter part of that period. The death rate for the total population declined by less than 1 percent between 1957 and 1966, whereas it decreased by more than 5 percent between 1967 and 1976. If this more rapid reduction continues, then a projected decrease of 11 percent in the death rate for all ages combined can be expected between 1978 and 2003 (table 1).

A comparison of projected changes in mortality for 1953–78 with those for 1978–2003 indicates more rapid reductions in future mortality than those experienced in the recent historic past and unprecedented low levels of mortality for the Nation by 2003. Whether the assumption of continuing declining mortality is likely to be realized is not known. However, it is indicative of possible improvements in mortality that might be experienced during the projection period. By contrast, the constant mortality assumption represents the most conservative projection of possible changes in aggregate mortality levels because it is highly unlikely that age-specific mortality in 2003 would be greater than corresponding mortality levels in 1978.

Procedure

For the constant mortality assumption, the set of age-sex-specific death rates for 1976, as published in *Vital Statistics of the United States, Volume II, Mortality,*[4] is assumed to prevail for each of the years during the projection period 1978–2003. For example, the death rate for men 65–69 years of age in 1976 was 3,586.9 deaths per 100,000 population (table II). This death rate is used for each year through 2003. The same is true of the death rates for each of the other age-sex groups in the population. The projected death rate for the total population is a weighted average of the death rates for men and women. For any age group, this is obtained by using the following equation:

$$r_{(m+f)} = \frac{r_m p_m + r_f p_f}{p_m + p_f}$$

where $r_{(m+f)}$ = death rate for total population in specified age group,

r_m = death rate for male population in specified age group,

p_m = male population in specified age group,

r_f = death rate for female population in specified age group, and

p_f = female population in specified age group.

For the declining mortality assumption, the set of age-sex-specific death rates is assumed to decrease at a uniform rate during the projection period 1978–2003, based on the average

annual rate of decrease experienced during 1966–76. Again, taking men 65–69 years of age as an example, the death rate for 1976 was 3,586.9 per 100,000 population. This figure represents a reduction of 14 percent during the period 1966–76, or an average annual reduction of 1.5 percent. The projection assumes that this average annual reduction will continue every year through 2003. Compounding the annual rate of decline of 1.5 percent through 2003 would result in an overall reduction of 33.5 percent. A 33.5 percent reduction for men 65–69 years of age from the rate of 3,586.9 in 1976 would be a rate of 2,384.5 in 2003. This extrapolation procedure is repeated for each 5-year age group for men and women separately to project the age-specific death rates for 2003 under the declining mortality assumption (table II).

Because the 1978 final mortality data were unavailable at the time initial calculations were made, the death rates used in this report for 1978 were estimates. A comparison of projected and final death rates for 1978, shown in table III, indicates a close correspondence between the two sets of figures.

Life expectancy

Description

Life expectancy is the average number of years that a group of newborn infants would live if they were to experience throughout life the age-specific death rates prevailing in the calendar year of their births. For 1976, the expectation of life at birth in this country was 72.8 years (figure 2). For 1978, estimated life expectancy was 73.3 years for the total population: 69.4 years for men and 77.3 years for women (table 2). Corresponding final life expectancy figures were 73.3 years, 69.5 years, and 77.2 years, respectively. Although the greatest gains in life expectancy occurred in the first half of this century, life expectancy has increased considerably in recent years. In fact, by 1978 life expectancy was 4.5 years higher than it was a quarter of a century ago. The tempo of improvement has accelerated as well. During the period 1957–67, 1 year was added to the number of years that a child born in the United States could expect to live; during 1968–78, the gain was more than 3 years.

Considerable room remains for improving life expectancy in this country. Compared with other industrialized nations, the United States ranked 18th in 1974 for men and 9th for women (figure 3). The difference in life expectancy between men in the United States and men in Sweden, the first ranked nation, was almost 4 years.

Projected death rates for 2003 can be used to determine the projected life expectancy in that year. Because age-specific death rates remain constant under the constant mortality assumption, probabilities of dying in an age interval also remain constant. Accordingly, life expectancy in 2003 would remain unchanged. This reinforces the concept of the constant mortality assumption as the "lower limit" of future mortality changes, because some increase in life expectancy by 2003 can be expected based on the observed historic pattern in the United States.

Declining age-specific death rates imply increases in life expectancy. The projected increase in life expectancy shown in table 2 results from the projected reductions in age-specific death rates under the declining mortality assumption. The projected increase during 1978–2003 is greater than the observed increase during 1953–78 because the sharp mortality

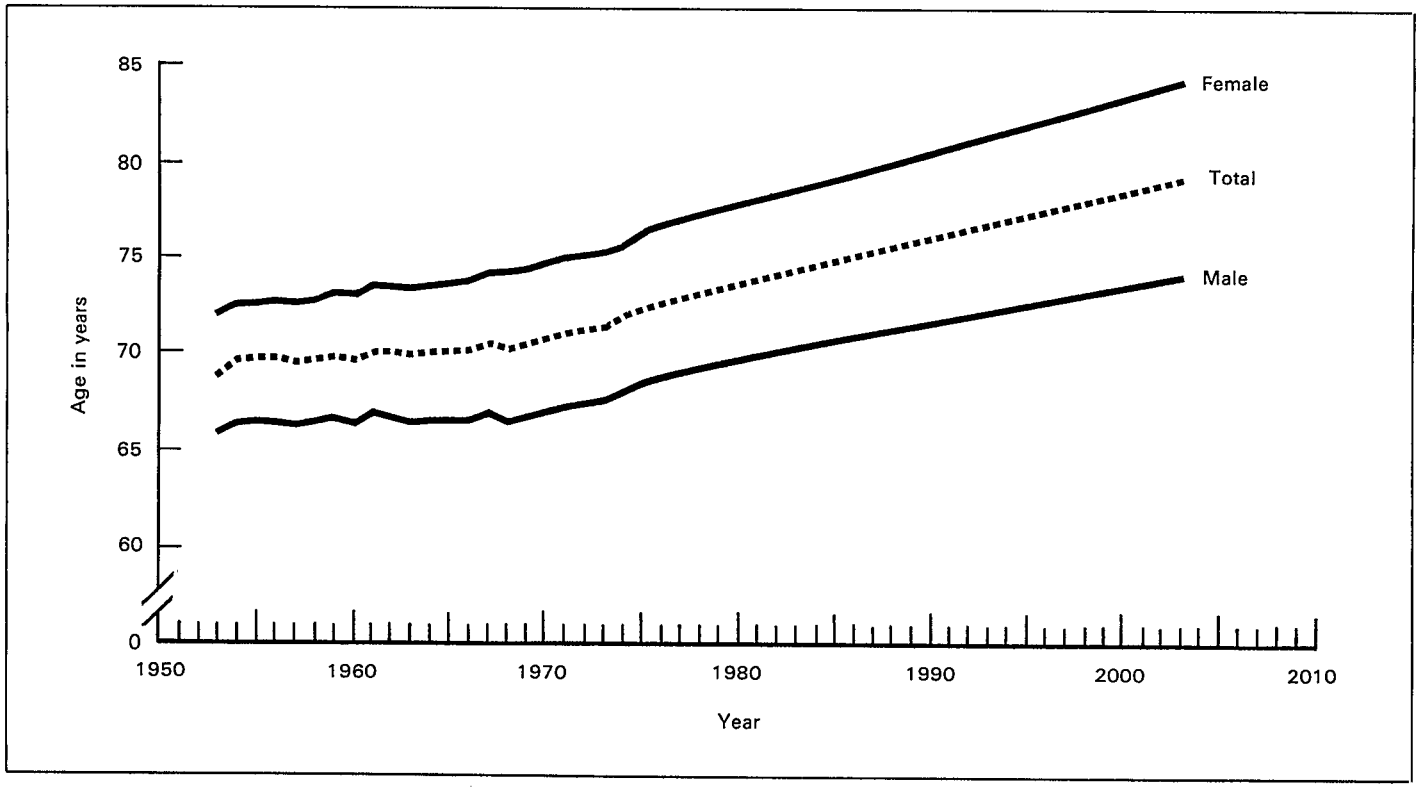
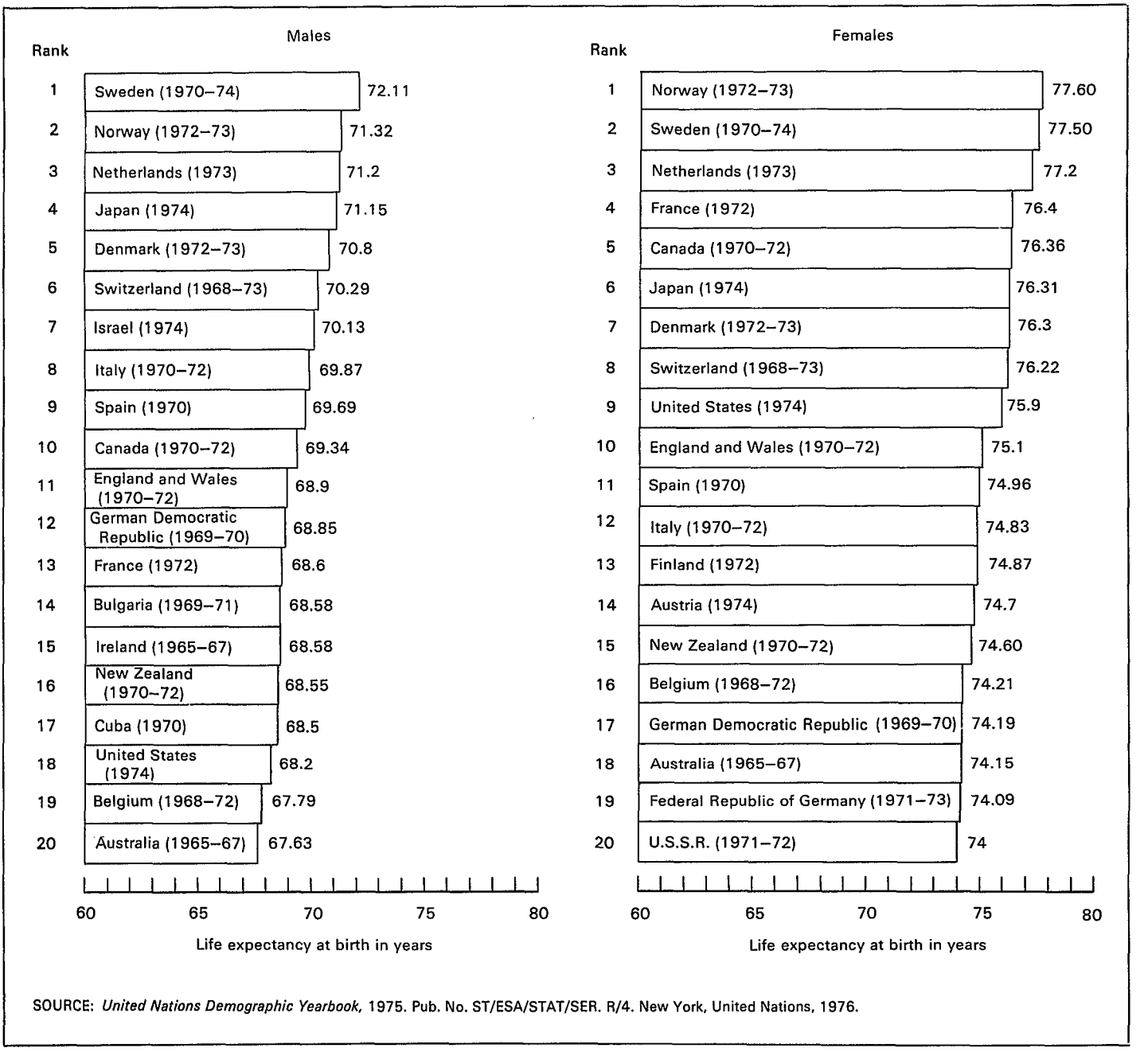


Figure 2. Life expectancy: United States, 1953–2003



SOURCE: *United Nations Demographic Yearbook,* 1975. Pub. No. ST/ESA/STAT/SER. R/4. New York, United Nations, 1976.

Figure 3. Life expectancy at birth by sex: selected countries

declines for the period 1966–76 are the basis for this projection.

Assuming that the momentum of the improvements in age-specific mortality experienced in the United States during 1966–76 continues through 2003, life expectancy at birth will increase considerably. The average length of life would increase by 6 years to more than 79 years of age by 2003. Life expectancy for men would be 74 years, still below the 1978 figure for women, and women could expect to live an average of 84 years. The gap between life expectancy for men and women would increase to 10 years, up from 8 years' difference in 1978 and 6 years' difference in 1953.

These projected life expectancy figures for men and women are consistent with those published by the Social Security Administration where three alternative assumptions for mortality reduction were explored.[5] Under the third alternative, which assumed the greatest decline in age-specific mortality, life expectancy in the year 2000 was projected to be 75.6 years for men and 85.1 years for women. No nation for which current information is available has achieved the life expectancy levels projected for the United States in 2003, providing the recent reductions in age-specific death rates are sustained (figure 3).

Procedure

For 1976, life tables by sex were computed directly from the age-sex-specific death rates. Standard procedures for computing life tables are discussed elsewhere.[6,7] In computing a

life table, age-specific death rates are initially converted into probabilities of dying. Probabilities of dying are then used to compute all other life table functions, including life expectancy and age-specific survival probabilities. The survival probabilities are used in the projection algorithm to obtain population estimates for men and women separately for each year during the projection period 1976–2003.

Calculation of probabilities of dying is most easily done when death rates by 5-year age intervals are first interpolated to provide estimated death rates for single years of age. A variety of interpolation procedures can be used. Life tables used in this report were constructed by the Social Security Administration, which used a Whittaker-Henderson type B graduation to estimate death rates for single years of age.[8] Given death rates by single years of age, the probability of dying betwen ages x and $x + 1$ is estimated by the equation

$$q_x = \frac{m_x}{1 + m_x/2}$$

where q_x = probability of dying in age interval $(x, x + 1)$
m_x = estimated death rate for age x.

For projecting population, the relevant information is the complement of q_x or the probability of survival, denoted by $p_x = 1 - q_x$. Thus, p_x is the probability that a person x years of age will survive to $x + 1$ years of age.

Because age-specific death rates remain unchanged under the constant mortality assumption, survival probabilities for each year 1977–2003 are the same as those for 1976, thus for men 65 years of age in 1976, the probability of surviving to 66 years of age in 1977 is $1 - 0.03052 = 0.96948$. The probability that men 65 years of age in 2003 will survive to 66 years of age in 2004 remains 0.96948.

Under the declining mortality assumption, age-specific death rates projected to 2003 are interpolated to single year of age death rates and then converted into single year of age survival probabilities. Linear interpolation of single year survival probabilities between 1976 and 2003 was used to obtain survival probabilities for each year 1977–2002. For example, the survival probability for men 65 years of age is 0.96948 in 1976 and 0.98024 in 2003. To estimate the survival probability for an intervening year, say 1985, the following linear interpolation is employed:

$$\text{Rate}_{1985} = \text{Rate}_{1976} + \frac{(1985 - 1976)(\text{Rate}_{2003} - \text{Rate}_{1976})}{2003 - 1976}$$

$$= 0.96948 + \frac{9(0.98024 - 0.96948)}{27}$$

$$= 0.97307$$

Thus, the estimated survival probability for men 65 years of age in 1985 is 0.97307. Other interpolation methods could be used, but they would not result in survival probabilities that differ substantially from those used.

Table 1. Death rates and percent change in rates, by age: United States, 1953 and projections for 1978 and 2003

Age	Year					
	1953	1978	2003		1953–1978	1978–2003, declining mortality
			Constant mortality	Declining mortality		
	Death rates per 1,000 population				Percent change in rates	
All ages	9.6	9.1	10.7	8.1	−5.2	−11.0
Under 20 years	2.7	1.3	1.3	0.6	−51.9	−53.8
20–44 years	2.3	1.7	1.9	1.4	−26.1	−17.6
45–64 years	12.6	10.3	9.7	6.5	−18.3	−36.9
65 years and over	61.0	54.4	62.2	43.5	−10.8	−20.0
65–74 years	39.4	31.4	32.1	22.2	−20.3	−29.3
75–84 years	90.6	73.1	73.4	51.6	−19.3	−29.4
85 years and over	191.9	154.7	161.8	87.1	−19.4	−43.7

Table 2. Life expectancy by sex: United States, 1953 and projections for 1978 and 2003

Sex	Life expectancy at birth		
	1953	1978	2003, declining mortality
Total	68.8	73.3	79.3
Men	66.0	69.4	74.2
Women	72.0	77.3	84.2

Chapter 4
Population projections

Description

For health policy formulation, one needs to be cognizant of the effect of future demographic patterns on the size and composition of our population. The aggregate demand for health services is influenced in part by changes in health service utilization patterns but also, and importantly, by changes in demographic patterns, especially the size of the elderly population, which has a disproportionate requirement for these services. Population projections indicate that the extraordinary demands and pressures for health and related social services experienced in recent years as a result of demographic factors are likely to continue in the future.

Population projections using the cohort-component technique are based on separate assumptions about trends in the three components of population change: births, migration, and deaths. For the population projections in this report, births are assumed to approach net replacement; that is, 2.1 children per woman for women born in 1970 and thereafter. Net annual immigration to the United States is assumed to be 400,000 per year throughout the projection period, with a constant age distribution each year (table I).

Only assumptions about future mortality differ. However, the projected total population size by 2003 is not much different for the two mortality assumptions—272 million for constant mortality versus 280 million for declining mortality. This is because births, the dynamic variable for projecting population size, is the same for both assumptions.

For the constant mortality assumption, the projected population increase for all ages combined would be less than the population increase observed during 1953–78 (a 24-percent increase, compared with a 38-percent increase); an absolute gain of 53 million people compared with an absolute gain of 60 million people. For the declining mortality assumption, the population would increase by 28 percent, or about 62 million people (table 3 and figure 4), about the same absolute gain experienced during 1953–78. However, the two population projections do differ by age, most markedly at the older ages where mortality has its greatest quantitative impact. Under 65 years of age, the projections show little difference between the two mortality assumptions, but at the older ages a clear difference exists.

Percent changes by broad age groups are shown in figures 5 and 6. For these age groups, beginning with those under 20 years of age, one can see a percent increase during 1953–78 that is much larger than either percent increase projected for 1978–2003 (28.4 percent, compared with 7.4 percent and 8.5 percent). The much smaller relative growth during the projection period reflects the assumption of future births at the net replacement level.

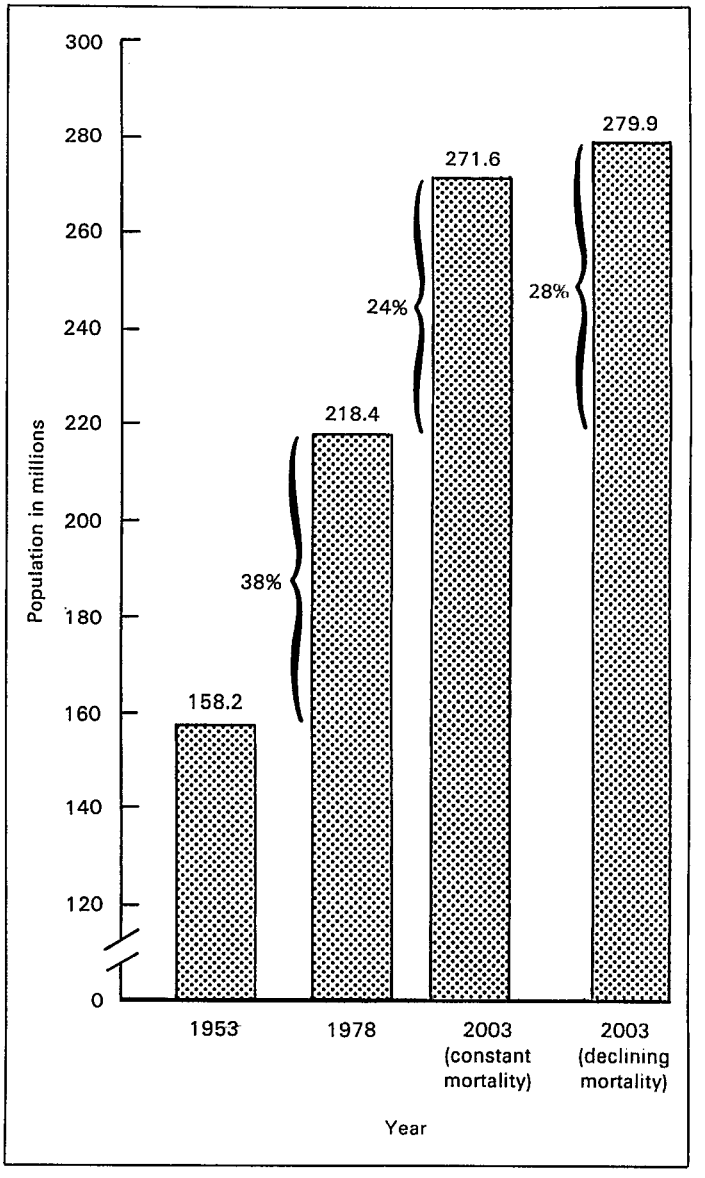


Figure 4. Population size: United States, 1953 and projections for 1978 and 2003

For both projections, the population 20–44 years of age would grow about half as fast in the future period as it did in the past. By contrast, the population 45–64 years of age would

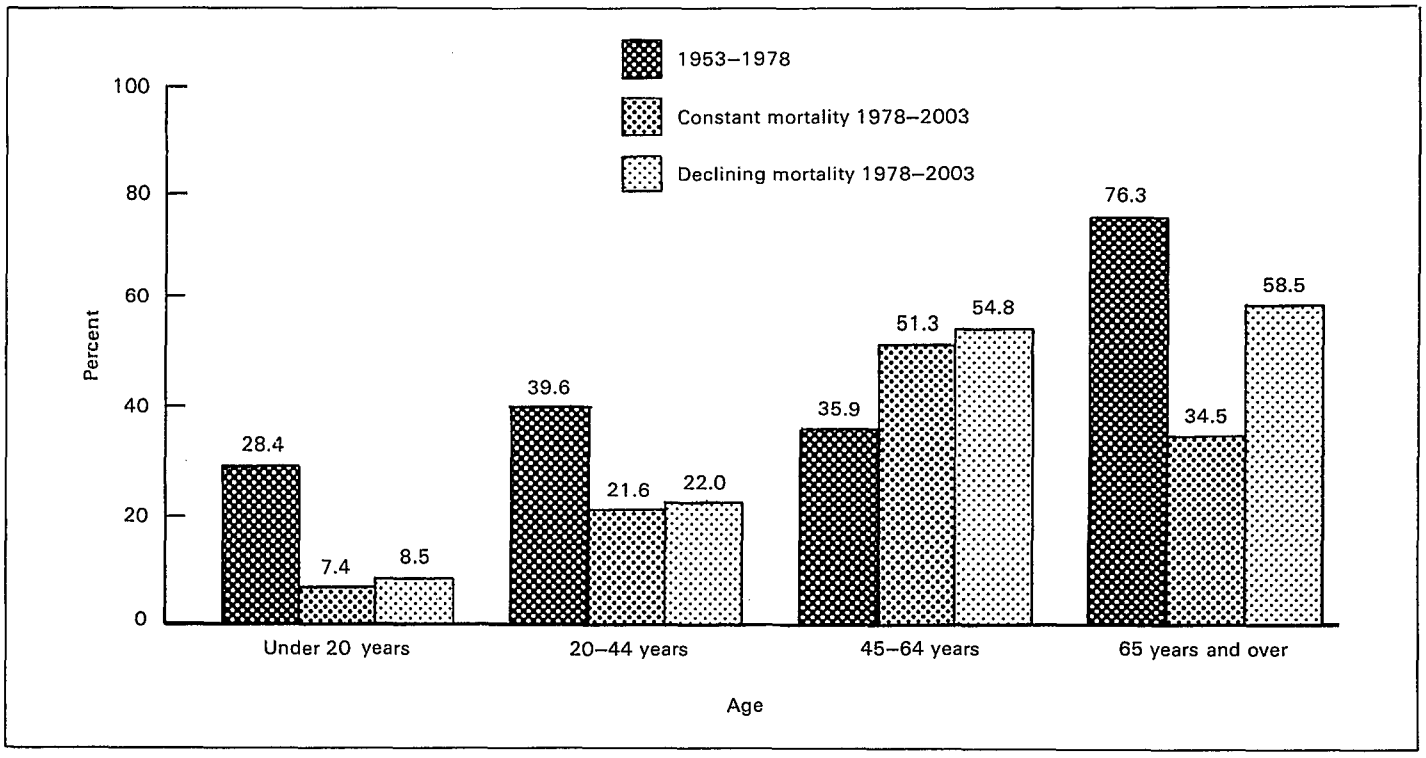


Figure 5. Percent increase in population by age: United States, 1953–1978 and 1978–2003

grow more rapidly than it did in the earlier period—at a rate of more than 50 percent for each projection, compared with 36 percent during 1953–78. This is attributable largely to the maturing of the "baby-boom" cohort of the early 1950's.

The age group in the "retirement years" presents a complex picture. During 1953–78, the size of the population 65 years of age and over grew twice as fast as the population as a whole—76 percent, compared with 38 percent. Under the declining mortality assumption, the aged population would again be the fastest growing demographic segment of our population, increasing by 59 percent to 38 million people in 2003, while the population of all ages would increase by only 28 percent. Under the constant mortality assumption, the size of the population 65 years of age and over would be 32 million in 2003.

Under the constant mortality assumption, the relative increase in the population 65 years of age and over would be smaller than it was during 1953–78 (34.5 percent, compared with 76.3 percent) and the absolute gain would also be smaller (8.3 million, compared with 10.4 million). Under the declining mortality assumption, the projected percent increase for this age group also would be smaller than it was during 1953–78 (58.5 percent, compared with 76.3 percent), but the absolute increase would be greater (14.0 million, compared with 10.4 million). The declining mortality assumption would yield, therefore, an increase 5.8 million greater in the population 65 years of age and over by 2003 than that projected by the constant mortality assumption.

For people 65 years of age and over, the relative declines in the projected rate of growth would be concentrated among those 65–74 years of age. Although this age group increased 62 percent during 1953–78, it would only increase 15 percent under the constant mortality assumption and 24 percent under the declining mortality assumption. The absolute gains in the number of people in this age group would also be smaller during the projection period: 2.2 million under the constant mortality assumption and 3.5 million under the declining mortality assumption, compared with 5.7 million during 1953–78.

During 1953–78, the population for the age group 75–84 years increased 88 percent for a gain of 3.2 million. The projected increase under the constant mortality assumption would be 62 percent, or 4.2 million persons, an absolute gain greater than that of the earlier period. The projected increase under the declining mortality assumption would be 86 percent, about the same rate of increase experienced during the earlier period. The absolute gain of 5.9 million, compared with 3.2 million, would be even greater, and the population 75–84 years of age would nearly double, from 7 million in 1978 to 13 million in 2003.

The most rapidly growing age group would be the oldest—people 85 years of age and over. Under the constant mortality assumption, that population group would nearly double. Under the declining mortality assumption, it would triple, growing from 2.1 million to more than 6.7 million people. This population also tripled during the period 1953–78, increasing from 700,000 to 2.1 million people.

The projected rapid increase in the size of the population 85 years and over arises from different sources than it did during the earlier period. To a large extent, the increases during 1953–78 reflected immigration to our Nation around the turn of the century; however, the projected future growth would be the result of improved health status as reflected in reduced age-specific death rates.

The different rate of growth in population age groups can have substantial consequences for many of our social institu-

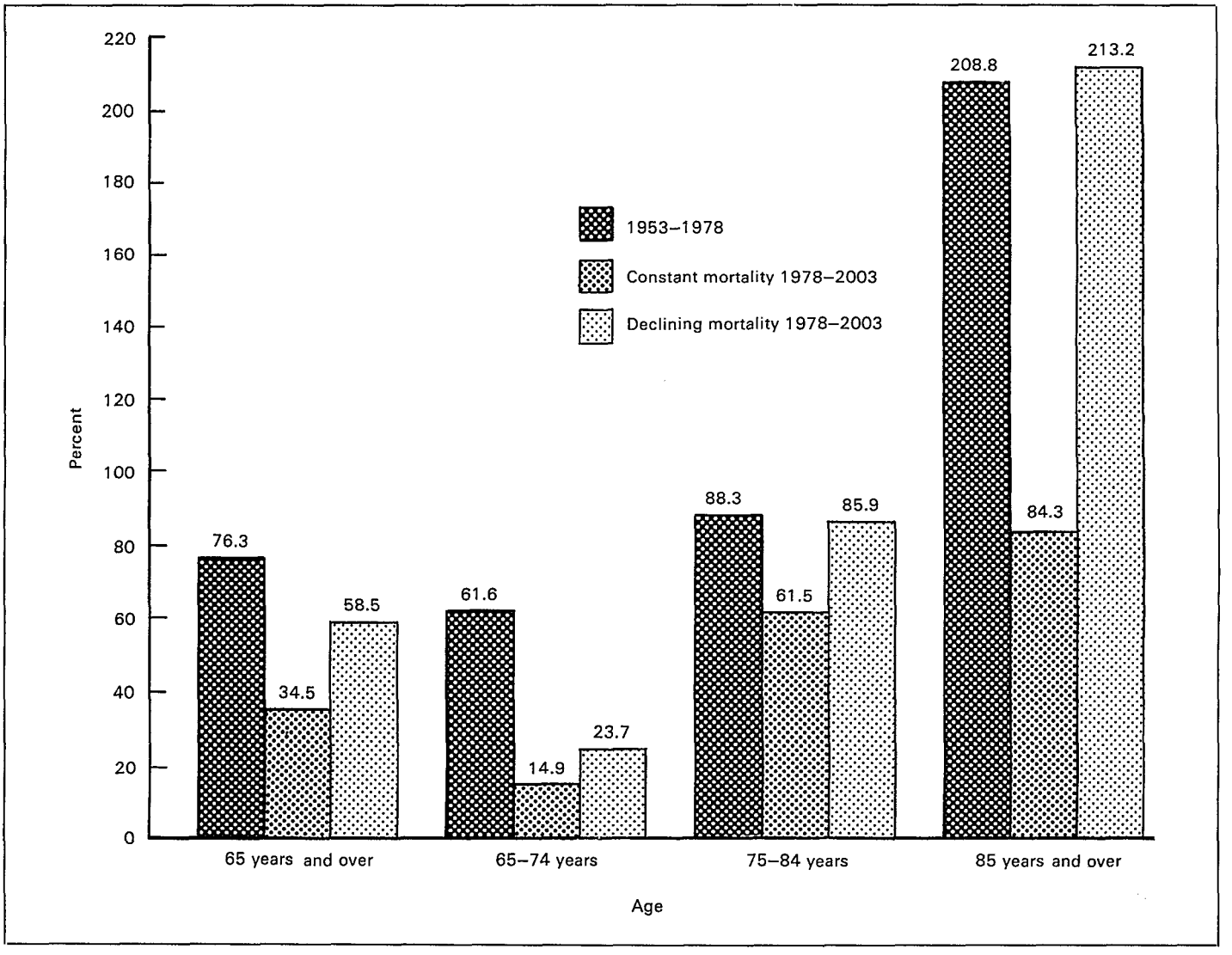


Figure 6. Projected percent increase in older population by age: United States, 1953–1978 and 1978–2003

tions, particularly in terms of dependency. The most slowly growing age group will be people under 20 years of age, and their proportionate share of the total population will diminish measurably (table 4). In 1953, they accounted for more than one-third of the population; by 2003, their share may have declined to slightly more than one-fourth of the population.

The group that will show the greatest increases will be the aged (table 4). People 65 years of age and over, who accounted for 9 percent of the population in 1953 and 11 percent of the population in 1978, would represent 12 percent of the population in 2003 under the constant mortality assumption and 14 percent of the population under the declining mortality assumption. The proportion of the population 75 years of age and over, which was 2.7 percent in 1953 and 4.2 percent in 1978, would grow to 5.5 percent under the constant mortality assumption and to 7.0 percent under the declining mortality assumption.

Procedure

The population projection begins with the estimated population for 1976,[9] which is then projected by age and sex through year-to-year adjustments that account for births, deaths, and net surviving immigrants. For each year, the projected population at age 0 years is derived by applying the survival probability at age 0 to the estimated number of new births and then adding net surviving immigrants for that age. The sex distribution of new births is assumed to remain constant at 105 males per 100 females. The projected population at age x years for ages 1 year and over is derived from the previous year's population at age $x - 1$ years by applying the projected survival probabilities and then adding the net number of surviving immigrants for each age and sex.

For example, under the constant mortality assumption, the survival probabilities for 1976 are assumed to apply for each year 1976–2003. When the survival probability of 0.96948 is applied to the estimated 795,000 men 65 years of age in 1976, there results 770,737 survivors to 66 years of age in 1977. A constant number of net surviving immigrants is added to get the estimated population 66 years of age in 1977. Projecting the population under the declining mortality assumption is procedurally identical except that a different set of survival probabilities is used.

Table 3. Population size and percent increase, by age: United States, 1953 and projections for 1978 and 2003

Age	Year						
			2003			1978–2003	
	1953[1]	1978[2]	Constant mortality	Declining mortality	1953–1978	Constant mortality	Declining mortality
	Population in thousands				Percent increase in population		
All ages	158,242	218,437	271,533	279,944	38.0	24.3	28.2
Under 20 years	55,948	71,840	77,154	77,932	28.4	7.4	8.5
20–44 years	56,424	78,796	95,814	96,159	39.6	21.6	22.0
45–64 years	32,286	43,862	66,369	67,904	35.9	51.3	54.8
65 years and over	13,582	23,941	32,196	37,949	76.3	34.5	58.5
65–74 years	9,230	14,915	17,130	18,451	61.6	14.9	23.7
75–84 years	3,661	6,892	11,134	12,814	88.3	61.5	85.9
85 years and over	691	2,134	3,932	6,684	208.8	84.3	213.2

[1]U.S. Bureau of the Census: *Current Population Reports*, Series P-25, No. 310. Washington. U.S. Government Printing Office, 1965.
[2]U.S. Bureau of the Census: *Projections of the Population of the United States: 1977 to 2050*. Series P25, No. 704. Washington. U.S. Government Printing Office, 1977.

Table 4. Percent distribution of the population by age: United States, 1953 and projections for 1978 and 2003

Age	Year			
			2003	
	1953	1978	Constant mortality	Declining mortality
	Percent of population			
All ages	100.0	100.0	100.0	100.0
Under 20 years	35.4	32.9	28.4	27.8
20–44 years	35.7	36.1	35.3	34.3
45–64 years	20.4	20.1	24.4	24.3
65 years and over	8.6	11.0	11.9	13.6
65–74 years	5.8	6.8	6.3	6.6
75–84 years	2.3	3.2	4.1	4.6
85 years and over	0.4	1.0	1.4	2.4

Chapter 5
Health sector projections

The focus of this report is on projections of future population size and age distributions. Future trends in other factors that affect utilization of health care services and expenditures for those services are not addressed. Changes in level of morbidity and mortality, in therapies, and in the availability and costs of care will contribute to utilization levels and patterns in 2003, just as change in population will. Some of these factors may increase utilization, while others may decrease it; however, the projected population changes alone will have a significant impact on utilization and consequently on expenditures. Because older people as a group tend to have more health problems than younger people, the impact of an aging population would be greater than the projected growth might suggest. This impact is examined as it relates to people with limitation of activity resulting from chronic conditions, the utilization of health care services, and health care expenditures. Two other studies that project health care expenditures under less restrictive assumptions than are used for this report are also briefly discussed.

Limitation of activity

Description

Limitation of activity resulting from chronic conditions is a measure of health status regularly reported in the National Health Interview Survey. If the current rates of activity limitation are applied to the projected populations for 2003, the number of activity-limited people will rise from 31 million in 1978 to approximately 42–46 million in 2003, an increase of 36 to 47 percent (table 5 and figure 7). Population increase will be only 24 percent to 28 percent (table 3). The difference between the rates of growth in population and in the activity-limited population, 12 to 19 percent, is a measure of the effect of the aging population.

No matter which mortality assumption is used, the age distribution of people with limitation of activity will not change much between 1978 and 2003; however, the percent increase by age will be larger at the older ages and will be even larger if mortality rates decline. For example, among people under 20 years of age, the increase would be 7 to 9 percent, but for those 65 years of age and over, the increase would be 38 percent if mortality rates remain constant and 64 percent if mortality rates delcine.

Although constant age-specific rates are assumed for the number of people limited in activity per 1,000 population, an aging population would result in an increase in the overall rate of from 9 to 15 percent. Compared with a rate of 143 limited people per 1,000 population in 1978, the corresponding rates in 2003 would be 156 per 1,000 population under the constant mortality assumption and 164 per 1,000 under the declining mortality assumption.

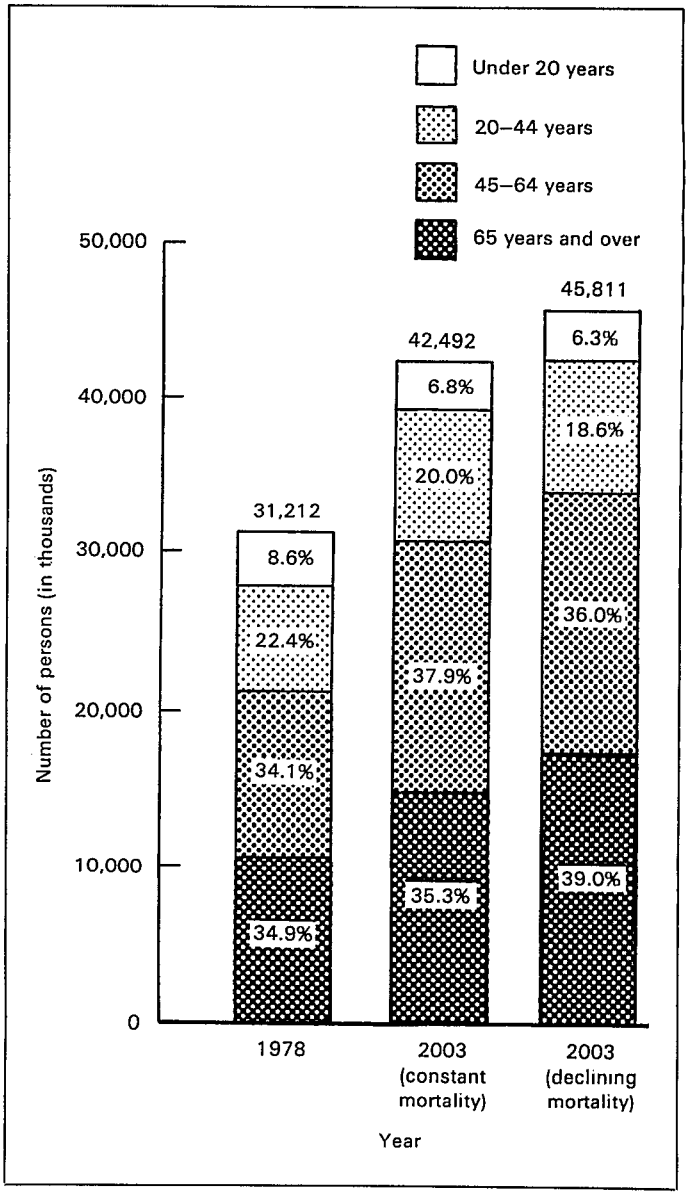


Figure 7. Projected number of persons with limitation of activity due to chronic conditions and percent distribution by age: United States, 1978 and 2003

Procedure

The procedure for projecting the number of people with limitation of activity can be illustrated by using people under 20 years of age from table 5. In the base period, there were 37.2 people with limitation of activity per 1,000 population in this age group. Multiplying this figure by the projected population in 2003 of 77.2 million people, under the constant mortality assumption, gives a projected number with limitation of activity of almost 2.9 million people. The same procedure is followed to project the number of people with limitation of activity for other age groups and under the declining mortality assumption.

The application of this procedure for other age groups using the rate of activity and projected population in this report may not produce exactly the number of people with limitation of activity projected in table 5. This occurs because the calculations are based on a larger number of age groups than shown. For example, for people 65 years of age and over, rates and numbers for 65 to 74 years of age and 75 years of age and over are employed. The effect of using age-specific rates of activity limitation for people 65 years of age and over is to produce a projected number of people with limitation of activity in 2003 somewhat larger than would be estimated from the average rate shown for people 65 years of age and over.

Utilization of health services

Description

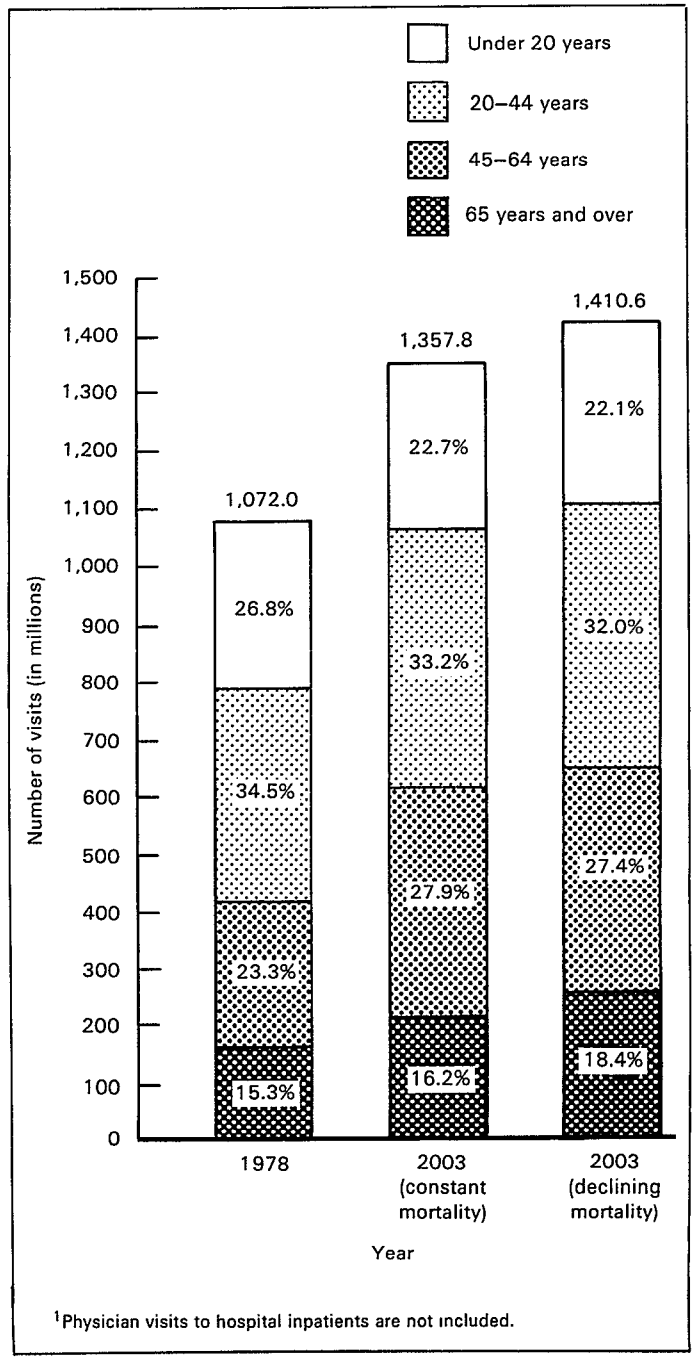
The aging of the population will affect the use of health services as shown in projections of physician visits (table 6 and figure 8), hospital days of care (table 7 and figure 9), and nursing home residents (table 8 and figure 10).

The number of physician visits will increase because the size of the population will increase, but the changing age distribution will have little effect because age-specific utilization rates do not vary as much for physician visits as they do for hospital and nursing home care. The age distributions projected for 2003 are similar under both assumptions, and are little changed from those prevailing in 1978. Only 2 to 3 percent of the almost 32 percent increase in visits from 1.1 billion in 1978 to 1.4 billion in 2003, will result from the aging of the population (table 6 and figure 8). The number of visits per capita will increase slightly from 4.9 to 5.0 (table 9).

The effect is quite different for hospital and nursing home care. Total hospital days will increase from 274 million in 1978 to 372 million, assuming constant mortality, or to 407 million, assuming declining mortality (table 7 and figure 9), with the largest increases among patients over 45 years of age. Total days would increase by 36 to 48 percent, with increases of 12 to 20 percent resulting from the aging population. Days of hospital care per 1,000 population will rise to 1,371 or 1,453 in the year 2003, a 9- or 16-percent increase (table 9).

Assuming that current patterns of use prevail in the future, large increases in the number of nursing home residents will occur. The number is projected to increase from 1.3 million in 1978 to 2.1 million under the constant mortality assumption, a 57-percent increase, and to 2.8 million under the declining mortality assumption, a 112-percent increase (table 8 and figure 10). The increases are particularly large among residents 85 years of age and older—84 percent, assuming constant mortality, and 213 percent, assuming declining mortality. The number of residents per 1,000 population will increase from 6 in 1978 to 8 in 2003, assuming constant mortality, and to 10 assuming declining mortality, changes of 25 and 64 percent, respectively (table 9).

The aging of the population has a much greater impact on nursing home residents than on days of hospital care or physician visits. The projections under the constant mortality assumption are close to those made by the Long Term Care Policy Group, Health Care Financing Administration (HCFA), which estimates that the number of nursing home



[1]Physician visits to hospital inpatients are not included.

Figure 8. Projected number of physician visits[1] and percent distribution by age: United States, 1978 and 2003

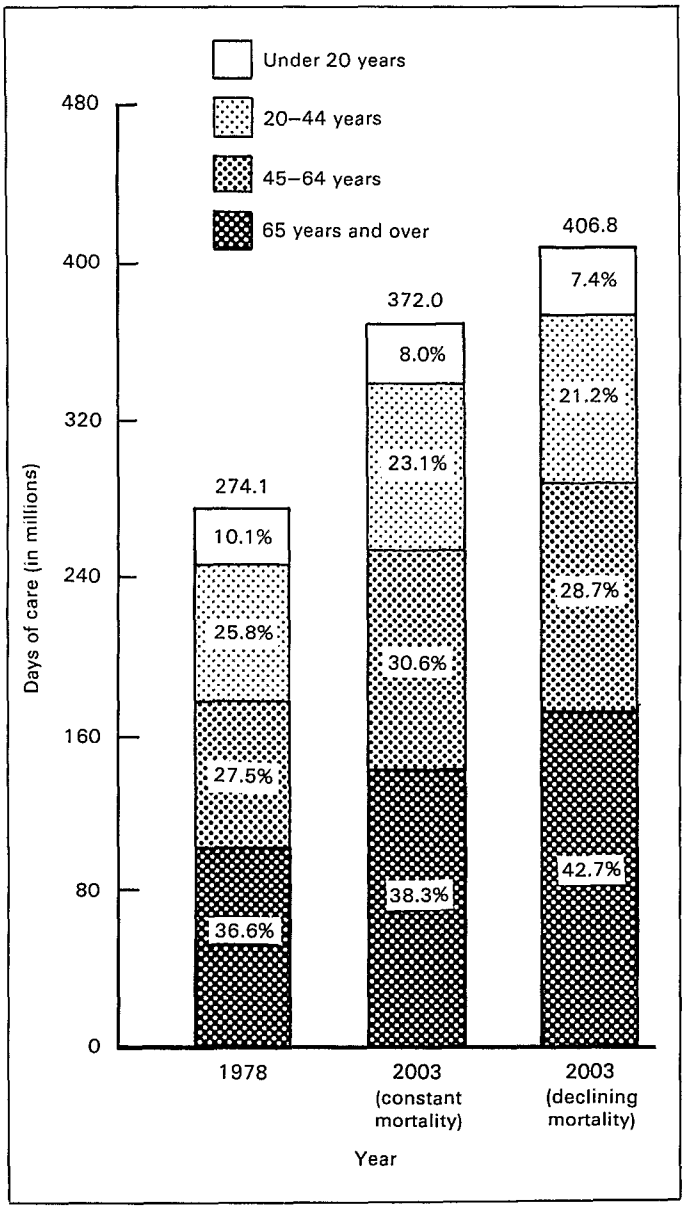


Figure 9. Projected days of care in non-Federal short-stay hospitals and percent distribution by age: United States, 1978 and 2003

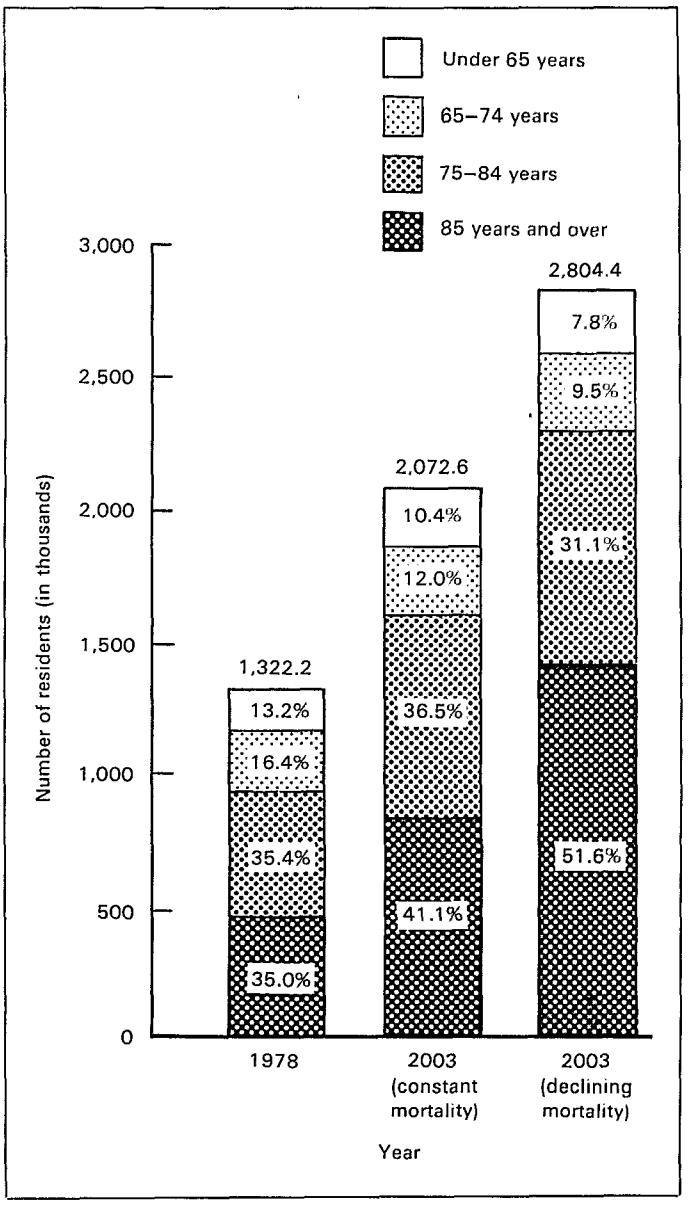


Figure 10. Projected number of residents in nursing homes and percent distribution by age: United States, 1978 and 2003

residents will increase to almost 2 million people by the year 2000.[10] However, the HCFA study projects that it will take until the year 2030 before the number of nursing home residents will approach 3 million people, a figure reached by 2003 under the declining morality assumption.

Similar trends in medical care use have also been projected by Louise Russell.[11] Assuming constant age and sex-specific rates of use and looking forward to the year 2050, Russell projects that the aging population will push per capita use of hospitals and nursing homes steadily higher, although physician visits will be largely unaffected by the change in age structure.

Procedure

The procedure for projecting the number of physician visits, hospital days, and nursing home residents is analogous to that described for people with limitation of activity. The number per 1,000 people in the base period is multiplied by the projected population in 2003. For example, people under 20 years of age experience 4,000 physician visits per 1,000 people. Multiplying this by the projected population of 77.2 million people, assuming constant mortality, gives a projected number of physician visits of 308.6 million (table 6). The projections for hospital care and nursing home residents are calculated in a similar manner.

As was the case for people with limitation of activity, the application of this procedure to the data in this report may not reproduce exactly the projected values in table 6–8 because the calculations are based on a larger number of age groups than shown. For example, the effect of using age-specific rates per 1,000 persons for people 65 years of age and over is to produce a projected number in 2003 somewhat different than would be estimated from the average rate shown for people 65 years of age and over.

Because the methodology employed to derive projected values assumes constant age-specific rates, it is the aging of the population that would result in the increases in the overall rates noted and shown in table 9 for physician visits, hospital days, and nursing home residents.

Health care expenditures

Description

Figures for 1978 were obtained from HCFA, which annually estimates personal health care expenditures by type of expenditure for three age groups. Dividing these health expenditures by the population figures in table 3 gives age-specific expenditures per capita for physician visits (table 10), hospital care (table 11), and nursing home residents (table 12).

The amount spent on physicians' services is projected to increase 30 to 37 percent, from $36 billion in 1978 to between $47 and $50 billion in 2003. However, little change will occur in the age distribution of expenditures, with people between 20 and 64 years of age accounting for more than 60 percent of the total (table 10 and figure 11). In 1978, spending for physicians' services averaged $166 per person. This is expected to rise 5 to 7 percent to $174 or $177 (table 13).

An estimated $74 billion was spent for hospital care in 1978 (table 11). This expenditure would rise to $98 billion in 2003, under the constant mortality assumption, and to $106 billion, under the declining mortality assumption—increases of 32 and 43 percent, respectively. As is the case for physician's services, people 20 to 64 years of age would continue to account for 60 percent of total expenditures for hospital care. Per capita hospital expenditures would rise from $338 in 1978 to $359, under the constant mortality assumption, and to $378, under the declining mortality assumption—increases of 6 and 12 percent, respectively (table 13).

The projected growth in spending is greatest for nursing home care. Under the constant mortality assumption, expenditures will increase 56 percent, from $15 billion to $23 billion (table 12). Under the declining mortality assumption, the increase will be 109 percent, meaning that total spending for nursing home care would more than double. The projected in-

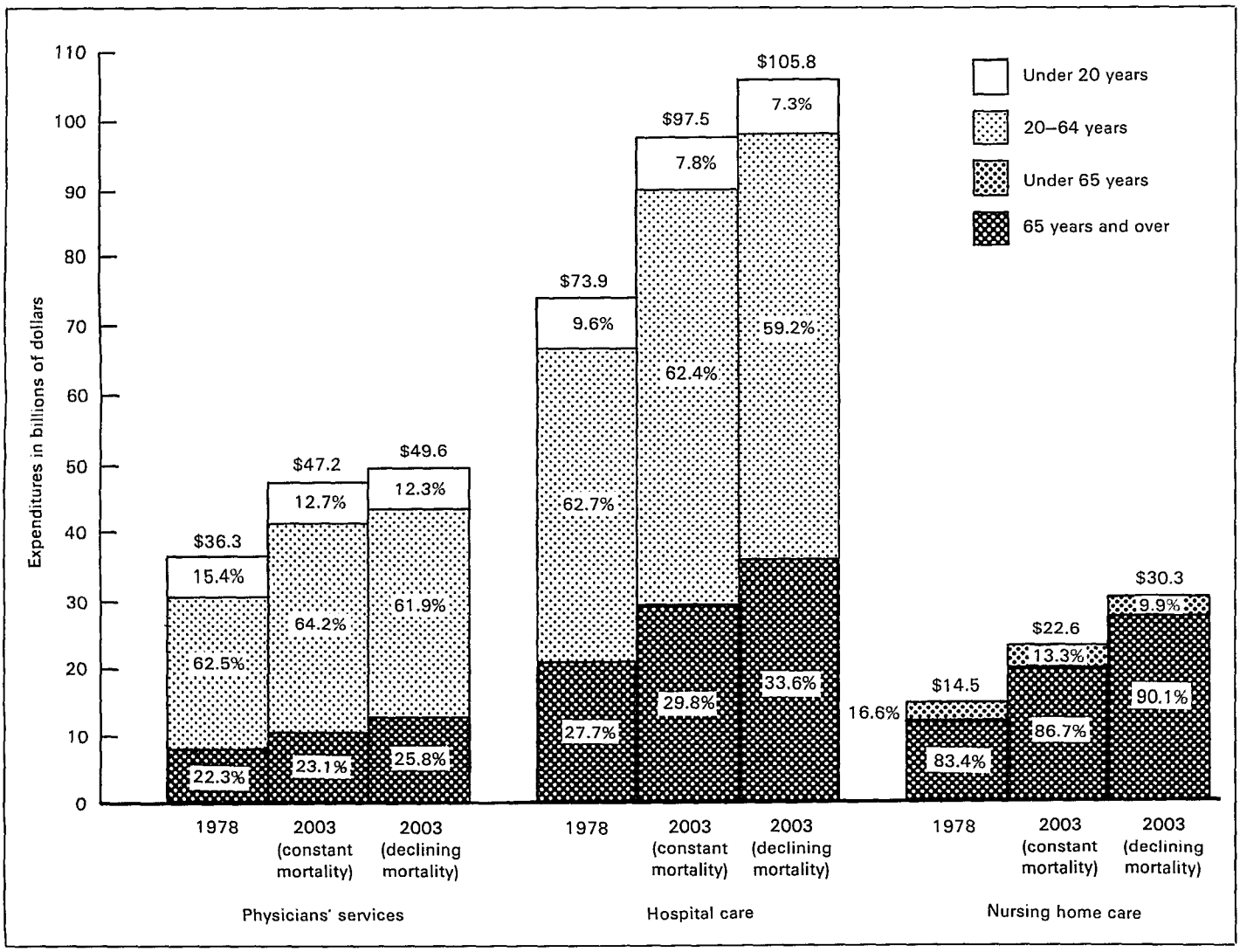


Figure 11. Projected expenditures for physician visits, hospital care, and nursing home care, and percent distribution by age: United States, 1978 and 2003

crease in per capita expenditures is from $66 in 1978 to $83 (26 percent), assuming constant mortality, or to $108 (63 percent), assuming declining mortality (table 13).

Procedure

If per capita utilization and medical care prices are assumed to remain constant between 1978 and 2003, or, in other words, expenditures per capita are the same in 2003 as in 1978, expenditures are projected for 2003 by multiplying expenditures per capita in the base period by the projected population in table 3. For example, per capita expenditures for physicians' services are $77 among people under 20 years of age. When this amount is multiplied by the projected population of 71.8 million people under 20 years of age, assuming constant mortality, total expenditures for this age group are $6 billion, as shown in table 10. Assuming constant prices, the projected increases in expenditures parallel increases in utilization, although not exactly, because unit charges for medical care vary somewhat by age. As with the amount of medical care, the proportional increase in expenditures is higher at older ages.

Other studies

To assess the effect of projected changes in the size and age distribution of the population for this report, age-specific per capita utilization of health services and medical care prices were assumed to remain constant between 1978 and 2003, even though this is not expected to be the case. This was a useful device for isolating the impact of alternative mortality rates on health care use and expenditures. However, changes will undoubtedly occur in other parameters that affect utilization and expenditures. Now that the potential impact of a growing and aging population has been examined, it will be instructive to briefly discuss two other studies that project national health expenditures based on less restrictive premises.

In 1980, the Nation spent $247 billion for health.[12] This included expenditures for hospital care, physicians' services, nursing home care, dentists' services, other professional services, drugs and drug sundries, eyeglasses and appliances, research, construction, Government public health activities, and prepayment and administration. Taking into account projected increases in real income and health insurance coverage, changes in the number of providers, and certain financial characteristics of the health care system, as well as population growth, a 1975 study projected total national health expenditures for all types of health services for the year 2000.[13] According to that projection, expenditures will be close to $1,000 billion in the year 2000 (about $400 billion in 1975 prices).

The Health Care Financing Administration recently projected national health expenditures for 1990.[14] This study assumed that current trends and relationships would continue in the future—specifically that the historical trends during the period 1965–1979 would continue for per capita use of medical care, that medical care prices would have the same relationship to the Consumer Price Index for all items as they did during that period, and that the population, health manpower, the Consumer Price Index, and the gross national product would grow according to projections of the Social Security Administration, the Bureau of Health Manpower, and the Office of Management and Budget, respectively.

This study projected that health expenditures will grow rapidly between 1981 and 1990, totaling $821 billion in 1990, almost three times the 1981 level (table 14). Per capita expenditures were projected to increase by a factor of 2.7, from $1,216 in 1981 to $3,309 in 1990. As a result of this rapid growth, national health expenditures will increase as a proportion of gross national product from 9.7 percent in 1981 to 10.8 percent in 1990. Projected aggregate and per capita amounts of national health expenditures by type of expenditure are shown in table 14 for calendar years 1981, 1985, and 1990.

Table 5. Number of persons with limitation of activity from chronic conditions per 1,000 population, number of persons with limitation of activity and percent increase, and percent distribution of persons with limitation of activity by mortality assumption and age: United States, 1978 and 2003 projections

Mortality assumption and age	*Persons with limitation of activity*					
	Number per 1,000 population	*1978*	*2003*	*Increase, 1978–2003*	*1978*	*2003*
Constant mortality		Number in thousands		Percent	Percent distribution	
All ages	143.3	31,212	42,492	36.1	100.0	100.0
Under 20 years	37.2	2,672	2,870	7.4	8.6	6.8
20–44 years	88.7	6,989	8,499	21.6	22.4	20.0
45–64 years	242.9	10,654	16,121	51.3	34.1	37.9
65 years and over	458.7	10,897	15,002	37.7	34.9	35.3
Declining mortality						
All ages	143.3	31,212	45,811	46.8	100.0	100.0
Under 20 years	37.2	2,672	2,899	8.5	8.6	6.3
20–44 years	88.7	6,989	8,529	22.0	22.4	18.6
45–64 years	242.9	10,654	16,494	54.8	34.1	36.0
65 years and over	453.7	10,897	17,889	64.2	34.9	39.0

Table 6. Number of physician visits per 1,000 population, number of physician visits and percent increase, and percent distribution of physician visits by mortality assumption and age: United States, 1978 and 2003 projections

Mortality assumption and age	*Physician visits*					
	Number per 1,000 population	*1978*	*2003*	*Increase, 1978–2003*	*1978*	*2003*
Constant mortality		Number in millions		Percent	Percent distribution	
All ages	4,900	1,072.0	1,357.8	26.7	100.0	100.0
Under 20 years	4,000	287.4	308.6	7.4	26.8	22.7
20–44 years	4,700	370.3	450.3	21.6	34.5	33.2
45–64 years	5,700	250.0	378.3	51.3	23.3	27.9
65 years and over	6,800	164.3	220.6	34.3	15.3	16.2
Declining mortality						
All ages	4,900	1,072.0	1,410.6	31.6	100.0	100.0
Under 20 years	4,000	287.4	311.7	8.5	26.8	22.1
20–44 years	4,700	370.3	451.9	22.0	34.5	32.0
45–64 years	5,700	250.0	387.1	54.8	23.3	27.4
65 years and over	6,800	164.3	259.9	58.2	15.3	18.4

Table 7. Number of days of care in non-Federal short-stay hospitals per 1,000 population, numbers of days and percent increase, and percent distribution of days of care by mortality assumption and age: United States, 1978 and 2003 projections

Mortality assumption and age	Days of care					
	Number per 1,000 population	1978	2003	Increase, 1978–2003	1978	2003
Constant mortality		Number in millions		Percent	Percent distribution	
All ages	1,255.0	274.1	372.0	35.8	100.0	100.0
Under 20 years	386.4	27.8	29.8	7.4	10.1	8.0
20–44 years	896.8	70.7	85.9	21.6	25.8	23.1
45–64 years	1,716.8	75.3	113.9	51.3	27.5	30.6
65 years and over	4,163.7	100.3	142.4	42.0	36.6	38.3
Declining mortality						
All ages	1,255.0	274.1	406.8	48.4	100.0	100.0
Under 20 years	386.4	27.8	30.1	8.5	10.1	7.4
20–44 years	896.8	70.7	86.2	22.0	25.8	21.2
45–64 years	1,716.8	75.3	116.6	54.8	27.5	28.7
65 years and over	4,163.7	100.3	173.9	73.3	36.6	42.7

Table 8. Number of nursing home residents per 1,000 population, number of nursing home residents and percent increase, and percent distribution of nursing home residents by mortality assumption and age: United States, 1978 and 2003 projections

Mortality assumption and age	Nursing home residents					
	Number per 1,000 population	1978	2003	Increase, 1978–2003	1978	2003
Constant mortality		Number in millions		Percent[1]	Percent distribution[1]	
All ages	6.1	1.3	2.1	56.8	100.0	100.0
Under 65 years	0.9	0.2	0.2	23.1	13.2	10.4
65–74 years	14.5	0.2	0.2	14.9	16.4	12.0
75–84 years	68.0	0.5	0.8	61.5	35.4	36.5
85 years and over	216.6	0.5	0.9	84.3	35.0	41.1
Declining mortality						
All ages	6.1	1.3	2.8	112.1	100.0	100.0
Under 65 years	0.9	0.2	0.2	24.4	13.2	7.8
65–74 years	14.5	0.2	0.3	23.7	16.4	9.5
75–84 years	68.0	0.5	0.9	85.9	35.4	31.1
85 years and over	216.6	0.5	1.4	213.2	35.6	51.6

[1]Percent distributions by age and percent increases in nursing home residents are calculated from whole numbers rather than from numbers in millions.

Table 9. Health services utilization and percent increase, by mortality assumption and type of care: United States, 1978 and 2003 projections

Mortality assumption and type of care	Year		
	1978	2003	Increase, 1978–2003
	Number per 1,000 population		Percent
Constant mortality			
Physician visits	4,908	5,001	1.9
Hospital days	1,255	1,371	9.2
Nursing home residents	6	8	24.6
Declining mortality			
Physician visits	4,908	5,039	2.7
Hospital days	1,255	1,453	15.8
Nursing home residents	6	10	63.9

Table 10. Expenditures in constant dollars for physician visits, percent increase, and percent distribution by mortality assumption and age: United States, 1978 and 2003 projections

Mortality assumption and age	Expenditures for physician visits					
	Per capita amount	1978	2003	Increase, 1978–2003	1978	2003
		Amount in billions		Percent	Percent distribution	
Constant mortality						
All ages	$166	$36.3	$47.2	30.0	100.0	100.0
Under 20 years	77	5.6	6.0	7.1	15.4	12.7
20–64 years	185	22.7	30.3	33.5	62.5	64.2
65 years and over	337	8.1	10.9	34.6	22.3	23.1
Declining mortality						
All ages	166	36.3	49.6	36.6	100.0	100.0
Under 20 years	77	5.6	6.1	8.9	15.4	12.3
20–64 years	185	22.7	30.7	35.2	62.5	61.9
65 years and over	337	8.1	12.8	58.0	22.3	25.8

Table 11. Expenditures in constant dollars for non-Federal short-stay hospital care, percent increase, and percent distribution by mortality assumption and age: United States, 1978 and 2003 projections

Mortality assumption and age	Expenditures for hospital care					
	Per capita amount	1978	2003	Increase, 1978–2003	1978	2003
		Amount in billions		Percent	Percent distribution	
Constant mortality						
All ages	$338	$73.9	$97.5	31.9	100.0	100.0
Under 20 years	99	7.1	7.6	7.0	9.6	7.8
20–64 years	377	46.3	60.8	31.3	62.7	62.4
65 years and over	855	20.5	29.1	42.0	27.7	29.8
Declining mortality						
All ages	388	73.9	105.8	43.2	100.0	100.0
Under 20 years	99	7.1	7.7	8.5	9.6	7.3
20–64 years	377	46.3	62.6	35.2	62.7	59.2
65 years and over	855	20.5	35.5	73.2	27.7	33.6

Table 12. Expenditures in constant dollars for nursing home care, percent increase, and percent distribution by mortality assumption and age: United States, 1978 and 2003 projections

Mortality assumption and age	Expenditures for nursing home					
	Per capita amount	*1978*	*2003*	*Increase, 1978–2003*	*1978*	*2003*
		Amount in billions		Percent	Percent distribution	
Constant mortality						
All ages	$66	$14.5	$22.6	55.9	100.0	100.0
Under 65 years	12	2.4	3.0	25.0	16.6	13.3
65 years and over	506	12.1	19.6	62.0	83.4	86.7
Declining mortality						
All ages	66	14.5	30.3	109.0	100.0	100.0
Under 65 years	12	2.4	3.0	25.0	16.6	9.9
65 years and over	506	12.1	27.3	125.6	83.4	90.1

Table 13. Per capita expenditures for health services and percent increase, by mortality assumption and type of care: United States, 1978 and 2003 projections

Mortality assumption and type of care	Year		
	1978	*2003*	*Increase, 1978–2003*
	Per capita amount		Percent
Constant mortality			
Hospital days	$338	$359	6.1
Physician visits	166	174	4.6
Nursing home residents	66	83	25.3
Declining mortality			
Hospital days	338	378	11.7
Physician visits	166	177	6.6
Nursing home residents	66	108	63.0

Table 14. Aggregate and per capita national health expenditures, by type of expenditure: United States, 1981, 1985, and 1990 projections

Type of expenditure	Year					
	1981	*1985*	*1990*	*1981*	*1985*	*1990*
	Amount in millions			Per capita amount[2]		
Total	$278,543	$462,229	$821,017	$1,216.00	$1,946.00	$3,309.00
Health services and supplies	266,618	444,575	794,590	1,164.00	1,872.00	3,203.00
Personal health care	246,686	440,288	731,438	1,077.00	1,727.00	2,948.00
Hospital care	112,277	189,528	355,089	490.00	798.00	1,430.00
Physicians' services	52,862	87,494	150,319	231.00	368.00	606.00
Dentists' services	18,054	29,863	52,022	79.00	126.00	210.00
Other professional services	6,343	10,858	19,139	28.00	46.00	77.00
Drugs and medical sundries	20,636	29,581	44,434	90.00	125.00	179.00
Eyeglasses and appliances	5,333	7,986	12,559	23.00	33.00	51.00
Nursing home care	24,485	44,565	81,788	107.00	188.00	330.00
Other health services	6,652	10,365	16,371	29.00	44.00	66.00
Prepayment and administration	11,629	18,872	32,441	51.00	80.00	133.00
Government public health activities	8,295	15,303	30,269	36.00	64.00	122.00
Research and construction of medical facilities	11,922	17,648	26,421	52.00	74.00	107.00
Research[1]	5,814	9,054	14,381	25.00	38.00	58.00
Construction	6,108	8,594	12,040	27.00	36.00	49.00

[1]Research and development expenditures of drug companies and other manufacturers and providers of medical equipment and supplies are excluded from "research expenditures," but are included in the expenditure class in which each product falls.
[2]Per capita amounts are rounded to nearest dollar.

SOURCE: Health Care Financing Administration, M. S. Freeland and C. E. Schendler: National health expenditures: Short-term outlook and long-term projections. *Health Care Financing Review.* HCFA Pub. No. 03090. Washington. U.S. Government Printing Office, Winter 1981.

Chapter 6
Discussion

Reductions in mortality levels can no longer greatly affect the rate of population growth; however, such reductions can have significant long-term effects on the age composition of the population as shown by the projections in this report under two differing mortality assumptions.

Under the constant mortality assumption, the population under 20 years of age is projected to increase by about 7 percent during 1978–2003, compared with 28 percent during 1953–1978. The population 20–44 years of age would grow about half as fast in the future period as it did in the past. In contrast, the population 45–64 years of age would grow at a rate greater than 50 percent, compared with 36 percent during 1953–1978.

The population 65 years of age and over will also grow rapidly. During 1953–78, this age group grew twice as fast as the population as a whole: 76 percent, compared with 38 percent. If the declining mortality assumption is realized, the aged population will again be the fastest growing demographic segment of the population, increasing 59 percent by the year 2003, while the population of all ages increases only 28 percent.

The most rapidly growing age group would be the oldest—people 85 years of age and over. A tripling in the size of this age group would occur if the declining mortality assumption is realized—from 2 million to more than 6 million people.

This projected rapid increase in the size of the population 85 years of age and over would arise from different sources than in the past. The tripling during 1953–78 reflected the impact of immigration patterns to our Nation around the turn of the century. In contrast, future growth would result from improved health status and greater longevity.

The differential growth of the population by age can have important consequences for many social institutions, particularly in terms of dependency. Because the most slowly growing age group will be those under 20 years of age, their proportionate share of the total population will diminish measurably. In 1953, they accounted for more than one-third of the population; by 2003, their share may decline to slightly more than one-fourth of the population. If the declining mortality assumption is realized, the group that will gain primarily will be the aged, increasing from less than 9 percent of the total population in 1953 to almost 14 percent in 2003.

As the number of elderly persons grows in relation to the working population, the use of public funds to finance services for the elderly may be constrained. Because the aged will be the most rapidly growing age group, the burden on the working population to provide necessary support for this group will increase.

Health care needs

An aging population raises issues relating to the availability of future health care services. Will the supply of physicians, hospital beds, and nursing home beds in 2003 be sufficient to meet the needs of the projected elderly population?

Physicians

The supply of physicians should be more than adequate to handle the projected number of visits. Under the declining mortality assumption, visits will increase by 32 percent between 1978 and 2003. The Graduate Medical Education National Advisory Committee projects an increase of almost 40 percent in the number of active physicians by 1990.[15] Even without any additional increase in physician supply between 1990 and 2003, the number per 100,000 population would increase from about 184 physicians in 1978 to 200 in 2003. The Nation may have an excess supply of physicians by the year 2003, but whether it will have adequate numbers specially trained in geriatric medicine is another issue. Dr. Robert Kane and colleagues, who looked at future requirements for geriatric manpower, concluded that about 8,000 geriatricians would be needed by 2030.[16]

Hospitals

The number of hospital days projected for 2003, under the constant mortality assumption, would require an average of 4.4 beds per 1,000 population if occupancy rates averaged 85 percent. A report by the Institute of Medicine concluded "current utilization patterns probably exaggerate current needs."[17] It noted that Health Maintenance Organizations "have experienced hospital utilization rates 30 to 50 percent below those of the conventional fee-for-service arrangements," which indicate a potential for reducing hospital utilization rates. If there were a 20-percent reduction in days of care projected for 2003, 3.5 beds per 1,000 population would be sufficient for the projected population at 85 percent occupancy.

Although there are some trends toward lower per capita use of hospitals, such as declining average lengths of stay and tightening of hospital admissions, the effect of these on utilization rates over the long run is uncertain. Many factors interact to determine supply and demand, including the possibility that supply creates demand. A careful watch should be kept on the need for and supply of hospital beds.

Nursing homes

Currently, nursing homes are experiencing an average annual occupancy rate of almost 90 percent, with a ratio of

1.07 beds per resident.[18] If average lengths of stay do not change, 2.1 million beds will be required to accommodate the number of residents projected for 2003 under the constant mortality assumption. Even more beds could be required if there is an attempt to reduce length of hospital stay by generally substituting nursing home care for hospital care.

The Health Care Financing Administration has projected use of nursing homes to the year 2030.[10] Under this projection, a 132-percent increase in the number of nursing home residents would occur between 1977 and 2030, using current age-specific utilization rates. The number of nursing home residents would increase from about 1.3 million in 1977 to about 1.9 million in the year 2000 and approximately 2.9 million by 2030. It is evident that the aging of the population will have a much greater impact on nursing home care than on days of hospital care or physician visits.

Alternative services

Alternative solutions to institutionalization of the elderly have long been sought, and a variety have been developed. These include foster care homes, congregate housing and retirement communities, home care, personal care, homemaker and chore services, home delivered and congregate meals, and adult daycare centers. The goal with many of these services is to enable the elderly to maintain their independence as long as possible. However, the development and availability of these services has been uneven around the country, and public funding, when available, has been inadequate. Coverage of noninstitutional care and social services by public and private health insurance is an important issue. Health insurance traditionally has emphasized and paid for hospital care, thereby discouraging the use of lower cost alternatives to hospital care.

Given efforts at health promotion and higher educational attainment, it is possible that the elderly of the future may reach old age in better health status than the elderly of the past. James Fries suggests that people in the future will have a longer disability-free life but not a much longer life span, thereby reducing the pressure for long-term care services.[19] If the period of diminished vigor associated with aging decreases, then chronic diseases may occupy a smaller proportion of the typical life span. However, there will still be a range of supportive services that the very old need even in the best of health. Alternative services may simply fill an as yet unmet need; they may not necessarily reduce expenditures for long-term care.

Other concerns

The elderly suffer from many conditions that are not life-threatening or debilitating but adversely affect the quality of life and the ability to live independently. These include hearing and vision impairments, incontinence, and senility to mention a few. More research is needed on the management of such conditions to enable the afflicted individual to cope better and to slow the progression of the disease or impairment and prevent complications.

A greater emphasis on geriatrics and gerontology in the training of health professionals is also needed to increase the understanding of the problems associated with aging for all levels and types of providers who serve the aged. This could be coupled with expanded education of the elderly themselves with a focus on preventive medicine, nutrition, and self-care.

Chapter 7
Conclusion

The longer the period of projection, the more difficult it is to reasonably predict the changes and the effect of changes in patterns of medical treatment, Government regulations, insurance coverage, education, income, and other important parameters. This report has purposely been restricted to changes in the size and age of the population, although other forces will have an impact on health care use and expenditures.

It is not known whether the momentum of sharp reductions in mortality levels experienced during the recent past will continue. However, because there is so much uncertainty over factors associated with trends in major causes of death, no other effective substitute exists for projecting the future health status of the United States than to extrapolate past trends.

The projections in this report emphasize the changing age distribution of the population in which the proportion of elderly in the population will grow rapidly whether mortality rates remain unchanged or continue to decline. If the constant mortality assumption is taken as a "minimum impact" projection, some increases would still occur in the number of people with limitation of activity, the number of hospital days, the number of nursing home residents, and corresponding costs. Under the declining mortality assumption there would be an even greater level of disability and dependence, and the costs associated with providing health care for an increasingly elderly population would be correspondingly higher.

The implications of the aging of the population in the years ahead for social institutions, including the health care delivery system, should be considered in policy planning. Although no one can say with any degree of certainty what the future will bring, the U.S. population will grow more elderly and the need for health care facilities may well increase. These projections indicate a need to continue activities aimed toward providing health care for the elderly.

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Appendix

Detailed projections of population by age, race, and sex were prepared by the Office of the Actuary, Social Security Administration, using alternative assumptions of future mortality developed by the National Center for Health Statistics. Assumptions about future fertility and future net immigration in this report are the same as those used by the Office of the Actuary. Age-sex specific death rates were used to generate life tables, also reflected in the population projections in this report. Detailed demographic information, which serves as the basis for projections and estimates in this report, is provided in tables I–V.

Contents

List of appendix tables

Table I. Assumed annual net surviving immigrants, by age and sex: United States

Age	Surviving net immigrants		
	Both sexes	Male	Female
All ages	400,000	188,649	211,351
0–4 years	51,461	25,752	25,709
5–9 years	33,848	16,987	16,861
10–14 years	35,671	18,228	17,443
15–19 years	40,439	19,186	21,253
20–24 years	51,814	20,673	31,141
25–29 years	66,676	32,217	34,459
30–34 years	39,417	20,020	19,397
35–39 years	24,908	12,260	12,648
40–44 years	16,053	7,695	8,358
45–49 years	12,339	5,426	6,913
50–54 years	10,442	4,167	6,275
55–59 years	7,871	2,968	4,903
60–64 years	5,842	2,134	3,708
65–69 years	1,816	549	1,267
70–74 years	1,025	383	642
75–79 years	173	[1]–22	195
80–84 years	205	26	179
85 years and over	-	-	-

[1]For this age group, the number of emigrants exceeds the number of immigrants, causing a negative figure.

Table II. Death rates by age and sex: United States, 1966, 1976, and projections for 2003

Age	Male			Female		
	1966	1976	2003	1966	1976	2003
	Deaths per 100,000 population					
Under 1 year	2,713.7	1,762.6	549.7	2,085.1	1,419.0	502.0
1–4 years	105.2	78.2	35.1	87.2	61.3	23.7
5–9 years	51.3	41.0	22.4	37.1	28.3	13.6
10–14 years	51.5	44.0	28.8	30.4	25.0	14.7
15–19 years	144.9	139.9	127.2	58.5	53.2	41.2
20–24 years	199.0	198.4	196.8	71.2	64.4	49.1
25–29 years	188.3	187.2	184.3	87.2	72.4	43.8
30–34 years	216.4	196.5	193.5	125.6	94.5	57.2
35–39 years	305.3	261.6	216.1	181.7	138.6	66.7
40–44 years	474.5	406.0	266.5	279.9	225.3	125.4
45–49 years	759.9	647.8	421.0	427.9	356.3	217.3
50–54 years	1,233.4	1,017.3	604.8	631.5	536.8	346.8
55–59 years	1,859.3	1,578.0	1,013.3	885.5	807.2	628.7
60–64 years	2,899.0	2,496.3	1,667.0	1,381.6	1,230.5	900.1
65–69 years	4,172.5	3,586.9	2,384.5	2,146.1	1,712.8	931.7
70–74 years	5,940.2	5,433.7	4,271.6	3,364.5	2,856.4	1,835.9
75–79 years	8,744.2	8,263.3	7,092.9	5,694.8	4,850.6	3,145.8
80–84 years	12,804.0	11,521.1	8,663.5	9,427.8	7,632.5	4,314.8
85 years and over	22,008.6	17,983.9	10,424.9	18,854.2	14,312.1	6,799.9

Table III. Final and projected death rates and percent difference, by age: United States, 1978

Age	1978 death rates		Percent difference
	Final	Projected	
All ages	8.8	9.1	3.4
Under 20 years	1.2	1.3	8.3
20–44 years	1.7	1.7	-
45–64 years	9.9	10.1	2.0
65 years and over	52.9	54.4	2.8
65–74 years	30.3	31.4	3.6
75–84 years	71.9	73.1	1.7
85 years and over	147.0	154.7	5.2

Table IV. Life tables by sex: United States, 1976 and projections for 2003

Year, sex, and age	Proportion of persons alive at beginning of age interval dying during interval	Of 100,000 born alive		Stationary population		Average number of years of life remaining at beginning of age interval
		Number living at beginning of age interval	Number dying during age interval	In the age interval	In this and all subsequent age intervals	
x *to* x + n	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	$\mathring{e}_x$
1976						
Male						
0	0.01695	100,000	1,695	98,398	6,899,787	69.0
1	0.00106	98,305	104	98,251	6,801,389	69.2
2	0.00082	98,201	80	98,159	6,703,138	68.3
3	0.00066	98,121	65	98,086	6,604,979	67.3
4	0.00056	98,056	54	98,027	6,506,893	66.4
5	0.00049	98,002	48	97,980	6,408,866	65.4
6	0.00045	97,954	44	97,933	6,310,886	64.4
7	0.00041	97,910	41	97,891	6,212,953	63.5
8	0.00037	97,869	36	97,852	6,115,062	62.5
9	0.00032	97,833	32	97,819	6,017,210	61.5
10	0.00028	97,801	28	97,785	5,919,391	60.5
11	0.00029	97,773	28	97,757	5,821,606	59.5
12	0.00036	97,745	35	97,726	5,723,849	58.6
13	0.00052	97,710	51	97,682	5,626,123	57.6
14	0.00075	97,659	73	97,621	5,528,441	56.6
15	0.00100	97,586	98	97,537	5,430,820	55.7
16	0.00124	97,488	121	97,428	5,333,283	54.7
17	0.00145	97,367	141	97,297	5,235,855	53.8
18	0.00162	97,226	157	97,147	5,138,558	52.9
19	0.00174	97,069	169	96,985	5,041,411	51.9
20	0.00186	96,900	180	96,810	4,944,426	51.0
21	0.00197	96,720	191	96,624	4,847,616	50.1
22	0.00204	96,529	197	96,431	4,750,992	49.2
23	0.00204	96,332	197	96,233	4,654,561	48.3
24	0.00200	96,135	192	96,039	4,558,328	47.4
25	0.00194	95,943	186	95,848	4,462,289	46.5
26	0.00188	95,757	181	95,665	4,366,441	45.6
27	0.00185	95,576	176	95,487	4,270,776	44.7
28	0.00183	95,400	175	95,311	4,175,289	43.8
29	0.00184	95,225	175	95,136	4,079,978	42.8
30	0.00186	95,050	177	94,966	3,984,842	41.9
31	0.00189	94,873	179	94,788	3,889,876	41.0
32	0.00194	94,694	184	94,606	3,795,088	40.1
33	0.00202	94,510	191	94,419	3,700,482	39.2
34	0.00212	94,319	200	94,224	3,606,063	38.2
35	0.00224	94,119	211	94,015	3,511,839	37.3
36	0.00239	93,908	225	93,796	3,417,824	36.4
37	0.00258	93,683	241	93,564	3,324,028	35.5
38	0.00279	93,442	261	93,312	3,230,464	34.6
39	0.00305	93,181	284	93,040	3,137,152	33.7
40	0.00333	92,897	309	92,737	3,044,112	32.8
41	0.00365	92,588	338	92,414	2,951,375	31.9
42	0.00401	92,250	370	92,060	2,858,961	31.0
43	0.00441	91,880	405	91,672	2,766,901	30.1
44	0.00484	91,475	443	91,249	2,675,229	29.2
45	0.00532	91,032	484	90,784	2,583,980	28.4
46	0.00585	90,548	530	90,276	2,493,196	27.5
47	0.00642	90,018	578	89,723	2,402,920	26.7
48	0.00704	89,440	630	89,119	2,313,197	25.9
49	0.00771	88,810	685	88,461	2,224,078	25.0
50	0.00844	88,125	744	87,759	2,135,617	24.2
51	0.00924	87,381	808	86,982	2,047,858	23.4
52	0.01010	86,573	874	86,142	1,960,876	22.6
53	0.01101	85,699	944	85,233	1,874,734	21.9
54	0.01200	84,755	1,017	84,252	1,789,501	21.1
55	0.01303	83,738	1,091	83,166	1,705,249	20.4
56	0.01416	82,647	1,170	82,036	1,622,083	19.6
57	0.01548	81,477	1,262	80,819	1,540,047	18.9
58	0.01707	80,215	1,369	79,505	1,459,228	18.2
59	0.01886	78,846	1,487	78,076	1,379,723	17.5
60	0.02083	77,359	1,612	76,541	1,301,647	16.8

Table IV. Life tables by sex: United States, 1976 and projections for 2003—Con.

Year, sex, and age	Proportion of persons alive at beginning of age interval dying during interval	Of 100,000 born alive		Stationary population		Average number of years of life remaining at beginning of age interval
		Number living at beginning of age interval	Number dying during age interval	In the age interval	In this and all subsequent age intervals	
x *to* x + n	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	$\mathring{e}_x$
1976—Con.						
Male—Con.						
61	0.02288	75,747	1,733	74,868	1,225,106	16.2
62	0.02489	74,014	1,842	73,081	1,150,238	15.5
63	0.02678	72,172	1,933	71,194	1,077,157	14.9
64	0.02863	70,239	2,011	69,221	1,005,963	14.3
65	0.03052	68,228	2,082	67,157	936,742	13.7
66	0.03261	66,146	2,157	65,038	869,585	13.1
67	0.03504	63,989	2,242	62,838	804,547	12.6
68	0.03795	61,747	2,343	60,546	741,709	12.0
69	0.04130	59,404	2,454	58,147	681,163	11.5
70	0.04492	56,950	2,558	55,593	623,016	10.9
71	0.04874	54,392	2,651	52,989	567,423	10.4
72	0.05294	51,741	2,739	50,294	514,434	9.9
73	0.05756	49,002	2,821	47,514	464,140	9.5
74	0.06262	46,181	2,892	44,657	416,626	9.0
75	0.06809	43,289	2,947	41,751	371,969	8.6
76	0.07391	40,342	2,982	38,787	330,218	8.2
77	0.08005	37,360	2,990	35,800	291,431	7.8
78	0.08644	34,370	2,971	32,820	255,631	7.4
79	0.09302	31,399	2,921	29,874	222,811	7.1
80	0.09964	28,478	2,837	27,138	192,937	6.8
81	0.10608	25,641	2,720	24,358	165,799	6.5
82	0.11195	22,921	2,566	21,717	141,441	6.2
83	0.11662	20,355	2,374	19,246	119,724	5.9
84	0.11912	17,981	2,142	16,988	100,478	5.6
85	1.00000	15,839	15,839	83,490	83,490	5.3
Female						
0	0.01369	100,000	1,369	98,681	7,665,372	76.7
1	0.00081	98,631	80	98,585	7,566,691	76.7
2	0.00065	98,551	64	98,514	7,468,106	75.8
3	0.00053	98,487	52	98,455	7,369,592	74.8
4	0.00044	98,435	43	98,408	7,271,137	73.9
5	0.00037	98,392	36	98,375	7,172,729	72.9
6	0.00032	98,356	31	98,342	7,074,354	71.9
7	0.00028	98,325	27	98,313	6,976,012	70.9
8	0.00024	98,298	24	98,287	6,877,699	70.0
9	0.00022	98,274	22	98,264	6,779,412	69.0
10	0.00020	98,252	20	98,241	6,681,148	68.0
11	0.00020	98,232	20	98,222	6,582,907	67.0
12	0.00023	98,212	22	98,200	6,484,685	66.0
13	0.00028	98,190	27	98,175	6,386,485	65.0
14	0.00034	98,163	34	98,145	6,288,310	64.1
15	0.00042	98,129	41	98,108	6,190,165	63.1
16	0.00049	98,088	49	98,064	6,092,057	62.1
17	0.00055	98,039	54	98,012	5,993,993	61.1
18	0.00059	97,985	58	97,956	5,895,981	60.2
19	0.00060	97,927	59	97,897	5,798,025	59.2
20	0.00062	97,868	60	97,838	5,700,128	58.2
21	0.00064	97,808	62	97,776	5,602,290	57.3
22	0.00065	97,746	64	97,714	5,504,514	56.3
23	0.00066	97,682	65	97,649	5,406,800	55.4
24	0.00067	97,617	66	97,584	5,309,151	54.4
25	0.00068	97,551	67	97,519	5,211,567	53.4
26	0.00070	97,484	68	97,451	5,114,048	52.5
27	0.00072	97,416	70	97,382	5,016,597	51.5
28	0.00075	97,346	73	97,311	4,919,215	50.5
29	0.00079	97,273	76	97,236	4,821,904	49.6
30	0.00083	97,197	81	97,159	4,724,668	48.6
31	0.00089	97,116	86	97,076	4,627,509	47.6
32	0.00094	97,030	92	96,987	4,530,433	46.7

Table IV. Life tables by sex: United States, 1976 and projections for 2003—Con.

Year, sex, and age	Proportion of persons alive at beginning of age interval dying during interval	Of 100,000 born alive		Stationary population		Average number of years of life remaining at beginning of age interval
		Number living at beginning of age interval	Number dying during age interval	In the age interval	In this and all subsequent age intervals	
x *to* x + n	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	$\mathring{e}_x$
1976—Con.						
Female—Con.						
33	0.00101	96,938	97	96,893	4,433,446	45.7
34	0.00107	96,841	104	96,792	4,336,553	44.8
35	0.00115	96,737	112	96,680	4,239,761	43.8
36	0.00125	96,625	121	96,564	4,143,081	42.9
37	0.00136	96,504	131	96,438	4,046,517	41.9
38	0.00150	96,373	144	96,300	3,950,079	41.0
39	0.00166	96,229	159	96,149	3,853,779	40.0
40	0.00183	96,070	176	95,976	3,757,630	39.1
41	0.00202	95,894	194	95,791	3,661,654	38.2
42	0.00223	95,700	213	95,588	3,565,863	37.3
43	0.00245	95,487	234	95,364	3,470,275	36.3
44	0.00270	95,253	257	95,119	3,374,911	35.4
45	0.00296	94,996	281	94,849	3,279,792	34.5
46	0.00325	94,715	308	94,555	3,184,943	33.6
47	0.00355	94,407	335	94,233	3,090,388	32.7
48	0.00386	94,072	363	93,885	2,996,155	31.8
49	0.00418	93,709	392	93,507	2,902,270	31.0
50	0.00454	93,317	423	93,101	2,808,763	30.1
51	0.00492	92,894	457	92,660	2,715,662	29.2
52	0.00534	92,437	493	92,186	2,623,002	28.4
53	0.00578	91,944	532	91,673	2,530,816	27.5
54	0.00627	91,412	573	91,121	2,439,143	26.7
55	0.00677	90,839	615	90,513	2,348,022	25.8
56	0.00732	90,224	661	89,875	2,257,509	25.0
57	0.00796	89,563	713	89,188	2,167,634	24.2
58	0.00871	88,850	774	88,444	2,078,446	23.4
59	0.00955	88,076	842	87,636	1,990,002	22.6
60	0.01051	87,234	917	86,801	1,902,366	21.8
61	0.01150	86,317	993	85,847	1,815,565	21.0
62	0.01241	85,324	1,059	84,820	1,729,718	20.3
63	0.01316	84,265	1,109	83,737	1,644,898	19.5
64	0.01385	83,156	1,151	82,606	1,561,161	18.8
65	0.01454	82,005	1,192	81,412	1,478,555	18.0
66	0.01543	80,813	1,247	80,191	1,397,143	17.3
67	0.01665	79,566	1,325	78,906	1,316,952	16.6
68	0.01834	78,241	1,435	77,526	1,238,046	15.8
69	0.02044	76,806	1,570	76,024	1,160,520	15.1
70	0.02272	75,236	1,709	74,327	1,084,496	14.4
71	0.02516	73,527	1,850	72,548	1,010,169	13.7
72	0.02797	71,677	2,005	70,621	937,621	13.1
73	0.03124	69,672	2,177	68,529	867,000	12.4
74	0.03492	67,495	2,357	66,263	798,471	11.8
75	0.03895	65,138	2,537	63,852	732,208	11.2
76	0.04324	62,601	2,707	61,231	668,356	10.7
77	0.04776	59,894	2,860	58,446	607,125	10.1
78	0.05249	57,034	2,994	55,520	548,679	9.6
79	0.05746	54,040	3,105	52,470	493,159	9.1
80	0.06271	50,935	3,194	49,315	440,689	8.7
81	0.06829	47,741	3,260	46,088	391,374	8.2
82	0.07428	44,481	3,304	42,806	345,286	7.8
83	0.08076	41,177	3,326	39,491	302,480	7.3
84	0.08782	37,851	3,324	36,166	262,989	6.9
85	1.00000	34,527	34,527	226,823	226,823	6.6
2003						
Male						
0	0.00547	100,000	547	99,508	7,421,747	74.22
1	0.00057	99,453	57	99,425	7,322,240	73.63
2	0.00035	99,396	34	99,378	7,222,815	72.67
3	0.00027	99,362	27	99,348	7,123,437	71.69

Table IV. Life tables by sex: United States, 1976 and projections for 2003—Con.

Year, sex, and age	Proportion of persons alive at beginning of age interval dying during interval	Of 100,000 born alive		Stationary population		Average number of years of life remaining at beginning of age interval
		Number living at beginning of age interval	Number dying during age interval	In the age interval	In this and all subsequent age intervals	
x *to* x + n	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	$\mathring{e}_x$
2003—Con.						
Male—Con.						
4	0.00022	99,335	22	99,324	7,024,089	70.71
5	0.00023	99,313	22	99,302	6,924,765	69.73
6	0.00024	99,291	24	99,279	6,825,463	68.74
7	0.00024	99,267	24	99,255	6,726,184	67.76
8	0.00022	99,243	23	99,231	6,626,930	66.78
9	0.00018	99,220	18	99,211	6,527,698	65.79
10	0.00014	99,202	14	99,195	6,428,487	64.80
11	0.00014	99,188	13	99,182	6,329,292	63.81
12	0.00020	99,175	20	99,166	6,230,111	62.82
13	0.00036	99,155	36	99,138	6,130,945	61.83
14	0.00059	99,119	59	99,091	6,031,807	60.85
15	0.00085	99,060	84	99,020	5,932,716	59.89
16	0.00108	98,976	107	98,924	5,833,697	58.94
17	0.00130	98,869	129	98,806	5,734,773	58.00
18	0.00149	98,740	147	98,668	5,635,967	57.08
19	0.00164	98,593	162	98,514	5,537,299	56.16
20	0.00180	98,431	177	98,344	5,438,785	55.25
21	0.00195	98,254	192	98,159	5,340,441	54.35
22	0.00204	98,062	200	97,963	5,242,282	53.46
23	0.00205	97,862	200	97,762	5,144,319	52.57
24	0.00200	97,662	195	97,564	5,046,557	51.67
25	0.00192	97,467	186	97,373	4,948,993	50.78
26	0.00185	97,281	180	97,190	4,851,620	49.87
27	0.00180	97,101	175	97,013	4,754,430	48.96
28	0.00180	96,926	175	96,838	4,657,417	48.05
29	0.00183	96,751	178	96,662	4,560,579	47.14
30	0.00187	96,573	180	96,483	4,463,916	46.22
31	0.00190	96,393	184	96,301	4,367,433	45.31
32	0.00193	96,209	186	96,116	4,271,132	44.39
33	0.00196	96,023	188	95,929	4,175,016	43.48
34	0.00200	95,835	192	95,739	4,079,086	42.56
35	0.00204	95,643	195	95,546	3,983,347	41.65
36	0.00210	95,448	201	95,348	3,887,801	40.73
37	0.00216	95,247	206	95,145	3,792,453	39.82
38	0.00221	95,041	210	94,936	3,697,308	38.90
39	0.00227	94,831	216	94,724	3,602,372	37.99
40	0.00233	94,615	220	94,506	3,507,648	37.07
41	0.00242	94,395	229	94,282	3,413,142	36.16
42	0.00256	94,166	243	94,046	3,318,861	35.24
43	0.00283	93,923	266	93,792	3,224,815	34.33
44	0.00315	93,657	294	93,513	3,131,022	33.43
45	0.00352	93,363	329	93,201	3,037,510	32.53
46	0.00391	93,034	363	92,855	2,944,309	31.65
47	0.00426	92,671	395	92,476	2,851,454	30.77
48	0.00454	92,276	419	92,069	2,758,978	29.90
49	0.00480	91,857	440	91,639	2,666,910	29.03
50	0.00507	91,417	464	91,187	2,575,271	28.17
51	0.00542	90,953	493	90,710	2,484,084	27.31
52	0.00589	90,460	533	90,197	2,393,374	26.46
53	0.00652	89,927	586	89,639	2,303,177	25.61
54	0.00728	89,341	650	89,021	2,213,538	24.78
55	0.00809	88,691	718	88,338	2,124,517	23.95
56	0.00896	87,973	788	87,585	2,036,180	23.15
57	0.00996	87,185	866	86,758	1,948,594	22.35
58	0.01111	86,317	959	85,845	1,861,836	21.57
59	0.01240	85,358	1,058	84,837	1,775,991	20.81
60	0.01387	84,300	1,170	83,724	1,691,153	20.06
61	0.01542	83,130	1,281	82,498	1,607,429	19.34
62	0.01680	81,849	1,375	81,168	1,524,931	18.63
63	0.01791	80,474	1,441	79,758	1,443,763	17.94
64	0.01887	79,033	1,491	78,291	1,364,005	17.26

Table IV. Life tables by sex: United States, 1976 and projections for 2003—Con.

Year, sex, and age	Proportion of persons alive at beginning of age interval dying during interval	Of 100,000 born alive		Stationary population		Average number of years of life remaining at beginning of age interval
		Number living at beginning of age interval	Number dying during age interval	In the age interval	In this and all subsequent age intervals	
x *to* x + n	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	$\mathring{e}_x$
2003—Con.						
Male—Con.						
65	0.01976	77,542	1,533	76,779	1,285,714	16.58
66	0.02094	76,009	1,592	75,220	1,208,935	15.91
67	0.02279	74,417	1,696	73,580	1,133,715	15.23
68	0.02561	72,721	1,862	71,805	1,060,134	14.58
69	0.02924	70,859	2,073	69,840	988,329	13.95
70	0.03319	68,786	2,283	67,662	918,489	13.35
71	0.03725	66,503	2,477	65,281	850,827	12.79
72	0.04175	64,026	2,673	62,706	785,546	12.27
73	0.04673	61,353	2,866	59,936	722,840	11.78
74	0.05212	58,487	3,049	56,978	662,904	11.33
75	0.05828	55,438	3,230	53,837	605,926	10.93
76	0.06477	52,208	3,382	50,526	552,090	10.57
77	0.07054	48,826	3,444	47,105	501,564	10.27
78	0.07476	45,382	3,393	43,678	454,459	10.01
79	0.07750	41,989	3,254	40,349	410,781	9.78
80	0.07955	38,735	3,081	37,180	370,432	9.56
81	0.08162	35,654	2,910	34,184	333,251	9.35
82	0.08340	32,744	2,731	31,363	299,067	9.13
83	0.08519	30,013	2,557	28,720	267,704	8.92
84	0.08700	27,456	2,389	26,247	238,984	8.70
85	1.00000	25,067	25,067	212,737	212,737	8.49
Female						
0	0.00500	100,000	500	99,550	8,415,617	84.16
1	0.00038	99,500	38	99,481	8,316,067	83.58
2	0.00024	99,462	23	99,449	8,216,586	82.61
3	0.00018	99,439	18	99,429	8,117,136	81.63
4	0.00015	99,421	15	99,413	8,017,707	80.64
5	0.00014	99,406	14	99,399	7,918,294	79.66
6	0.00014	99,392	15	99,385	7,818,895	78.67
7	0.00014	99,377	14	99,370	7,719,511	77.68
8	0.00013	99,363	13	99,357	7,620,140	76.69
9	0.00012	99,350	12	99,344	7,520,784	75.70
10	0.00011	99,338	10	99,333	7,421,439	74.71
11	0.00010	99,328	10	99,323	7,322,106	73.72
12	0.00012	99,318	12	99,312	7,222,784	72.72
13	0.00017	99,306	17	99,298	7,123,472	71.73
14	0.00024	99,289	24	99,278	7,024,174	70.74
15	0.00031	99,265	30	99,251	6,924,896	69.76
16	0.00038	99,235	38	99,216	6,825,646	68.78
17	0.00043	99,197	43	99,176	6,726,430	67.81
18	0.00046	99,154	46	99,131	6,627,254	66.84
19	0.00048	99,108	47	99,085	6,528,122	65.87
20	0.00049	99,061	48	99,037	6,429,307	64.90
21	0.00050	99,013	50	98,988	6,330,000	63.93
22	0.00050	98,963	50	98,938	6,231,012	62.96
23	0.00049	98,913	48	98,889	6,132,074	61.99
24	0.00047	98,865	47	98,841	6,033,185	61.02
25	0.00044	98,818	44	98,796	5,934,344	60.05
26	0.00042	98,774	41	98,753	5,835,548	59.08
27	0.00042	98,733	42	98,712	5,736,795	58.10
28	0.00043	98,691	43	98,670	5,638,083	57.13
29	0.00047	98,648	46	98,626	5,539,413	56.15
30	0.00052	98,602	51	98,577	5,440,787	55.16
31	0.00056	98,551	56	98,523	5,342,210	54.21
32	0.00059	98,495	58	98,466	5,243,687	53.24
33	0.00060	98,437	59	98,408	5,145,220	52.27
34	0.00059	98,378	58	98,349	5,046,813	51.30
35	0.00058	98,320	57	98,292	4,948,463	50.33
36	0.00059	98,263	57	98,235	4,850,171	49.36
37	0.00063	98,206	62	98,175	4,751,937	48.39

Table IV. Life tables by sex: United States, 1976 and projections for 2003—Con.

Year, sex, and age	Proportion of persons alive at beginning of age interval dying during interval	Of 100,000 born alive		Stationary population		Average number of years of life remaining at beginning of age interval
		Number living at beginning of age interval	Number dying during age interval	In the age interval	In this and all subsequent age intervals	
x *to* x + n	$_nq_x$	l_x	$_nd_x$	$_nL_x$	T_x	$\mathring{e}_x$
2003—Con.						
Female—Con.						
38	0.00071	98,144	70	98,110	4,653,762	47.42
39	0.00083	98,074	81	98,035	4,555,652	46.45
40	0.00096	97,993	94	97,947	4,457,618	45.49
41	0.00110	97,899	107	97,847	4,359,670	44.53
42	0.00125	97,792	122	97,732	4,261,824	43.58
43	0.00140	97,670	137	97,603	4,164,091	42.63
44	0.00157	97,533	153	97,458	4,066,488	41.69
45	0.00176	97,380	171	97,296	3,969,030	40.76
46	0.00198	97,209	192	97,114	3,871,734	39.83
47	0.00218	97,017	212	96,912	3,774,619	38.91
48	0.00237	96,805	230	96,691	3,677,707	37.99
49	0.00256	96,575	247	96,453	3,581,016	37.08
50	0.00275	96,328	265	96,197	3,484,563	36.17
51	0.00298	96,063	287	95,922	3,388,366	35.27
52	0.00333	95,776	316	95,620	3,292,444	34.38
53	0.00382	95,458	365	95,280	3,196,824	33.49
54	0.00442	95,093	420	94,888	3,101,544	32.62
55	0.00504	94,673	477	94,439	3,006,656	31.76
56	0.00565	94,196	532	93,934	2,912,217	30.92
57	0.00627	93,664	588	93,375	2,818,283	30.09
58	0.00690	93,076	642	92,760	2,724,908	29.28
59	0.00751	92,434	694	92,092	2,632,149	28.48
60	0.00825	91,740	757	91,366	2,540,057	27.69
61	0.00897	90,983	817	90,578	2,448,691	26.91
62	0.00937	90,166	844	89,745	2,358,112	26.15
63	0.00930	89,322	830	88,904	2,268,368	25.40
64	0.00893	88,492	791	88,093	2,179,463	24.63
65	0.00842	87,701	739	87,328	2,091,371	23.85
66	0.00817	86,962	710	86,607	2,004,042	23.04
67	0.00851	86,252	734	85,890	1,917,435	22.23
68	0.00972	85,518	832	85,112	1,831,545	21.42
69	0.01161	84,686	983	84,208	1,746,432	20.62
70	0.01373	83,703	1,149	83,142	1,662,224	19.86
71	0.01585	82,554	1,309	81,913	1,579,083	19.13
72	0.01814	81,245	1,473	80,523	1,497,170	18.43
73	0.02056	79,772	1,640	78,966	1,416,647	17.76
74	0.02309	78,132	1,804	77,244	1,337,681	17.12
75	0.02586	76,328	1,974	75,355	1,260,438	16.51
76	0.02874	74,354	2,137	73,298	1,185,083	15.94
77	0.03143	72,217	2,270	71,091	1,111,784	15.40
78	0.03375	69,947	2,361	68,773	1,040,693	14.88
79	0.03579	67,586	2,419	66,381	971,920	14.38
80	0.03782	65,167	2,465	63,939	905,539	13.90
81	0.04002	62,702	2,509	61,451	841,601	13.42
82	0.04230	60,193	2,547	58,922	780,150	12.96
83	0.04472	57,646	2,578	56,360	721,227	12.51
84	0.04731	55,068	2,605	53,767	664,868	12.07
85	1.00000	52,463	52,463	611,100	611,100	11.65

Table V. Population by age, sex, and mortality assumption: United States, 1978 and 2003 projections

Age	Constant mortality						Declining mortality					
	Both sexes		Male		Female		Both sexes		Male		Female	
	1978	2003	1978	2003	1978	2003	1978	2003	1978	2003	1978	2003
	Population in thousands											
All ages	227,940	271,533	111,838	132,852	116,102	138,681	227,952	279,944	111,843	136,354	116,109	143,590
0–4 years	16,351	19,604	8,370	9,511	7,981	9,093	16,351	18,841	8,370	9,645	7,981	9,196
5–9 years	17,812	19,101	9,098	9,760	8,714	9,341	17,812	19,319	9,098	9,883	8,714	9,436
10–14 years	19,243	19,784	9,815	10,106	9,428	9,678	19,243	19,970	9,815	10,212	9,428	9,758
15–19 years	21,686	19,665	11,044	10,030	10,642	9,635	21,686	19,802	11,044	10,108	10,642	9,694
20–24 years	21,273	18,545	10,776	9,410	10,497	9,135	21,273	18,620	10,776	9,451	10,497	9,169
25–29 years	19,237	17,114	9,685	8,647	9,552	9,467	19,237	17,145	9,685	8,659	9,552	8,486
30–34 years	16,729	18,539	8,391	9,330	8,338	9,209	16,729	18,575	8,391	9,338	8,338	9,237
35–39 years	13,761	19,773	6,870	9,917	6,891	9,856	13,761	19,834	6,870	9,931	6,891	9,903
40–44 years	11,821	21,843	5,885	10,919	5,936	10,924	11,822	21,985	5,886	10,975	5,936	11,010
45–49 years	11,856	20,994	5,887	10,429	5,969	10,565	11,856	21,240	5,887	10,552	5,969	10,688
50–54 years	12,116	18,375	5,914	9,028	6,202	9,347	12,116	18,739	5,914	9,238	6,202	9,501
55–59 years	11,620	15,252	5,577	7,372	6,043	7,980	11,621	15,701	5,578	7,661	6,043	8,040
60–64 years	9,794	11,748	4,581	5,622	5,213	6,226	9,795	12,224	4,582	5,849	5,213	6,375
65–69 years	8,512	9,168	3,802	4,139	4,710	5,029	8,513	9,744	3,803	4,507	4,710	5,237
70–74 years	6,441	7,962	2,708	3,400	3,733	4,562	6,443	8,707	2,709	3,805	3,734	4,902
75–79 years	4,441	6,555	1,708	2,560	2,733	3,995	4,442	7,357	1,708	2,884	2,734	4,473
80–84 years	2,909	4,579	1,012	1,607	1,897	2,972	2,910	5,457	1,012	1,858	1,898	3,599
85–89 years	1,609	2,430	507	760	1,102	1,670	1,611	3,389	507	1,004	1,104	2,385
80–94 years	587	1,073	171	300	416	773	588	1,958	171	509	417	1,449
95–99 years	122	318	32	80	90	238	123	867	32	197	91	670
100 years and over	20	111	5	25	15	96	20	470	5	88	15	382

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