2003 Technical Panel on Assumptions and Methods

Report to the

Social Security Advisory Board

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Table 2
Population in 2003 (observed) and 2023, 2050, and 2080 (projected), and Implied Population Growth Rates, according to 2003 Trustees Report and Panel's Recommendations

	Total Social Security area population (January 1, in millions)				Population growth rate (in percent)		
	2003	2023	2050	2080	2003-2023	2023-2050	2050-2080
2003 Trustees Report							
High-cost	298	341	372	394	0.68	0.32	0.19
Intermediate scenario	298	348	389	421	0.78	0.41	0.27
Low-cost	298	357	414	465	0.91	0.54	0.39
Recommendations							
High-cost	298	353	405	452	0.84	0.51	0.36
Intermediate scenario	298	354	413	471	0.87	0.57	0.44
Low-cost	298	356	423	499	0.89	0.64	0.55

Note: High- and low-cost scenarios vary only the net migration assumption (relative to the intermediate scenario).

Comment on Categories and Terminology

In Social Security analysis, immigrants are described either as legal or other-than-legal. The second term may be misinterpreted as a polite euphemism for undocumented migration, even though it also tracks some persons who enter the U.S. as legal non-immigrants (for example, temporary workers who participate lawfully in Social Security). For purposes of projecting the OASDI trust funds, this grouping makes sense for various reasons (see Wilmoth 2003a). However, to avoid misunderstanding, the Panel recommends simply relabeling the other-than-legal category as other migration.

C. Mortality

Assumption Recommendation A-3. **For the intermediate scenario, the Panel recommends that assumed ultimate rates of mortality decline by age and sex be increased to levels that are broadly consistent with those observed during 1950-2000 for the total population, but with a continued deceleration for ages 0-14 comparable to the reduction in rates of decline that occurred between the first and second halves of the 20th century. Rates of mortality decline for the low- and high-cost scenarios should be raised by a similar amount. The Panel also recommends decreasing assumed rates of decline after 75 years, so that they equal zero beginning in 2200 (or some similar date) under all scenarios. The Panel proposes a simple projection method that observes these basic principles and leads to a projected life expectancy at birth of 84.4 in 2070, compared to the Trustees' current value of 82.9.**

Methods Recommendation M-2. **The Panel recommends that the mortality projection model be simplified by dropping separate projections by cause of death and stating assumptions in terms of age-specific rates of decline for all-cause mortality.**

Overview

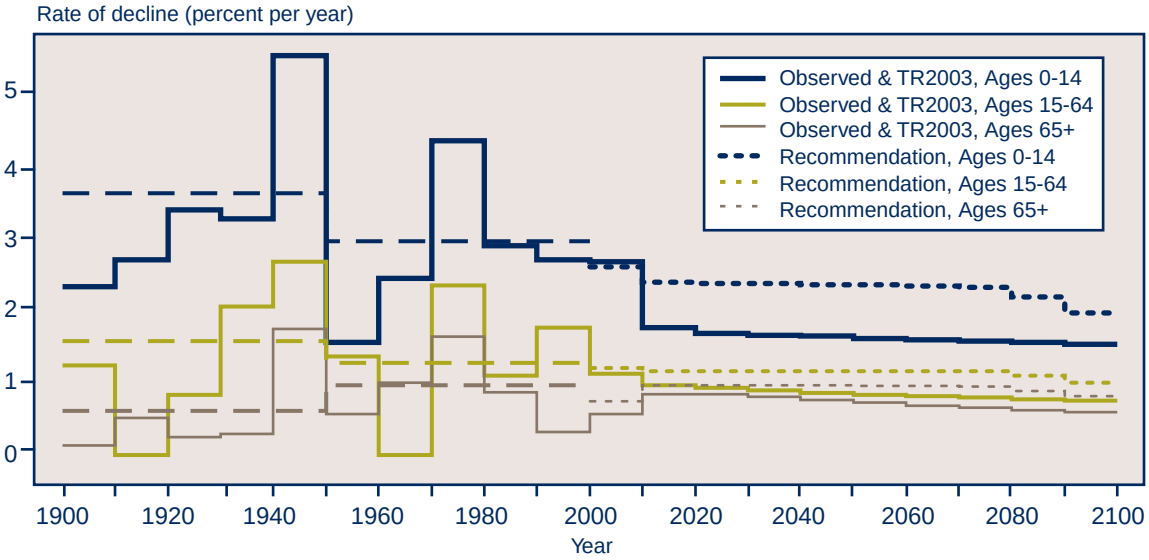
The Panel recommends that the Trustees increase assumed rates of mortality decline, while also simplifying the projection model by eliminating the breakdown by causes of death. Increasing the assumed rates of decline can be justified by an analysis of historical trends for the United States alone, but it is supported as well by a review of the recent mortality experience of other high-income countries. The Trustees currently project rates of mortality decline separately for each cause of death. Such detail should be dropped from the projection process; it is unlikely to produce more accurate results, and there is little empirical basis for current assumptions.

The Panel recommends that the Trustees increase assumed rates of mortality decline by a significant amount, resulting in higher projected levels of life expectancy at birth. However, compared to the 1999 Technical Panel, we recommend slower rates of mortality decline at older ages and thus lower projected values of life expectancy at birth. In 1998 (the point of departure for the 1999 Panel), the Trustees' assumptions implied a life expectancy in 2070 of 81.5, compared to 82.9 in 2003. By comparison, the 1999 Panel's recommendations yield a life expectancy in 2070 of 85.2, compared to our suggested value of 84.4.

Historical Background

Mortality risks across the age range fell dramatically during the 20th century, leading to a large rise in life expectancy at birth (and at all ages) for both men and women in the United States. For the total population, life expectancy at birth rose from 47.7 years in 1900 to 76.6 in 2000, a 60 percent increase over the century. However, most of this change (72 percent) occurred before 1950. Life expectancy at older ages presents a similar story overall, but there is one key difference. At age 65, for example, life expectancy rose from 11.7 years in 1900 to 21.2 in 2000, an 81 percent increase. However, most of this change (75 percent) occurred after 1950.

Figure 5
Rates of Decline in Age-sex-adjusted Death Rates by Age, for Decades and Selected 50-year Periods, U.S. Total Population, 1900-2000 (Observed) and 2001-2100 (Projected, TR2003 and Panel's Recommendation, Intermediate Scenario)



Source: Calculations by Panel, using data from the Office of the Chief Actuary, Social Security Administration.

Note: Dashed lines depict average rates of decline within 50-year intervals (1900-1950 and 1950-2000).

Part of the slowdown in the rise of life expectancy at birth occurred mechanically, due to the disproportionate influence of infant and child survival on this measure of average lifespan. Once childhood mortality became rare, there were few deaths left to eliminate in early life, making it more difficult to raise life expectancy at birth (Keyfitz 1985; Wilmoth 1998). In addition, there was a substantial reduction between the first and second halves of the 20th century in rates of mortality decline among both children (ages 0-14) and adults of working age (15-64), as shown in Figure 5. On the other hand, at ages 65 and above, the pace of mortality decline generally accelerated over the century, thanks to an unprecedented reduction in certain forms of old-age mortality (especially cardiovascular disease) beginning in the late 1960s.

Nevertheless, Figure 5 demonstrates clearly that rates of mortality decline varied considerably from decade to decade. The 1940s and 1970s stand out as periods of very rapid improvement, while the last 20 years have been less favorable. The arrested decline above age 80 beginning in the 1980s—as well as increasing mortality above age 85 during the 1990s—must be considered when making decisions about how to project such trends into the future. The 1999 Panel suggested that the unfavorable trends in old-age mortality during the 1980s and 1990s may reflect the delayed effects of increased levels of smoking among women, and a more recent article offers important empirical support for this explanation (Pampel 2002).

Current Trustees' Assumptions

For several years, the Trustees have specified their mortality assumptions in terms of rates of mortality decline by age, sex, and cause of death. In their 2003 Report, the complete set of assumptions consists of 70 numbers (5 age groups x 2 sexes x 7 cause categories). Technically, these are the underlying assumptions of the model, and all other summary statistics are results of the projection exercise. For example, OCACT often summarizes these assumptions with the implied ultimate rates of decline (i.e., during the last 50 years of the 75-year projection horizon) for all-cause mortality and for a limited number of broad age groups (e.g., 0-14, 15-64, and over 65), adjusted to remove the effects of changes in the distribution of the population by age and sex.

As shown in Figure 5, these assumptions imply a gradual deceleration in the pace of mortality decline throughout the projection interval. During the ultimate period and beyond, this deceleration is driven by the cause-of-death methodology: over time, categories that are assumed to decline the most slowly account for a increasing portion of deaths (Wilmoth 1995). In addition to this built-in deceleration, there is also an explicit assumption of a pronounced slowdown in mortality decline below age 65 during the first 25 years of the projection period. As seen in Figure 5 (also Table 3), below age 15 this deceleration is roughly twice as large as the historical slowdown that occurred between the first and second halves of the 20th century; for ages 15-64 it is about 1.5 times as large. For ages 65 and above, the Trustees' assumptions imply rates of mortality decline throughout the projection interval that lie below the historical average for 1950-2000. Furthermore, the implied rate of mortality decline above age 65 during 2027-2077 (0.68 percent per year, as seen in Table 3) is below the historical average even for the 20th century as a whole (0.78 percent).

Table 3
Rates of Mortality Decline in Age-Sex-Adjusted Death Rates, U.S., 1900-2000 (Observed) and 2000-2077 (Projected, TR2003, 2003 and 1999 Technical Panels, Intermediate Scenario)

	Observed			2003 Trustees		2003 Panel		1999 Panel	
Age group	1900-1950	1950-2000	1900-2000	2000-2027	2027-2077	2000-2027	2027-2077	1996-2023	2023-2073
0-14	3.56	2.90	3.26	1.97	1.57	2.40	2.29	3.15	2.23
15-64	1.52	1.22	1.44	0.96	0.80	1.12	1.11	1.47	1.13
65+	0.55	0.91	0.78	0.70	0.68	0.84	0.90	0.75	0.99
All ages	1.13	1.05	1.14	0.78	0.72	0.93	0.96	0.94	1.03

Notes: 1) Rates of mortality decline shown here equal the average of values found by the slope and endpoint methods; 2) Age-sex adjustment was based on the 1990 Census Population; 3) Comparable time periods for 1999 Panel were 4 years earlier than for TR2003 and 2003 Panel; 4) Values for 1999 Panel only are an average of male and female rates of decline in age-adjusted death rates, rather than rates of decline in age-sex-adjusted death rates.

Source: Calculations by Panel, using data from the Office of the Chief Actuary, Social Security Administration.

Explanation of Panel's Recommendation

Mortality projection involves a series of choices about how to extrapolate historical trends in death rates by age. Five of the most important choices concern the following:

1. Method(s) for computing historical rates of change in age-specific death rates;
2. Whether to consider various components of mortality separately (i.e., causes of death);
3. Whether to perform separate projections for subpopulations (by sex, race, etc.);
4. Historical period(s) from which assumed rates of future mortality decline are derived;
5. Whether to accelerate or decelerate rates of decline compared to the historical baseline.

More detail about various aspects of these topics is contained in a separate working paper (Wilmoth 2003b).

The first issue is methodological, concerning the formulas used to compute rates of mortality decline by age. The Panel considered two methods, which can be referred to as the "slope" and "endpoint" methods. Briefly, the slope method consists of using a simple statistical technique to find the line that best fits the historical mortality trend for a given age group.[3] On the other hand, the endpoint method considers only the decline between the beginning and the end of the time period, ignoring intermediate data.[4] Differences between the two methods can be quite significant in certain cases, affecting assumed rates of mortality decline that are derived from historical experience. Nevertheless, each method possesses certain advantages from a methodological point of view (see Wilmoth 2003b). Therefore, we use an average value based on both methods for analyzing historical trends and setting assumptions.

[3] Technically, a least-squares regression line is fit to the logarithm of death rates over time, and then the negative slope of the fitted line is used to estimate the rate of mortality decline.

[4] Technically, one computes the negative logarithm of the ratio of ending to starting values, divided by the length of the time period.

The second and third issues are examples of the need to balance simplicity and complexity. In both cases, the Panel decided in favor of simplicity. However, this principle of simplicity should apply only to methods of projection, not to the analysis of historical trends. Thus, the Panel applauds the Trustees and OCACT for investigating past mortality trends separately by cause of death and for men and women. (Other breakdowns could be useful as well, for example, by race, ethnicity, income class, or nativity.) However, making separate assumptions about future rates of mortality decline by cause of death or for subpopulations adds complexity to the projection model without evidence of improved accuracy in forecasting.

A model based on separate projections by cause of death over a long time horizon is both implausible and inconsistent with historical experience. Historically, rates of decline for specific causes of death (or broad categories of causes) have tended to vary much more than for all-cause mortality, as populations often focus on combating those causes of death that dominate mortality patterns at a given moment. In the most successful cases, breakthroughs against specific diseases lead to rapid reductions in deaths from that cause. For example, antibiotic therapies sharply reduced infectious disease in the 1940s, and various factors decreased cardiovascular disease in the 1970s.

Furthermore, the empirical basis for the Trustees' current cause-specific assumptions seems to be weak. In general, it is very difficult to construct consistent time series of mortality data by cause of death over long historical periods (for any country, not just the U.S.), due both to a lack of data for earlier periods and to changes in coding practices over time. The Trustees' current projections are based on mortality data by cause for the U.S. that begin only in 1979. On the basis of trends over little more than two decades, they derive rates of mortality decline for seven cause-of-death categories over what is now an infinite time horizon. However, the connection between data and assumptions is not always clear. For example, the assumed ultimate rate of decline for cancer mortality in the 65-84 age range is 0.5 percent per year for both sexes, although observed values were -0.06 for men and -1.13 for women during 1979-1999 (OCACT 2002: Table 3). There is little written explanation of how these assumptions were developed, and the Panel recommends that this information be made more readily available if the current method is retained.

Regarding subpopulations, separate mortality projections based on different historical rates of decline lead either to continual divergence between groups, or to convergence and eventual crossover (i.e., where groups change their relative positions). Both situations seem rather unlikely, at least for long-term projections. Although recent differential trends by sex could plausibly continue for another 10 to 20 years, the Panel recommends that ultimate rates of mortality decline be equal for men and women, derived from trends for the total population.

Similarly, international comparisons can be helpful as a guide to future mortality trends despite differences in levels. The U.S. differs from other wealthy countries in ways that affect the overall level of mortality (e.g., more inequality, a less extensive social safety net), and the current gap in levels could remain for many years. However, it seems much less likely that the pace of mortality decline will be vastly different over the long term amongst this close-knit group of nations. The post-1980 slowdown in mortality reduction for the U.S. was not typical; most high-income countries have enjoyed an accelerated mortality decline at older ages during the last two decades, sometimes starting from lower levels than the U.S. in 1980 (Wilmoth 2003b). These experiences support the Panel's recommendation for a projected recovery from the recent period of slow mortality decline in the U.S.

The last two items in the list concern the subjective application of historical experience to choices about assumed rates of future mortality decline. The Panel recommends using 1950-

2000 as the historical baseline. Using the full 20th century for this purpose is another possibility, but then the assumed pace of mortality decline at older ages would be slightly slower (see either Figure 5 or Table 3). In contrast, mortality decline at younger ages was much slower on average during the second half of the century; therefore, assumed rates of decline would be much higher with a baseline of 1900-2000 instead of 1950-2000. Perhaps the main reason to prefer a baseline of 1950-2000 over 1900-2000 is that the second half of the century was characterized by a more even pace of mortality decline across the age range, and this pattern seems likely to prevail in the future as well.

Although long-term mortality projections should not be based on short historical intervals, half a century seems long enough to avoid giving undue weight to atypical, short-term trends. Furthermore, it is prudent to be skeptical about the quality of mortality data from the first half of the 20th century, especially at older ages, since assumptions about the pace of mortality reduction at older ages are the most critical component of a mortality projection for the U.S. today (or for any low-mortality population). Finally, the range of forces that may plausibly contribute to future mortality reductions seems to be best represented by a baseline that goes back 50 to 70 years. During this period, the medical treatment of sick persons became, for the first time in history, one of the major forces propelling mortality downward. This trend began only in the 1930s, with the introduction of an early generation of anti-bacterial drugs (McKeown 1979). Other factors, broadly characterized as improvements in living standards and public health, drove earlier mortality declines. Probably all of these factors played a role in the mortality reductions observed since 1950 in the U.S., and all of them seem likely to influence future trends as well.

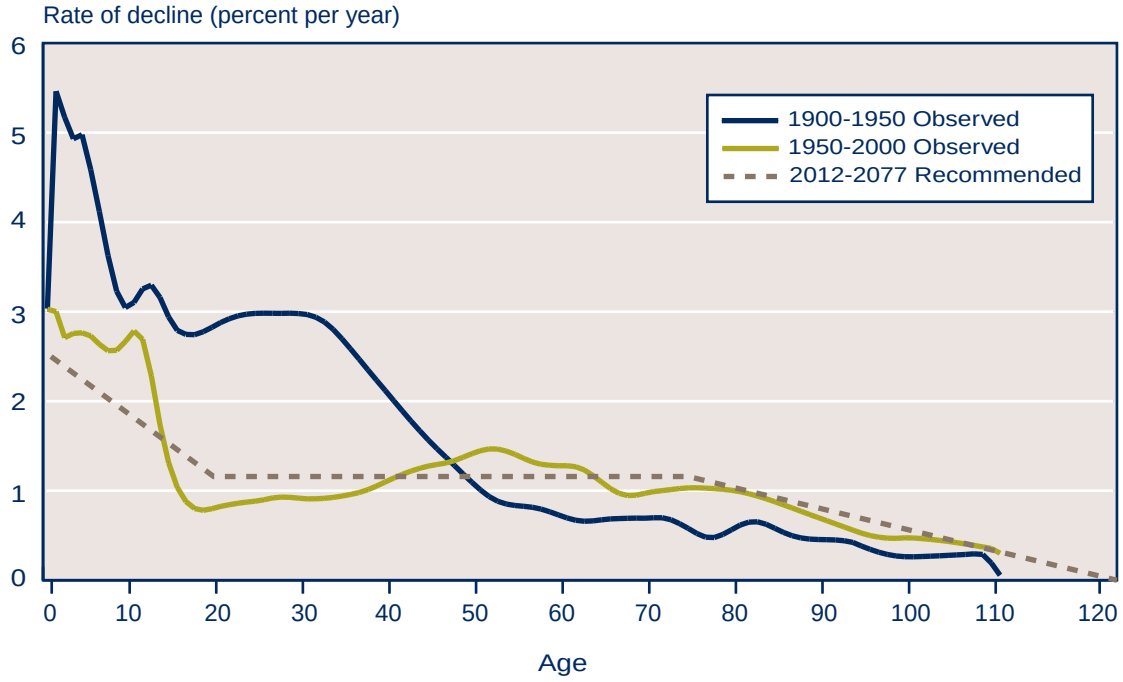
Even if 1950-2000 is chosen to serve as the historical baseline for mortality projection, a comparison of 20th-century trends before and after 1950 is still informative. Although the trend in rates of mortality decline at younger ages was quite variable from decade to decade (see Figure 5), there was a pronounced deceleration overall between 1900-1950 and 1950-2000. Therefore, the Panel recommends assuming a continued reduction in rates of mortality decline below age 15, similar in magnitude to the deceleration that occurred from the first to the second half of the 20th century.

On the other hand, Figure 5 also shows that the average rate of mortality decline above age 65 increased from the first to the second half of the 20th century. This change might be taken to suggest that the historical peak rate of mortality decline at older ages has not yet arrived. Indeed, the possibility of major breakthroughs in biology and biomedicine could be used to justify an assumption of a continued acceleration of mortality decline at older ages. However, this argument seems too speculative to serve as the basis for an intermediate assumption. Thus, the Panel recommends that assumed ultimate rates of mortality decline at older ages be based directly on the experience of 1950-2000, without the slowdown implied by the Trustees' current assumptions.

The choices outlined above form the basis for the mortality projections proposed by the Panel. These projections refer to an initial period of 2000-2002 and an ultimate period of 2012-2077. Initial rates of mortality decline, derived from historical average values for 1980-2000, are assumed to converge linearly over just 10 years to the ultimate rates. For the intermediate scenario, the ultimate rates are based primarily on trends during 1950-2000 (the deceleration at younger ages is based on trends for the whole century), as illustrated in Figure 6. The constant level for ages 20-74 was derived from the average value across this age range for 1950-2000.

Assumed ultimate rates of mortality decline for the low- and high-cost assumptions were also derived based on historical experience (Wilmoth 2003b). Generally, the low-cost scenario has slower rates of decline (and a shorter life expectancy), and the high-cost scenario has a faster

Figure 6
Rates of Mortality Decline by Age, U.S. Total Population, 1900-1950 and 1950-2000 (observed), and 2012-2077 (projected, Panel's Recommendation, Intermediate Scenario)



decline (and longer life expectancy). However, this situation is reversed for younger ages, since more rapid mortality decline at younger ages leads, like increased fertility, to a younger population age structure and thus to higher trust fund balances, and vice versa.

The Panel recommends assuming a cessation of mortality decline at all ages beginning in 2200, following a linear reduction in rates of decline (toward zero) beginning at the end of the ultimate period (i.e., 2077). The exact choice of the starting point for the infinite assumption is probably not important (though further analysis is needed), and any date around 200-300 years from now would have been just as appropriate. In general, this assumption can be justified by the argument that one should not assume positive rates of mortality decline farther into the future than has been observed in the past. Since most of the mortality decline in human history has occurred during the past 200-300 years, forcing rates of decline to zero within a similar future time horizon seems reasonable.

Figures 5 and 7 illustrate the results of these various assumptions. Figure 6 compares historical rates of mortality decline to those implied by the Panel's intermediate scenario. This graph also illustrates three key features that distinguish the Panel's projection from the Trustees': 1) stable rates of mortality decline during the ultimate period, 2) no slowdown of mortality decline at older ages vis-à-vis a baseline of 1950-2000 until after 2077, and 3) a more modest deceleration at younger ages. The divergent implications of the two projection methods are visible as well in Figure 7, which shows historical and projected values of life expectancy at birth and age 65.

Figure 7
Life Expectancy at Birth and Age 65, United States, Total Population, 1900-2000 (Observed) and 2001-2100 (Projected, TR2003 and Panel's Recommendation, Intermediate Scenario)