National Health Objectives for the Year 2000: The Demographic Impact of Health Promotion and Disease Prevention

ABSTRACT

Background. The national objectives in *Healthy People 2000,* drafted by health professionals aware of currently available public health interventions, represent a wealth of information about near-term future mortality and morbidity.

Methods. Life table methods were used to calculate the impact of projected changes in mortality and activity limitation rates on life expectancy and expected disability years.

Results. Meeting the mortality objectives would increase life expectancy at birth by 1.5 to 2.1 years, raising life expectancy to 76.6 to 77.2 years. In addition, meeting the target for disability from chronic conditions would increase the number of years of life without activity limitations from 66.8 years to 69.3–69.7 years. If the targets for coronary heart disease and unintentional injury were changed to reflect recent trends, a greater improvement in life expectancy at birth would be achieved: from 1.8 to 2.7 years to 76.9 to 77.8 years.

Conclusion. Meeting the targets would have an important demographic impact. Including changes in the coronary heart disease and injuries targets, life expectancy in the year 2000 would be above the middle of the ranges used in current Census Bureau projections. (*Am J Public Health.* 1991;81:1456–1465)

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Introduction

On September 6, 1990, the US Public Health Service (PHS) released *Healthy People 2000: National Health Promotion and Disease Prevention Objectives,*[1] a report on some 300 national health objectives for the year 2000. Based on the input of scientists and health professionals in many fields, PHS set specific numerical targets that are thought to be achievable over the next decade and identified data to track progress toward these targets. As experience with the earlier 1990 Objectives for the Nation[2] has shown, tracking these objectives can help to identify areas of success as well as areas that need more attention and resources. Thus the objectives will help guide health policy over the next decade.

The objectives are organized into 22 "priority areas" relating to specific problems, conditions, or diseases; risk factors; or potential interventions (see Table 1). Each priority area presents objectives for particular health status measures, for reduction of risk factors, and for provision of health services and protective measures. In total, the report contains about 300 objectives for the general population plus more for minority groups and other populations of special concern.

The objectives bring to bear in a specific and quantitative way the informed judgment of public health experts on a critical demographic issue, future improvements in mortality and morbidity. The objectives were developed by groups of scientists and public health professionals who are aware of the currently available and soon-to-be available public health interventions. Therefore, they represent a wealth of information about both future mortality and morbidity in the United States and the potential for health promotion and disease prevention interventions.

The objectives were, however, written by many independent committees and appear in a number of different formats. Some objectives target improvements in specific causes of mortality and morbidity but use noncomparable or nonstandard measures to provide a baseline. Other objectives specify potential changes in risk factors, use of preventive services, and other implementation strategies, and they are not directly translated into mortality or morbidity measures.

The intent of this paper is to organize and analyze in demographic terms the potential for future reductions in mortality and morbidity implicit in the national objectives. Specifically, we calculate the impact on life expectancy and other summary demographic measures of meeting the targets set in the objectives. This analysis serves two purposes. First, it summarizes in quantitative terms the scientific and medical knowledge of the many experts who participated in setting the objectives. This should be of interest to demographers and forecasters who want a stronger scientific backing for their future mortality and morbidity projections. Second, it offers guidance for enhancing further efforts in health promotion and disease prevention. The analysis shows where the potential for health status improvements is high and low and thus in-

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forms discussions about setting priorities among the objectives.

Methods

A number of technical features of objectives development should be taken into account in trying to develop measures of the overall mortality impact of meeting the objectives.

Because the objectives were drafted by 21 different working groups, the statistical measures used lack the unity of method that they would have if they had been developed by demographers and statisticians. Among mortality measures, for instance, nonstandard cause-of-death categories, rather than the categories used in vital statistics reports[3] and *Health, United States 1989*,[4] are used for coronary heart disease, diabetes, pneumonia and influenza, and a number of specific kinds of injuries.

One of the hallmarks of the national objectives process is that it sets specific numerical targets for the future. This allows policymakers to assess progress in mid-decade and to redirect efforts in areas where we are falling behind. The groups drafting the objectives had varying approaches to setting targets, including (1) detailed demographic models of the impact of changes in risk factors and the use of preventive services on disease incidence and mortality, (2) simple and sophisticated statistical trend analyses, and (3) eyeballing the most recent data points in conjunction with educated guesswork. Because of the different methods used, some of the targets—specifically, those for coronary heart disease and unintentional injuries—look somewhat optimistic or conservative when compared to each other and to mortality trends.

The analysis in this paper focuses primarily on the mortality objectives, a small fraction of the total set of objectives. The objectives address many other health status concerns—such as the incidence or prevalence of specific diseases, disabilities, or other conditions—as well as present targets for risk factor reductions and improvements in the provision of preventive services. Because they were expressed in so many different ways, we were not able to incorporate most of the morbidity and disability measures into a common framework. We were, however, able to incorporate a single objective addressing overall activity limitation into a comprehensive measure of mortality and disability.

Demographic Framework

In order to sum up the demographic impact of achieving the mortality objectives by the year 2000, we had to translate the objectives developed by PHS into a common framework for demographic calculations. As shown in Table 2, we developed a cause-of-death list that is a compromise between the specific measures used in the objectives (and the prevention relevance that they represent) and the standard groupings from the International Classification of Diseases, Ninth Revision (ICD-9)[5] used to report vital statistics. The 1987 death rates for these causes of death serve as the base for our calculations.

Infant mortality is included in the list, even though it is not a single cause of death, because the measure appears prominently in *Healthy People 2000*[1] and is frequently cited in health policy discussions. Pneumonia and influenza are grouped in a residual category, Other Causes, for which there are no objectives or the objectives cannot be translated to appropriate death rates.

To translate the mortality measures in the objectives into a common set of cause-specific death rates, we assumed that the annual rate of change implied by comparing the baseline figure and the target applied to the change in death rates from 1987 to 2000 for standard ICD groups.

One category in Table 2, heart disease, has a residual that represents the part of the category that is not covered by the target of any specific objective, primarily because prevention efforts are thought to be significant only for the heart disease deaths due to coronary heart disease. Together the heart disease residual and the overall residual made up 10% of total deaths in 1987. For heart disease and

TABLE 1—Priority Areas for *Healthy People 2000*[1] Objectives

- Health promotion
  - Physical activity and fitness
  - Nutrition
  - Tobacco
  - Alcohol and other drugs
  - Family planning
  - Mental health and mental disorders
  - Violent and abusive behavior
  - Educational and community-based programs
- Health protection
  - Unintentional injuries
  - Occupational safety and health
  - Environmental health
  - Food and drug safety
  - Oral health
- Preventive services
  - Maternal and infant health
  - Heart disease and stroke
  - Cancer
  - Diabetes and chronic disabling conditions
  - HIV infection
  - Sexually transmitted diseases
  - Immunization and infectious diseases
  - Clinical preventive services
- Surveillance and data systems

TABLE 2—Major Causes of Death: 1987 Age-adjusted Death Rates and Alternative Rates of Change to the Year 2000[6]

Causes of Death	1987 Death Rate[a]	Alternative Annual Rates of Change: High Mortality Trend	Low Mortality Trend	PHS Targets	Target and No Change in Residual	Target and Residual Trend
Chronic diseases						
Heart disease	169.6	−2.23	−2.37	−2.28	−1.43	−1.78
Cancer	132.9	0.13	0.06	−0.18		
Stroke	30.3	−3.04	−5.19	−3.15		
COPD[b]	18.7	3.00	0.00	2.26		
Diabetes	9.8	0.16	−2.44	−0.79		
Cirrhosis	9.1	−3.22	−3.94	−3.15		
Injuries						
Suicide	11.7	0.50	−0.32	−0.83		
Homicide	8.6	−0.98	−3.23	−1.27		
Unintentional injuries	34.6	−2.53	−2.96	−1.25		
Infant mortality	1018.5	−2.70	−4.15	−2.78		
Other causes of death						
Pneumonia and influenza	13.1	1.64	−3.44	−1.68		
All other causes	97.0	0.26	−2.11	0.00	0.00	0.26

[a]Death rates are per 100 000 population; the infant mortality rate is given per 100 000 live births.
[b]Chronic obstructive pulmonary disease.

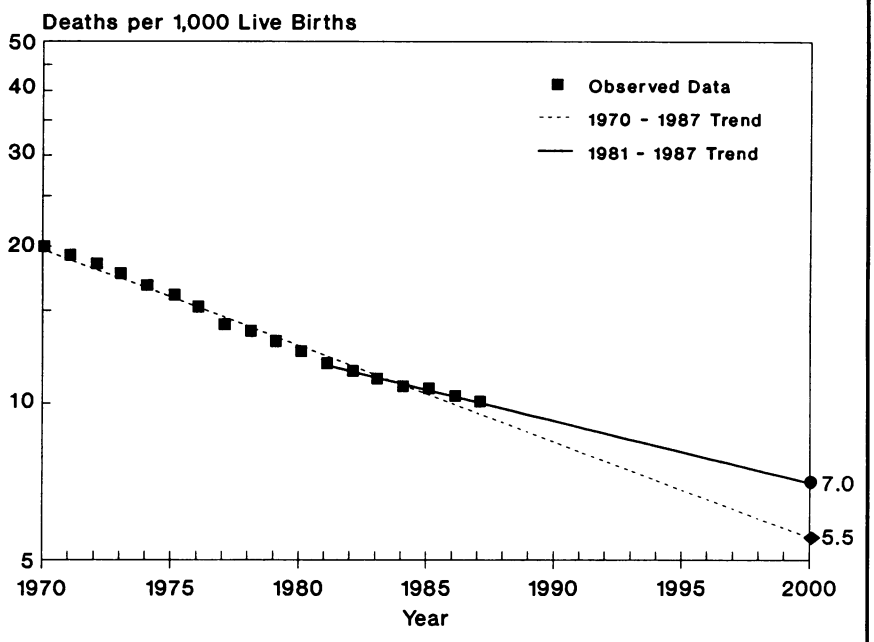

FIGURE 1—Infant mortality rate, 1970 to 1987, with 1970–1987 and 1981–1987 trends projected to the year 2000 (logarithmic scale), from *Health, United States, 1989*[4] and earlier editions of that report.

total mortality we calculated the target rate of change using three assumptions about the rate of change in the residual categories:

1. *Target:* the residual heart disease component changes at the same rate as the targeted part, and the overall residual mortality rate does not change.
2. *No change:* the residual heart disease component and the overall residual do not change.
3. *Own trend:* the residual heart disease component and the overall residual change according to the trend observed from 1979 to 1987.

Table 2 shows the three variants for the annual rate of change. The Appendix lists these and other specific assumptions made in translating the year 2000 objectives to a common demographic framework.

Trend Analyses for Comparison Purposes

To establish a reference point in a comparable manner for all of the cause-of-death categories, we chose to use simple trend analyses to estimate the potential changes in mortality that might come about even without the efforts implicit in the objectives process. More sophisticated techniques could be used here, but, given the illustrative nature of the effort, simple trend analyses are sufficient.

Because most of the rates are moving toward zero and some would become negative if linearly extrapolated to the year 2000, all of our trend analyses are in a logarithmic scale, implying a constant relative annual change. The trend analyses are based on rates for the whole population age-adjusted to the 1940 US standard million population.[4]

A look at the data going back to 1970 indicates that some trends were not simple. For example, infant mortality, as shown in Figure 1, saw a leveling off in the 1980s of the sharp downward trend experienced in the 1970s. The result is that a trend line fit to the data from 1970 to 1987 gives a very different rate of change than one fit to the data from 1981 to 1987, the years used by PHS to determine the target value for the infant mortality rate (IMR). For some other causes, the death rate is actually increasing, and the rates for other causes show substantial variability over the period.

To reflect the uncertainty in these simple trend analyses, we have developed high and low mortality variants for each cause of death. This approach assumes that the major source of uncertainty is in deciding which points to include in the trend calculation, not variation around the trend line. For most causes, the high and low variants reflect the different trend estimates calculated using data from 1970 to 1987 and data from 1979 or later to 1987. The 1970 starting point was chosen arbitrarily. The 1979 starting point corresponds to the implementation of ICD-9 in the United States, and in some cases changes between ICD-8 and ICD-9 cause major discontinuities in the data. For some causes of death PHS based the target on a trend analysis starting after 1979; for those causes we considered the additional trend line in establishing high and low mortality variants. For chronic obstructive pulmonary disease (COPD) the trend in the death rate is increasing, and we assumed a zero rate of change for the low mortality alternative. Table 2 shows the annual rate of change for the high and low mortality projections for each cause of death.

Calculation of Summary Mortality Measures

We present our results in terms of standard life table parameters e_0 (life expectancy at birth), l_{65} (the probability of surviving to age 65), and l_{65} (life expectancy at age 65). Further calculations suggest that the major qualitative conclusions regarding mortality are seen in these measures alone. The calculations were done as follows.

We started with the age- and cause-specific rates for 1987,[6] using the following age ranges: 0, 1, 5(10)85. For each cause we then applied the relative annual rate of change from Table 2 to each 1987 age-specific rate for that cause to calculate cause-specific death rates for the year 2000. For infant mortality we assumed that the targeted rate of change for IMR applied to ${}_1q_0$. We did not take cause-specific mortality rates into account in calculating ${}_1q_0$.

These cause-specific rates were aggregated into age-specific ${}_nM_x$ rates, and transformed into life table ${}_nq_x$ rates using Chiang's a's,[7] modified for 10-year intervals. Although these abridged calculations are not exact, if we assume no change for every cause, we can reconstruct the 1987 life table parameters[6] without excessive error. For instance, the actual and calculated values for e_0, e_{65}, and l_{65} are as follows:

Parameter	Actual	Calculated
e_0	75.0	75.1
l_{65}	16.9	17.2
l_{65}	79 040	79 139

Because most of the objectives are stated in terms of total population rates, we have not attempted to differentiate targets or trends in age, race, or sex-specific

rates. All of the rates of change in Table 2 are for the total population.

In order to consolidate these calculations on the impact of changes in mortality with a targeted reduction in disability, we adapted methodology developed by Sullivan[8] and used by others[9,10] that allows us to estimate an expectation of life free of disability. The measure of disability that we use is drawn from Objective 17.2 in *Healthy People 2000,*[1] which calls for a decline in the proportion of the population with major activity limitations from 9.4% in 1988 to 8.0% in 2000, a decrease of 1.34% per year. The baseline data come from the National Health Interview Survey (NHIS), which provides estimates of the proportion of the civilian noninstitutionalized population that experiences a limitation in their "major activity" due to a chronic health condition.[11] Major activity is defined as the predominant social role expected of a person of a given age: playing for children under age 5, attending school for children aged 5 to 17, working or keeping house for adults aged 18 to 69, and living independently for adults aged 70 and older.

We assumed that the 1.34 annual percentage decline between the baseline and the target would apply in each of the age groups in which the NHIS data are tabulated. For the base year and 2000, we calculated the number of life table years lived with major activity limitation by multiplying the prevalence of major activity limitation in each age group by the number of life table years lived in that age group ($_nL_x$) and summing the products for age x and above. The result can be expressed as the life expectancy with major activity limitation. Subtracting that value from total life expectancy gives an estimate of expected years of life free of limitation in major activity. Because the NHIS figures exclude the institutionalized population, including residents of nursing homes and other long-term care facilities, our calculations underestimate time with activity limitations.

Results

We have calculated the effect of meeting the objectives on overall mortality and on life expectancy without limitation in major activity, examined the impact of meeting specific objectives and groups of objectives on overall mortality and on the distribution of causes of death, and carried out an in-depth exploration of the specific targets chosen for coronary heart disease and unintentional injuries.

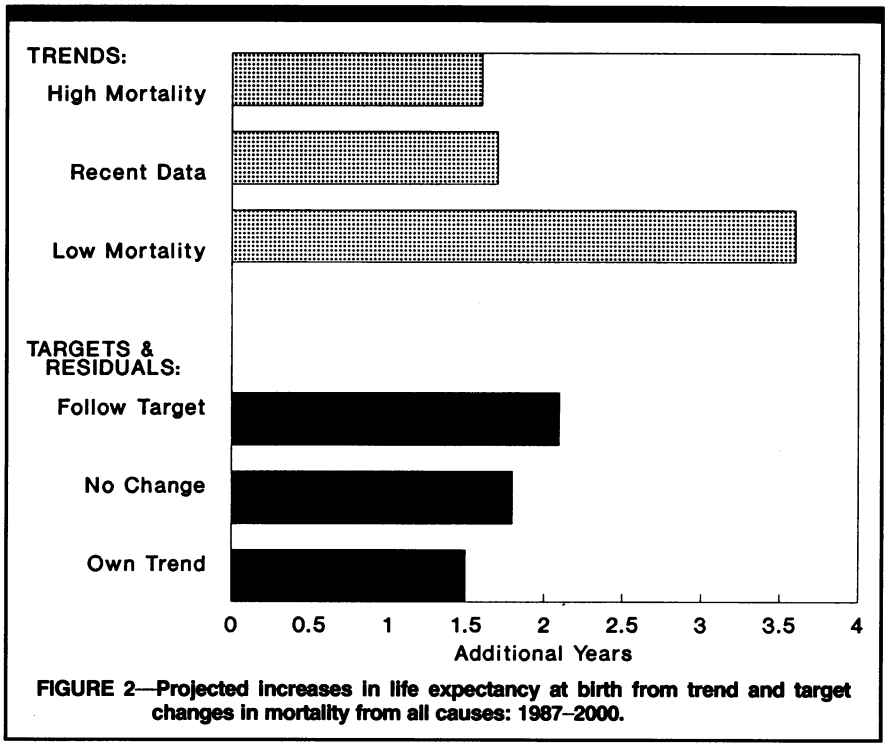

FIGURE 2—Projected increases in life expectancy at birth from trend and target changes in mortality from all causes: 1987–2000.

Overall Mortality

The effect of meeting the mortality objectives on overall life expectancy is shown in Figure 2. Depending on which of the two trend variants is used, the increase in life expectancy at birth by the year 2000 can range from 1.6 to 3.6 years. Although the trends based on data from the 1980s are not the least optimistic for every cause of death, they are in most cases. If trends based only on the more recent data were assumed, the increase in life expectancy at birth by the year 2000 would be about 1.7 years. Figure 2 also shows that the increase in life expectancy at birth to be expected if the *Healthy People 2000*[1] objectives are met is from 1.5 (assuming trends for the nontargeted causes of death) to 2.1 years (if residual rates improve at the same rate as the targeted rates). These figures imply a life expectancy of 76.6 to 77.2 years. Life expectancy at age 65 increases by 1.0 to 2.5 years with trends alone, and by 1.0 to 1.4 years if the year 2000 objectives are achieved. The current life expectancy at age 65 is 17.2 years.

Similarly, the increase in l_{65}, the life table probability of living to age 65, increases by 1.9 to 3.7 percentage points according to the two trend variants, but from 1.8 to 2.3 points if the year 2000 objectives are achieved. Thus, meeting the mortality targets would increase the probability of surviving to age 65 from 79.1% to 80.9–81.5%. Alternatively, one could say that the probability of a "premature death" would decrease from 20.9% to 18.5–19.1%. For all three measures, the targets are closer to the low end of the range defined by the alternative trends than the high end of the range.

Years without Limitations in Major Activity

With current mortality and disability statistics, an average of 66.8 years out of 75.1—89% of life expectancy at birth—would be spent free of limitation in major activity. If the target rate for major activity limitation is achieved, however, the number of years without limitation will increase to 69.3 to 69.7 years—approximately 90% of total life expectancy—depending on the assumption about trends in nontargeted causes of death as above. The scenario that produces the largest increase in total life expectancy also produces the largest increase in disability-free life. That same scenario, however, also results in the greatest remaining number of years with activity limitation (7.5 years) because relatively more people survive to the older ages at which disability is most prevalent.

Under current conditions, an average of 13.2 disability-free years would be experienced after age 65—about 77% of the life expectancy at that age. Assuming that the year 2000 objectives are met, the number of disability-free years experienced af-

TABLE 3—Estimated Impact on e_0 and l_{65} of Projected and Targeted Changes in Death Rates for Individual and Grouped Causes of Death: Year 2000

Causes of Death	Projected Changes: High Mortality Trend	Projected Changes: Low Mortality Trend	Targeted Changes: PHS Targets	Targeted Changes: Target and No Change in Residual	Targeted Changes: Target and Residual Trend
Added years of life expected at birth (e_0)					
All causes	1.6	3.6	2.1	1.8	1.5
Chronic diseases	1.3	1.9	1.5	1.3	1.1
Heart disease	1.2	1.2	1.2	0.9	0.8
Cancer	−0.1	0.0	0.1		
Stroke	0.3	0.4	0.3		
COPD[a]	−0.2	0.0	−0.1		
Diabetes	0.0	0.1	0.0		
Cirrhosis	0.1	0.1	0.1		
Injuries	0.3	0.4	0.2		
Suicide	0.0	0.0	0.0		
Homicide	0.0	0.1	0.0		
Unintentional injuries	0.3	0.3	0.1		
Infant mortality	0.2	0.3	0.2		
Other causes of death	−0.2	0.7	0.1	0.1	0.0
Pneumonia and influenza	−0.1	0.1	0.1		
All other causes	−0.1	0.5	0.0	0.0	−0.1
Increase in percentage surviving to age 65 (l_{65})					
All causes	1.7	3.7	2.3	2.1	1.8
Chronic diseases	1.3	1.9	1.6	1.4	1.2
Heart disease	1.2	1.3	1.2	1.0	0.8
Cancer	−0.1	0.0	0.1		
Stroke	0.2	0.3	0.2		
COPD[a]	−0.2	0.0	−0.2		
Diabetes	0.0	0.1	0.0		
Cirrhosis	0.2	0.2	0.2		
Injuries	0.5	0.7	0.4		
Suicide	0.0	0.0	0.1		
Homicide	0.1	0.2	0.1		
Unintentional injuries	0.5	0.5	0.2		
Infant mortality	0.2	0.3	0.2		
Other causes of death	−0.2	0.8	0.0	0.0	0.0
Pneumonia and influenza	−0.1	0.1	0.0		
All other causes	−0.1	0.7	0.0	0.0	−0.1

[a]Chronic obstructive pulmonary disease.

ter age 65 increases to 14.6–15.0 years—about 80% of the life expectancy at that age.

Changes in Specific Causes of Death

To understand these results better we need to explore the contributions of specific causes and groups of causes to these summary measures. Table 3 shows the effect on e_0 of trend and target changes for each cause of death, assuming no changes in mortality for other causes. The potential changes in heart disease will have the largest impact on the increase in life expectancy (0.8 to 1.2 years), followed by stroke (0.3 to 0.4 years) and infant mortality (0.2 to 0.3 years). This should be compared to a range of 1.5 to 3.6 years of potential increase in overall e_0. Cancer mortality trends are increasing slightly, and the effect of meeting the target would change a 0.1 year decrease in life expectancy to an increase of 0.1 year. With only two exceptions (injury and "other"), none of the variants of the other causes of death lead to a change in life expectancy of more than 0.2 years.

Table 3 also shows the effect on l_{65} of trend and target changes for each cause of death, assuming no changes in mortality for other causes. The same causes as above are also the most prominent in their effect on l_{65}. Unintentional injury deaths, however, achieve more prominence.

Because of competing risks, looking at changes in one cause of death at a time tends to diminish the apparent effect of health promotion and disease prevention efforts.[12] The chronic diseases, for example, are all related to a common set of risk factors (diet, smoking, alcohol, exercise) and would all tend to benefit from any increases in the accessibility of clinical preventive services for any one of them.[13] Therefore, we decided to look at the potential for reducing mortality for all chronic diseases. Similarly, since risk factors for injury deaths would tend to run together, we will also look at intentional and unintentional injuries taken together. Infant mortality is itself a combination of causes of death at ages under 1 year, and the final category is the combination of pneumonia and influenza with the residual "other," which includes AIDS and other infectious diseases.

Figure 3 and Table 3 show the impact of trend and targeted changes on e_0 and l_{65}. The major impact in either scale is still the chronic diseases (1.1 to 1.9 additional years of life expected at birth; 1.2 to 1.9 percentage point increase in the probability of living to age 65). Because they improve survival at younger ages, changes due to reduction in infant mortality and injuries are relatively more prominent in l_{65} than in e_0, but are still less important than changes in the chronic diseases.

Another way of looking at the projected changes is to look at the changes in the distribution of the causes of death. The distribution of deaths was determined by applying the projected age- and cause-specific mortality rates to the Census Bureau's median projected population for the year 2000.[14] The ranges indicate the highest and lowest proportions resulting from the three assumptions for nontargeted rates. Based on these calculations, chronic diseases fall from 72.7% to 70.5–71.2% of all deaths; the proportion of deaths due to injuries stays about the same: 6.1% to 5.8–6.1%; infant deaths fall from 1.3% to 1.0%; and other deaths increase from 20.0% to 21.9–22.4%. Clearly, achieving the targets would not mean a major shift in the distribution of causes of death, at least in these broad categories.

For specific causes, however, there are more marked changes. The largest drop is for heart disease: 36.9% to 31.8–34.1% of deaths. The proportion also goes down for stroke: 7.5% to 5.5–5.7%. For cancer, however, the proportion increases from 21.7% to 23.6–24.6%. COPD also increases, from 3.6% of deaths to 5.3–5.6%. The smaller shares for heart disease and stroke are nearly canceled out by the larger shares for cancer and COPD, leading to little overall change in the proportion of deaths from chronic diseases.

Reevaluation of Heart Disease and Injury Targets

Further analysis shows that the targeted reductions in heart disease and un-

intentional injuries are less than the trends would predict. Figure 4, for instance, shows trends in coronary heart disease since 1972. (As used in *Healthy People 2000*[1] and elsewhere by PHS, coronary heart disease refers to specific ICD codes within the broader category of Diseases of the heart.[15]) Depending on which years are used for trend analysis, the projected death rate for the year 2000 is either 90.8 or 92.6 per 100 000. The target is set conservatively at 100 per 100 000, although the trend data suggest that 90 per 100 000 might be a more reasonable level.

Figure 5 and Table 4 show that changing the target to 90 per 100 000 would have a major impact on the gain in e_0 (an additional increase of about 0.3–0.4 years) and in l_{65} (an additional increase of 0.3–0.4 percentage points). It would also affect the proportion of deaths due to heart disease and to chronic diseases. Assuming 1987 rates, 36.9% of all deaths are due to diseases of the heart. The percentage would fall to 29.5–32.4% with the new target. With the original heart disease target, this drop would only be to 31.8–34.6%. Similarly, the proportion of all deaths due to chronic diseases with 1987 rates is 72.7% and would fall to 69.6–70.4%. With the original heart disease target, this drop would only be to 70.5–71.2%.

Figure 5 and Table 4 also show the impact of a change in the target for unintentional injury mortality. A report has shown that accident mortality of all types has fallen by 21% between 1979 and 1989.[16] This rate of change is about double that called for in the PHS objectives. Changing the target from 29.3 to 22.0 per 100 000, consistent with the 10-year trend, would lead to a 0.2–0.3 year increase in life expectancy at birth and a 0.3–0.4 percentage point increase in the probability of surviving to age 65. The proportion of deaths due to all injuries would drop from 6.1% to 4.9–5.1% of all deaths.

Taken together, lowering both the heart disease and unintentional injury targets would increase overall life expectancy at birth by 0.6 years to 77.2–77.8 years. The probability of surviving to age 65 would increase by 0.6–0.8 percentage points.

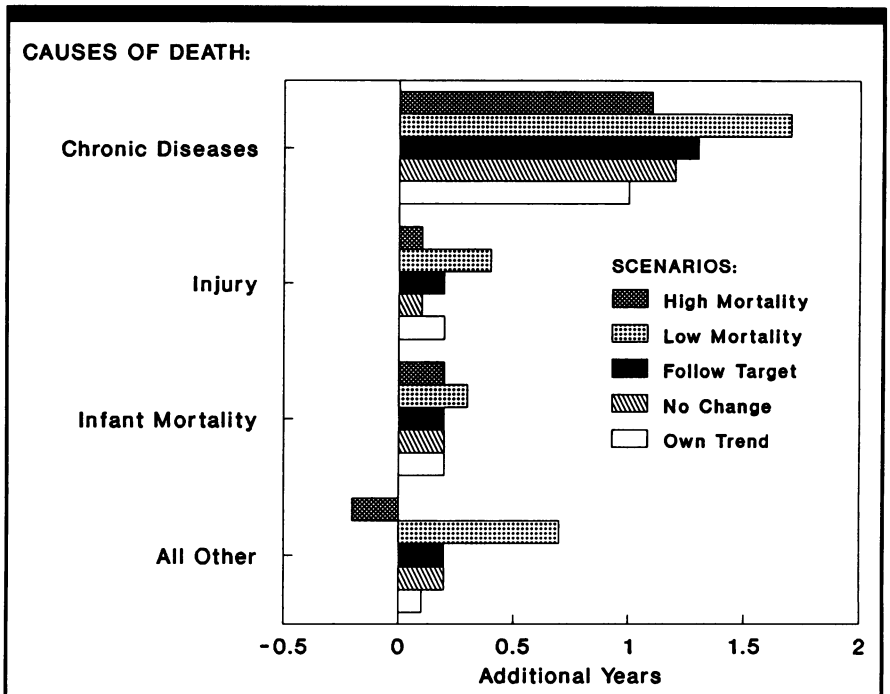

FIGURE 3—Projected increases in life expectancy at birth from trend and target changes in mortality from specified groups of causes: 1987–2000.

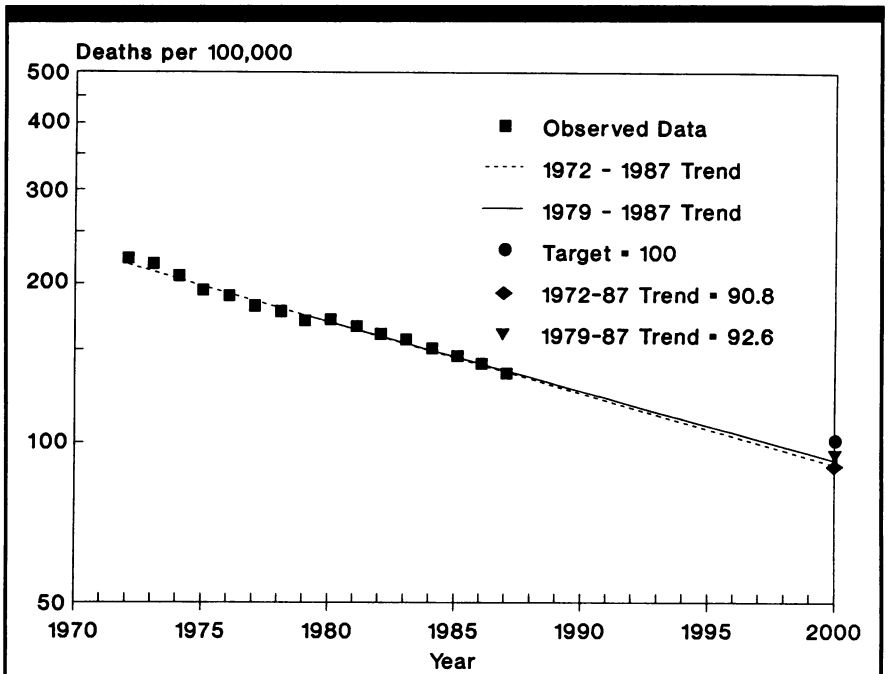

FIGURE 4—Age-adjusted coronary heart disease death rate, 1972 to 1987, with 1972–1987 and 1981–1987 trends projected to the year 2000, and year 2000 target rate (logarithmic scale, 1940 standard population). Data for 1972 to 1987 calculated by C. Sempos, National Center for Health Statistics, and provided by the Office of Disease Prevention and Health Promotion, US Public Health Service.

Discussion

Meeting the mortality targets set in *Healthy People 2000*[1] would have an important demographic impact. Taking the coronary heart disease and unintentional injury targets as stated in the objectives, the increase in life expectancy at birth would be 1.5 to 2.1 years, implying a life expectancy of 76.6 to 77.2 years. If the coronary heart disease and unintentional injury targets were changed to be somewhat more optimistic than the recent trend, life expectancy at birth would increase by 2.1 to 2.7 years to 77.2 to 77.8 years (see Figure 6). Trends in the cause-specific death rates used in this paper suggest an increase of 1.6–3.6 years to 76.7–78.7 years, with the lower end of the range being more likely. The results can also be

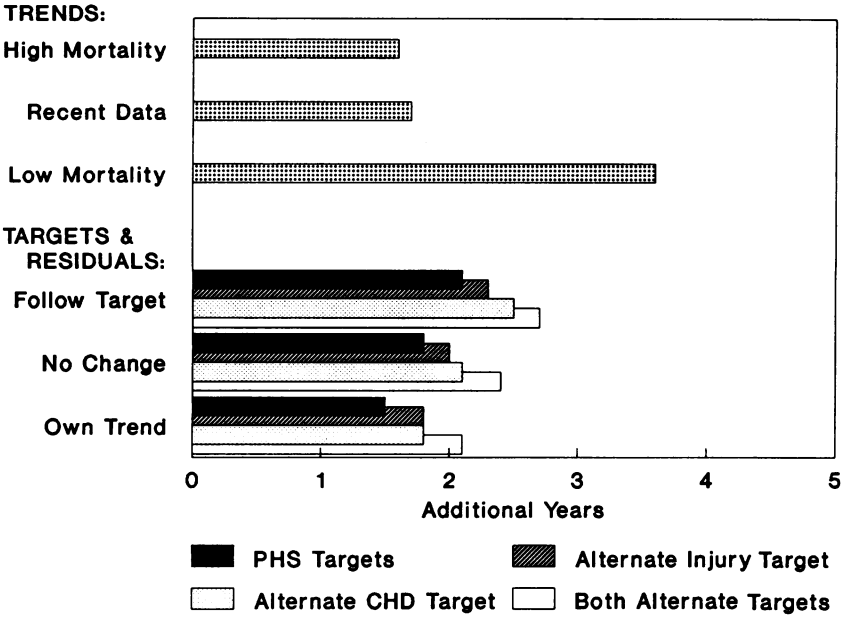

FIGURE 5—Projected increases in life expectancy at birth from trend, target, and alternative target changes in mortality from all causes: 1987–2000.

TABLE 4—Estimated Impact on e_0 and l_{65} of Alternative Targets for Coronary Heart Disease and Unintentional Injuries and Their Associated Grouped Causes of Death: Year 2000

Causes of Death	Target Changes: Alternate Targets	Target and No Change in Residual	Target and Residual Trend
Added years of life expected at birth (e_0)			
All causes	2.7	2.4	2.1
Heart disease only	2.5	2.1	1.8
Unintentional injuries only	2.3	2.0	1.8
Chronic diseases	1.9	1.6	1.4
Heart disease	1.6	1.2	1.0
Injuries	0.4		
Unintentional injuries	0.3		
Increase in percentage surviving to age 65 (l_{65})			
All causes	3.1	2.7	2.4
Heart disease ony	2.7	2.4	2.1
Unintentional injuries only	2.7	2.4	2.2
Chronic diseases	2.0	1.7	1.5
Heart disease	1.6	1.3	1.1
Injuries	0.7		
Unintentional injuries	0.6		

compared to ranges used in current Census Bureau[14] and Social Security Administration[17] projections of 75.3 to 78.9 years and 75.9 to 78.6 years, respectively. These are based on extrapolations as well, but using a different methodology. As Figure 6 shows, meeting the targets with the changes in the coronary heart disease and unintentional injury targets suggested above would put overall life expectancy above the middle of these ranges.

There are two reasons why demographic forecasters ought to note these results. First, they represent the substantive input of public health professionals asked to think about what might be achievable with known interventions. This kind of input is something that demographers would like to have but often cannot obtain. Second, the public health establishment is committed to making these changes come about. If progress reviews in mid-decade indicate that the nation is falling behind in measures needed to meet these targets, more resources might actually be brought to bear on interventions to reduce mortality, closing the feedback loop.

It is important to note, however, that the process used to set the targets might not have used the substantive knowledge of the experts as effectively as possible. Much of the energy used in setting the objectives has gone into discussions about which subjects should be included in the list of priority areas, into determining specific issues to be addressed within those areas, and into deciding how the objectives should be expressed in quantitative terms. In some cases, the specific numerical targets emerged after careful analyses and thought, but in others they were set at the last minute with little technical or substantive input. The process might have been improved if the content and the measures of the objectives had been determined first, and then a concerted effort made across the board to set target levels based on trend analyses and mathematical models that were feasible, realistic, and internally consistent.

Meeting the objective for reductions in activity limitation would lead to an additional 2.5 to 2.9 years of limitation-free life at birth and 1.4 to 1.8 years of limitation-free life after age 65. Chronic conditions of the circulatory system and injuries are major causes of disability as well as mortality.[18] Depending on whether increased survival consistent with the targets suggested in this article comes about through primary prevention or through better medical treatment of persons with heart disease and injury, further improvements in limitation-free years may be possible. Our analysis, however, focuses on mortality rather than other important health status variables such as morbidity and disability, and the available information does not permit explicit calculations.

The analysis does not specifically study the effect of projected changes in risk factors and preventive services. Nor does it address the question of different age patterns of change in mortality rates. The analysis needs to be expanded in order to appreciate the full range of benefits to be achieved and to better understand the contributions that various interventions can make to improvements in health status. As discussed above, this has not been possible for two reasons: lack of a consistent framework for nonmortality health status measures and lack of com-

plete information on the effect on health status of changes in risk factors and use of preventive services.

Progress in expanding the discussion beyond mortality alone depends on the development of consistent, systematic, and timely measures of health status, risk factors, and preventive services. Data from the annual NHIS are used for many of the objectives, and with changes in the objectives and the survey a more integrated system might be achievable.

Erickson and her colleagues have suggested that composite health status measures that incorporate morbidity, disability, and quality of life could be obtained from the NHIS, and that these could be the basis for the calculation of a measure of quality-adjusted life years (QALY) that is analogous to life expectancy except that each year of life is discounted by the average "quality of life" people experience at that age.[19] To the extent that the year 2000 objectives for the prevalence of specific conditions relate to the measures that go into the QALY calculation, the impact of meeting those objectives could be summed up in the same way we have done here for objectives on mortality levels.

Because the PHS objectives are generally stated in terms of overall death rates without specific mention of age or sex patterns, we assumed for this analysis that the same percentage change applied to all age-specific death rates and did not differentiate by sex. The current patterns of risk reduction and use of preventive services probably do not result in the same percentage reductions in death rates at all ages, as we were forced to assume. Clearly, further analysis needs to be used using more complex models of mortality decline than the ones we have used. Manton and his colleagues[20] and Olshansky,[21] for instance, have investigated the impact of delaying the progression of chronic diseases, not reducing their incidence.

Making the link between changes in risk factors and preventive services to health status measures will require two things. First, we need more extensive epidemiological studies on the prevalence of risk factors and the effect of changes in risk factors and preventive services on a full range of health status measures. Furthermore, preventive interventions must be carefully evaluated so that their population impact can be better understood. Second, more extensive demographic and epidemiological modeling efforts are needed to bring this information together so that the impact of changes in risk factors and access to clinical preventive services can be better predicted. There is some work in this area that could be drawn on,[22-27] but generally for one disease or risk factor at a time, and it is difficult to integrate this information.

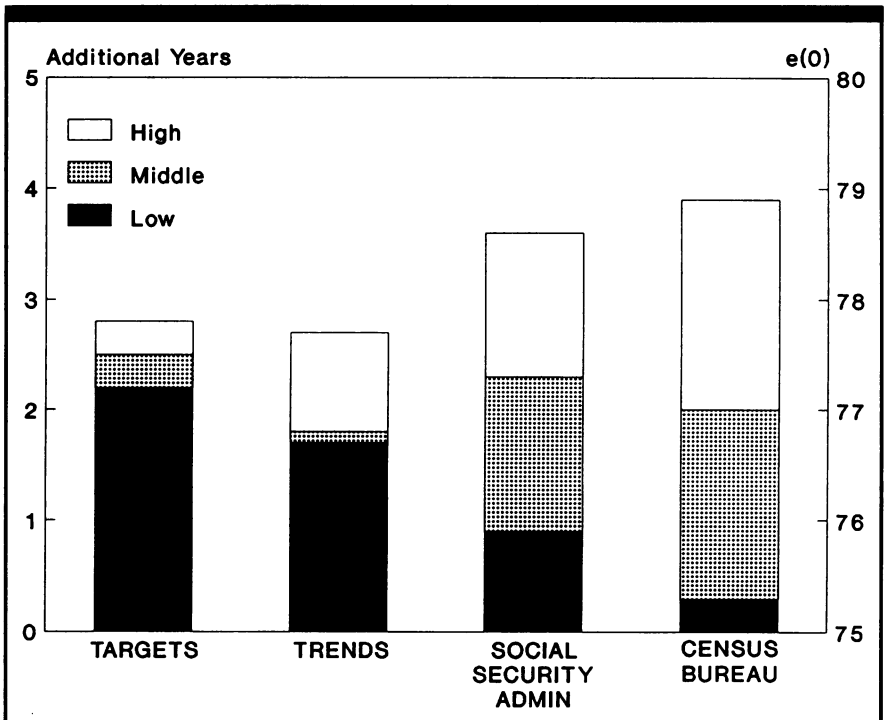

FIGURE 6—Alternative ranges of projected increases in life expectancy at birth (e_0) from 1987 to 2000 and of projected values of e_0 in the year 2000: PHS targets, trends, Social Security Administration, and Bureau of the Census. Census Bureau values are arithmetic averages of separate projections for males and females. From Spencer[14] and Wade[17].

Models of this sort can also shed light on the age-specific impact of preventive interventions that is lacking in this analysis. Manton, for instance, argues that risk factors and mortality reductions have a very different relationship at older ages than they do at younger ages.[28] Two kinds of issues need to be explored. First, detailed studies of the actual patterns of mortality reductions would lead to a fuller understanding of the demographic impact of meeting the year 2000 objectives. Second, we need to explore the impact of interventions targeted at different age groups and thus get a better idea about the most effective way to manage health promotion and disease prevention interventions. □

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APPENDIX—Demographic Assumptions

Cause-of-Death Categories (ICD-9 Codes)	*Healthy People 2000* Objectives	1987 Baseline Rate[a]	2000 Target Rate[a]	High Mortality Trend	Low Mortality Trend	Notes on Trend Data[b]
Heart disease (Diseases of the heart: 390-398, 402, 404-429)	Objective 15.1: Coronary heart disease (410-414, 402, 429.2)	135.0	100.0	1979–1987	1970–1987	Trends calculated from vital statistics rates for "Diseases of the heart"; nontargeted portion of heart disease (the residual) was calculated by subtracting the coronary heart disease rate from the total heart disease rate; coronary heart disease rates for 1972–1987 were calculated by C. Sempos, National Center for Health Statistics, and provided by the Office of Disease Prevention and Health Promotion (ODPHP), US Public Health Service.
Cancer (Malignant neoplasms: 140-208)	Objective 16.1: Cancer (all sites)	133.0	130.0	1970–1987	1979–1987	
Stroke (Cerebrovascular disease: 430-438)	Objective 15.2: Stroke	30.3	20.0	1982–1987	1972–1987	Trends calculated from rates prepared by the National Heart, Lung, and Blood Institute and provided by the ODPHP. These rates include a small adjustment in published vital statistics rates to establish consistency of ICD-8 and ICD-9 rates.
COPD (Chronic obstructive pulmonary diseases and allied conditions: (490-496)	Objective 3.3: COPD	18.7	25.0	1979–1987	—	Trend was calculated only for vital statistics rates based on ICD-9; rates under ICD-8 are not comparable.
Diabetes (Diabetes mellitus: 250)	Objective 17.9: Diabetes-related deaths (as underlying or contributing cause)	38.0[c]	34.0	1979–1986	1970–1987	High mortality trend was calculated from rates for diabetes as underlying or contributing cause of death; rates were prepared by the Centers for Disease Control (CDC) and provided by the ODPHP. Low mortality trend was calculated from vital statistics rates for diabetes as an underlying cause of death.
Cirrhosis (Chronic liver disease and cirrhosis: 571)	Objective 4.2: Cirrhosis	9.1	6.0	1970–1987	1979–1987	
Suicide (E950-E959)	Objective 6.1: Suicide	11.7	10.5	1980–1987	1970–1987	High mortality trend calculated from rates for suicide prepared by CDC and provided by the ODPHP; low mortality trend calculated from vital statistics rates for suicide.
Homicide (Homicide and legal intervention: E960-E978)	Objective 7.1: Homicide (E960-E969)	8.5	7.2	1970–1987	1980–1987	High mortality trend calculated from vital statistics rates for "Homicide and legal intervention"; low mortality trend calculated from rates for "homicide" alone; rates were prepared by CDC and provided by the ODPHP.
Unintentional injuries (Accidents and adverse effects: E810-E949)	Objective 9.1: Unintentional injuries	34.5	29.3	1980–1987	1979–1987	High mortality trend calculated from rates for unintentional injuries prepared by CDC and provided by the ODPHP; low mortality trend calculated from vital statistics rates for "Accidents and adverse effects."
Infant mortality (all deaths at less than 1 year old)	Objective 14.1: Infant mortality	10.1	7.0	1981–1987	1970–1987	Rates are from *Health, United States, 1989*[4] and earlier editions.
Pneumonia and influenza (480-487)	Objective 20.2: Epidemic-related pneumonia and influenza deaths among people ages 65 and older	9.1	7.3	1979–1987	1970–1987	
All other causes	—	—	—	1979–1987	1970–1987	Rates for each year in this category determined by subtracting vital statistics rates for the specified causes of death from the total death rate for the year.

[a]Source: Reference 1. Rates, except for the infant mortality rate, are per 100 000 population and are age-adjusted to the 1940 standard population. The infant mortality rate is per 1000 live births.
[b]Source: Reference 3, except where noted.
[c]Baseline is for 1986.