A Potential Decline in Life Expectancy in the United States in the 21st Century

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Forecasts of life expectancy are an important component of public policy that influence age-based entitlement programs such as Social Security and Medicare. Although the Social Security Administration recently raised its estimates of how long Americans are going to live in the 21st century, current trends in obesity in the United States suggest that these estimates may not be accurate. From our analysis of the effect of obesity on longevity, we conclude that the steady rise in life expectancy during the past two centuries may soon come to an end.

The trend in the life expectancy of humans during the past thousand years has been characterized by a slow, steady increase—^a pattern frequently punctuated by a volatility in death rates caused by epidemics and pandemic infectious diseases, famines, and war. This volatility was dramatically curtailed in the mid-19th century as infectious diseases yielded swiftly to improved living conditions, advances in public health, and medical interventions. During the past 30 years, the rise in life expectancy at birth in the United States decelerated relative to this historical pattern, and gains in life expectancy at older ages are now much smaller than they were in previous decades.

How much higher can life expectancy rise? This is not just an academic question. The answer formulated today will have substantial influence on the rate at which taxes are levied and on the potential solvency of age-entitlement programs. Some scientists answer this question by extrapolating from historical trends, which has led to the recent prediction that life expectancy at birth will rise to 100 years in the United States and other developed nations by the year 2060. The United Nations used a similar method but different assumptions to arrive at a projected life expectancy of 100 years for males and females in most countries by the year 2300. The Social Security Administration (SSA) arrived at a more tempered but still optimistic view that life expectancy in the United States will continue its steady increases, reaching the mid-80s later in this century.

A recently convened panel of advisers, and some mathematical demographers who advocate the use of extrapolation, have advised the SSA to project an even more rapid rate of increase in life expectancy for the U.S. population beyond that already anticipated between now and the latter part of this century. The bases for this advice include a demonstration that the maximum life span in Sweden has increased since the mid-19th century, the world record for life expectancy at birth in developed nations has been increasing by three months per year since 1850, mortality declines occurred at older ages in the Group of Seven industrialized nations during the latter half of the 20th century, and the prediction that "negligible senescence" will be scientifically engineered for humans in this century. Negligible senescence is defined as age-specific mortality rates that remain constant throughout life as opposed to rising exponentially after puberty, which is common among humans and most other animals. This last point is important because it is the only "biologic" justification offered for the decision to raise forecasts of life expectancy.

Life-extending technology that might lead to much higher life expectancies does not yet exist and, should it be developed, must be widely implemented before it would influence statistics on population levels. We believe that potential forms of technology do not justify developing or revising forecasts of life expectancy. Extrapolation models fail to consider the health status of people currently...
alive and explicitly assume that the past can predict
the future. Given that past gains in life expectancy
have largely been a product of saving the young, and
since future gains must result from extending life
among the old, another quantum leap in life expect-
ancy can occur only if the future is different from
the past.14

An informed approach to forecasting life expect-
ancy should rely on trends in health and mortality
that may be observed in the current population.
Forecasting life expectancy by extrapolating from
the past is like forecasting the weather on the basis
of its history. Looking out the window, we see a
threatening storm — obesity — that will, if un-
checked, have a negative effect on life expectancy.
Despite widespread knowledge about how to reduce
the severity of the problem, observed trends in obe-
sity continue to worsen. These trends threaten to
diminish the health and life expectancy of current
and future generations.

THE RISE IN OBESITY

After remaining relatively stable in the 1960s and
1970s, the prevalence of obesity among adults in the
United States increased by approximately 50 per-
cent per decade throughout the 1980s and 1990s.15
Two thirds of adults in the United States today are
obese or overweight. In the United States, 28 per-
cent of men, 34 percent of women, and nearly 50
percent of non-Hispanic black women are currently
obese. The distribution of body-mass index (BMI,
the weight in kilograms divided by the square of the
height in meters)24 has shifted in a skewed fash-
on such that the proportion of people with extreme
obesity has increased at an especially rapid rate.
These trends have affected all major racial and eth-
ic groups, all regions of the country, and all socio-
economic strata,18 with the largest increases in obe-
sity occurring among children and minorities.19 It
should be noted, however, that data from studies on
the relation between BMI and mortality have been
interpreted by some to suggest that current tables
of ideal height and weight and, by extension, ideal
ranges of BMI should be adjusted to include lower
ideal weights for height or BMIs before age 40, as
well as higher ideal weights for height or BMIs after
age 40.20 Redefining ideal weights for height in this
way would increase the projected negative effect of
obesity on life expectancy because of the large in-
creases in obesity now observed among people un-
der age 40.

Obesity is a multisystem condition associated
with an elevated risk of type 2 diabetes, coronary
heart disease, cancer, and other complications.21,22
The effect of body weight on mortality has been
studied extensively. In a study of more than a mil-
lion U.S. adults, the lowest death rates were found
among men with a BMI of 23.5 to 24.9 and among
women with a BMI of 22.0 to 23.4.23 Death rates
from cardiovascular diseases were substantially el-
evated among people with higher BMIs. A prospec-
tive study of 6139 subjects in Germany found the
greatest obesity-associated excess mortality to be
among the young24 — the standardized mortality
ratio for people 18 to 29 years of age with a BMI of
40 or over was 4.2 in men and 3.8 in women. Fonta-
taine et al. estimated the effect of obesity on years of
life lost across the lifespan of adults.25 For any de-
gree of excessive body weight, young age was asso-
ciated with greater years of life lost. Allison et al.
used data from six cohort studies in the United
States to determine that obesity causes approxima-
tely 300,000 deaths per year,26 although a study by the
Centers for Disease Control and Prevention (CDC)27
may have overestimated deaths due to obesity.

Being overweight in childhood increases the
risk among men of death from any cause and death
from cardiovascular disease; it also increases the
risk of cardiovascular morbidity among both men
and women.28 The lifetime risk of diabetes among
people born in the United States has risen rapidly
to 30 to 40 percent — a phenomenon presumably
attributable to the obesity “epidemic.”29 Having
diabetes in adulthood increases the risk of a heart
attack by as much as having had a previous heart at-
tack,30 and the life-shortening effect of diabetes is
approximately 13 years.31 Evidence also suggests
that at younger ages, disability rates have risen and
fitness levels have declined dramatically in the Unit-
ed States, with both trends attributed, at least in
part, to the rise in obesity.32,33 The incidence of
type 2 diabetes in childhood in the United States
has increased many times over in the past two de-
cades, an increase that is due almost entirely to the
obesity epidemic34,35; shockingly, life-threatening
complications, including renal failure, may develop
by young adulthood in at least 10 percent of children
with type 2 diabetes.36

If left unchecked, the rising prevalence of obesity
that has already occurred in the past 30 years is ex-
pected to lead to an elevated risk of a range of fatal
and nonfatal conditions for these cohorts as they
age.29 If the prevalence of obesity continues to rise,
especially at younger ages, the negative effect on health and longevity in the coming decades could be much worse. It is not possible to predict exactly when obesity among the young will have its largest negative effect on life expectancy. However, in the absence of successful interventions, it seems likely that it will be in the first half of this century, when at-risk populations reach the ages of greatest vulnerability.

**OBESITY AND FUTURE LIFE EXPECTANCY**

Obesity has been shown to have a substantial negative effect on longevity, reducing the length of life of people who are severely obese by an estimated 5 to 20 years. Although the life-shortening effect of obesity is evident for people who are obese, its negative effect on the future life expectancy of the population is also critically important to public policy.

We have estimated the effect of obesity on the life expectancy of the U.S. population by calculating the reduction in the rates of death that would occur if everyone who is currently obese were to lose enough weight to obtain an “optimal” BMI, which we defined as a BMI of 24. This calculation can be performed by linking data on the age-, race-, and sex-specific prevalence of obesity in the United States from the Third National Health and Nutrition Examination Survey with estimates of race- and sex-specific rates of death for people 20 to 85 years of age who have BMIs that range from 17 to 45. Complete life tables for the United States according to race and sex for 2000 were obtained from the National Center for Health Statistics.

The calculations begin by estimating the conditional probability of death at age x of the nonobese population, q(x\text{no}), as follows:

\[ q(x_{\text{no}}) = \left[ q(x) - q(x_{\text{ob}}) P(x_{\text{ob}}) \right] + P(x_{\text{no}}). \]

where \( q(x) \) is the conditional probability of death at age x for the entire population, \( q(x_{\text{ob}}) \) is the conditional probability of death at age x for the obese population, \( P(x_{\text{ob}}) \) is the proportion of the population at age x that is obese, and \( P(x_{\text{no}}) \) is 1 – \( P(x_{\text{ob}}) \), which is the proportion of the population at age x that is not obese.

Because the distribution of BMIs is skewed toward higher levels, and the population is shifting toward higher BMIs, we provide a range of estimates for the effect of obesity on life expectancy by assuming that everyone who is obese has a BMI of 30 or 35. The effect of eliminating obesity on the life expectancy of the population (encompassed within this range) is then estimated by assuming that everyone who is obese acquires the mortality risk, \( q(x_{30}) \), of those with the optimal BMI of 24. The obesity-adjusted conditional probability of death, \( q(x) \), at age x may then be obtained as follows:

\[ q(x) = q(x_{\text{no}}) P(x_{\text{no}}) + q(x_{30}) P(x_{30}). \]

These obesity-adjusted conditional probabilities of death were estimated separately by race and sex. When a BMI of 30 or 35 did not lead to lower death rates than the optimal BMI of 24, it was assumed that there was no change in the conditional probability of death. This occurred for black males at 62 to 85 years of age at a BMI of 30 and at 67 to 85 years of age at a BMI of 35, and for black females at 60 to 85 years of age at a BMI of 30 and at 67 to 85 years of age at a BMI of 35. These calculations yielded a range of age-, race-, and sex-specific rates of death and hypothetical life tables for the year 2000 under the assumption that obesity has been eliminated.

A more detailed analysis of this kind could be performed using the full age distribution of BMIs and integrating these into the calculations at a finer level of detail. However, given that the methods required for such estimates are currently being reviewed by a panel of scientists convened by the Institute of Medicine, and in the interest of identifying plausible estimates rather than precise numbers, we took this simpler approach.

Our approach probably underestimates the negative effect of obesity on life expectancy at BMIs of 30 and overestimates it at BMIs of 35. Clearly, the absence of rates of death for obese people under 19 years of age (which forces the assumption that rates of death in this age range remained unchanged from the levels in 2000) leads to an underestimate of the overall effect of obesity on life expectancy. Finally, it is possible that the use of period (cross-sectional) rather than cohort data may also lead to substantial underestimates of the effects of obesity on life expectancy.

Our conservative estimate is that life expectancy at birth in the United States would be higher by 0.33 to 0.93 year for white males, 0.30 to 0.81 year for white females, 0.30 to 1.08 years for black males, and 0.21 to 0.73 year for black females if obesity did
not exist (Fig. 1). Assuming that current rates of death associated with obesity remain constant in this century, the overall negative effect of obesity on life expectancy in the United States is a reduction in life expectancy of one third to three fourths of a year. This reduction in life expectancy is not trivial—it is larger than the negative effect of all accidental deaths combined (e.g., accidents, homicide, and suicide), and there is reason to believe that it will rapidly approach and could exceed the negative effect that ischemic heart disease or cancer has on life expectancy.

Several facts that suggest that the prevalence and severity of obesity and its complications will worsen and that rates of obesity-induced death will rise are as follows: current estimates of the effect of eliminating obesity are based on past trends, when the prevalence was much lower; the prevalence of obesity, especially among children, is likely to continue to rise; with obesity occurring at younger ages, the children and young adults of today will carry and express obesity-related risks for more of their lifetime than previous generations have done; a significant shift toward higher BMIs throughout the age ranges has occurred; death rates from diabetes have risen steadily in the past 20 years and are expected to rise further as younger cohorts age; and the medical treatment of obesity has been largely unsuccessful. These trends suggest that the relative influence of obesity on the life expectancy of future generations could be markedly worse than it is for current generations. In other words, the life-shortening effect of obesity could rise from its current level of about one third to three fourths of a year to two to five years, or more, in the coming decades, as the obese who are now at younger ages carry their elevated risk of death into middle and older ages.

**DISCUSSION**

A rise in life expectancy to 100 years in the United States in this century would profoundly influence many aspects of society, including the solvency of age-based entitlement programs and tax rates levied by the federal government. Even marginal increases in life expectancy beyond those anticipated by the SSA would markedly increase the number of octogenarians, nonagenarians, and centenarians that the SSA expects. However, in light of the obesity-driven trends in the health status of the U.S. popula-

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**Figure 1. Life-Shortening Effect of Obesity According to Race and Sex in the United States in 2000.**

This figure shows the potential gain in life expectancy at birth for the U.S. population in 2000, by race and sex, if obesity were eliminated. The range of estimates is shown between the bars on the basis of the assumption that everyone who is obese has a body-mass index (BMI) between 30 (lower bar) and 35 (upper bar) and acquires the risk of death of people with a BMI of 24. The horizontal bars are not error bars.

**Figure 2. Observed and Projected Life Expectancy at Age 65 for U.S. Females (1900 to 2000).**

Shown are observed changes, from 1900 to 1980, in expected remaining years of life at age 65 for U.S. females, and projections of the expected remaining years of life at age 65 made by the SSA in actuarial studies published in 1952, 1966, and 1974.

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Illustrated by its projections for diabetes. From 1979 to 1999, rates of death from diabetes increased annually by an average of 2.8 percent for males and 1.8 percent for females. In 1990, diabetes decreased life expectancy by 0.22 year for males and 0.31 year for females, but the negative effect of diabetes on life expectancy has grown rapidly since then. However, the negative effect of diabetes on the life expectancy of the population could now be several times as great as it was in 1990. Given the rapidly rising prevalence of diabetes and the prospect that childhood obesity today will probably accelerate the rising prevalence of diabetes in the coming decades, it is difficult to justify the SSA’s assumption that rates of death from diabetes will decline by 1.0 percent to 3.2 percent annually throughout the 21st century, beginning in the year 2010.

We anticipate that as a result of the substantial rise in the prevalence of obesity and its life-shortening complications such as diabetes, life expectancy at birth and at older ages could level off or even decline within the first half of this century. This is in contrast to both the recent decision by the SSA to raise its forecast of life expectancy and what we consider to be the simple but unrealistic extrapolation of past trends in life expectancy into the future.

There are other realistic threats to increases in life expectancy. From 1980 to 1992 in the United States, the age-adjusted rate of death from infectious diseases rose by 39 percent, an increase fueled mostly by the AIDS epidemic; the overall rate of death from infectious diseases increased 4.8 percent per year from 1980 to 1995; hospital-acquired infections have increased; hospital-acquired and antibiotic-resistant pathogens have entered the community and our food supply; and recent decreases in mortality related to the human immunodeficiency virus have leveled off.

Infectious diseases could decrease life expectancy substantially if pandemic influenza strikes. Developing and developed nations are far more vulnerable to a global pandemic of influenza today than in 1918, owing to an aging population, resistance to antibiotics, and more rapid transport of microbes, among other reasons. This heightened risk is balanced in part by better global surveillance and interventions already present. Although estimating the negative effects of epidemics on the future course of life expectancy is problematic, it has been established that infectious diseases, when they do emerge, can wipe out a century’s worth of gains in health and longevity in less than one generation.
Other forces that could attenuate the rise in life expectancy include pollution, lack of regular exercise, ineffective blood-pressure screening, tobacco use, and stress.

Advances in the medical treatment of major fatal diseases, including the complications of obesity, are likely to continue. Unfortunately, recent trends in the prevalence of cancer and in the rates of death from cardiovascular diseases in the United States reveal only marginal gains in longevity in recent decades, and even the gains produced from the elimination of any one of today’s major fatal diseases would not exceed the negative effects of obesity that appear to be forthcoming.

A leveling off or decline in life expectancy in the United States is not inevitable. We remain hopeful that the public health community and public policymakers will respond to the impending dangers that obesity poses to both the quality and the length of life. However, the negative effect on health and longevity of unchecked obesity is substantial according to statistics on health and mortality that can be observed for the generations currently alive, as has already been shown in Okinawa, Japan. It is important to emphasize that our conclusions about the future are based on our collective judgment, as are all forecasts, and we acknowledge that forces that influence human mortality can change rapidly.

Finally, our forecast has other public-policy implications. Dire predictions about the impending bankruptcy of Social Security based on the SSA’s projections of large increases in survival past 65 years of age appear to be premature. However, this “benefit” will occur at the expense of the economy in the form of lost productivity before citizens reach retirement and large increases in Medicare costs associated with obesity and its complications. Presently, annual health care costs attributable to obesity are conservatively estimated at $70 billion to $100 billion. With rapid increases in the prevalence of diabetes, and a decrease in mean age at the onset of diabetes, the cost of treating diabetes-related complications, such as heart disease, stroke, limb amputation, renal failure, and blindness, will increase substantially. A similar escalation of health care costs from other complications associated with obesity (e.g., cardiovascular disease, hypertension, asthma, cancer, and gastrointestinal problems) is inevitable. The U.S. population may be inadvertent ly saving Social Security by becoming more obese, but the price to be paid by obese people themselves and the economy is already high enough to justify considerably increased spending on public health interventions aimed at reducing the incidence and severity of obesity.

Unless effective population-level interventions to reduce obesity are developed, the steady rise in life expectancy observed in the modern era may soon come to an end and the youth of today may, on average, live less healthy and possibly even shorter lives than their parents. The health and life expectancy of minority populations may be hit hardest by obesity, because within these subgroups, access to health care is limited and childhood and adult obesity has increased the fastest. In fact, if the negative effect of obesity on life expectancy continues to worsen, and current trends in prevalence suggest it will, then gains in health and longevity that have taken decades to achieve may be quickly reversed. The optimism of scientists and of policymaking bodies about the future course of life expectancy should be tempered by a realistic acknowledgment that major threats to the health and longevity of younger generations today are already visible.

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10. Testimony before the trustees of the Social Security Administration by Dr. S. Jay Olshansky, Dr. John Wilmoth, and Dr. Ron Lee, September 13, 2002. Baltimore: Social Security Administration, 2002 (transcript).
32. Lakdawalla DN, Bhattacharya J, Goldman DR. Are the young becoming more disabled? Health Aff (Millwood) 2004;23(1):168-76.

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