Peering Into the Future of American Longevity

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

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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 the potential solvency of age-entitlement programs. Some researchers predict that life expectancy will rise dramatically in this century, leading public policy makers to raise their estimates of how long Americans will live. It is predicted that historical trends in rising life expectancy will continue throughout this century, fueled primarily by anticipated but yet-to-exist advances in biomedical technology. Some have even predicted that aging itself will soon be mastered by science, enabling people to live well beyond 100 years.

Forecasting life expectancy by extrapolating from the past is similar to forecasting the weather. In both cases, the accuracy of the predictions diminish with their distance from the present. Assuming life expectancy will be significantly higher in the future as a result of technologies that have yet to be developed, and basing government forecasts on such an assumption, is highly speculative.

We suggest that instead of basing forecasts of life expectancy on the development of life-extending technologies that do not exist, or blindly extrapolating trends in life expectancy from the past, an alternative way of peering into the future is to observe our children. Looking into the future of American health and longevity, we see an ominous storm approaching -- an obesity epidemic of unprecedented proportions. This is not an idle speculation -- the detrimental effects of this epidemic can be observed today in the obese youth of

America.

The Rise in Obesity

After remaining relatively stable in the 1960s and 1970s, the prevalence of obesity among adults in the United States skyrocketed by approximately 50 percent per decade throughout the 1980s and 1990s (Hedley et al., 2004). Two-thirds of adults in the United States today are obese or overweight while 28 percent of men and 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) has shifted in a skewed fashion because the proportion of people with extreme obesity has increased at an especially alarming rate. These trends have affected all major racial and ethnic groups, all regions of the country, and all socioeconomic strata, with the largest increases in obesity occurring among children and minorities (Ebbeling et al., 2002).

Obesity is a multisystem condition associated with an elevated risk of type 2 diabetes, coronary heart disease, cancer, and other complications. Being overweight in childhood increases the risk among men of death from any cause and death from cardiovascular disease, but it also increases the risk of cardiovascular morbidity among both men and women. The lifetime risk of diabetes among people born in the United States has already risen rapidly in recent decades to 30 to 40 percent -- a phenomenon attributable to the obesity "epidemic" (Allison et al., 1999). Having diabetes in adulthood increases the risk of a heart attack by as much as having had a previous heart attack, and the life-shortening effect of diabetes is approximately 13 years. Evidence also suggests that at younger ages, disability rates have risen and fitness levels have declined dramatically in the United States, with both trends attributed, at least in part, to the rise in obesity. The incidence of type 2 diabetes in childhood in the United States has increased many times over in the past two decades, an increase due almost entirely to the obesity epidemic. Shockingly, life-threatening complications, including renal failure, may develop by young adulthood in at least 10 percent of children with type 2 diabetes (Ludwig and Ebbeling, 2001).

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 the obese, its negative effect on the future life expectancy of the population -- the focus of our work -- is also critically important to public policy.

"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."

We have estimated the effect of obesity on the life expectancy of the U.S. population by calculating the reduction in death rates that would occur if everyone who is currently obese were to lose enough weight to obtain an "optimal" body mass index (BMI), and published our findings in the *New England Journal of Medicine* (Olshansky et al., 2005). We found that if obesity did not exist, life expectancy at birth in the United States would be higher by 0.33 to 0.93 years for white males, 0.30 to 0.81 years for white females, 0.30 to 1.08 years for black males, and 0.21 to 0.73 years for black females (Figure 1). The reduction in life expectancy due to obesity is not trivial -- it is larger than the negative impact 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 impact that ischemic heart disease or cancer has on life expectancy.

Several facts suggest that the prevalence and severity of obesity and its complications will worsen and that obesity-induced death rates will rise in the coming decades: 1) current estimates of the effect of eliminating obesity are based on past trends, when the prevalence was much lower, 2) the prevalence of obesity, especially among children, is likely to continue to rise, 3) with obesity occurring at younger ages, the children and young adults of today will carry and express obesity-related health risks for more of their lifetime than pre-

vious generations have done, 4) a significant shift toward higher BMIs throughout the age structure has occurred, 5) death rates from diabetes have risen steadily in the past 20 years and are expected to rise further as younger cohorts age, and 6) the medical treatment of obesity has been largely unsuccessful. These trends suggest the relative influence of obesity on the life expectancy of future generations could be markedly worse than is the case for current generations. In other words, the life-shortening effect of obesity could decrease life expectancy as much as 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 (see Figure 1).

The negative effect of obesity on life expectancy will occur in three waves that will sweep through the age structure. The first wave, which we can already measure because it is here today, is the rising prevalence of obesity among young children. The second phase, which we are just beginning to observe, is the manifestation of obesity-induced health conditions that were rarely or never before seen in young people. The rise of type 2 diabetes in children is a case in point -- a condition that was unheard of in children just 30 years ago but which is now occurring among obese children with an alarming frequency. The third wave will be obesity-induced mortality over the next 50 years as these children begin living into their third through sixth decades of life which is when obesity begins to kill.

It is only as these children age, when the consequences of childhood obesity manifests itself in higher death rates, that life expectancy among Americans is likely to decline. How could the prolonged trend of increasing life expectancy be reversed in an era of unprecedented advances in medicine and health care? The reason is that increasing death rates among the young have a much greater negative impact on life expectancy than comparable increases among the old. Examples in the last century include the influenza pandemics of 1918, 1957, and 1968, high losses among the young during wars, and HIV/AIDS -- all of which yielded short-term declines in life expectancy at birth. The difference in the case of obesity is that the negative pressure on life expectancy will be sustained as long as younger generations continue to become and remain obese, and as long as the detrimental effect of obesity on mortality rates persists. Today, all of the signs point in the direction of a sustained negative impact of obesity on life expectancy.

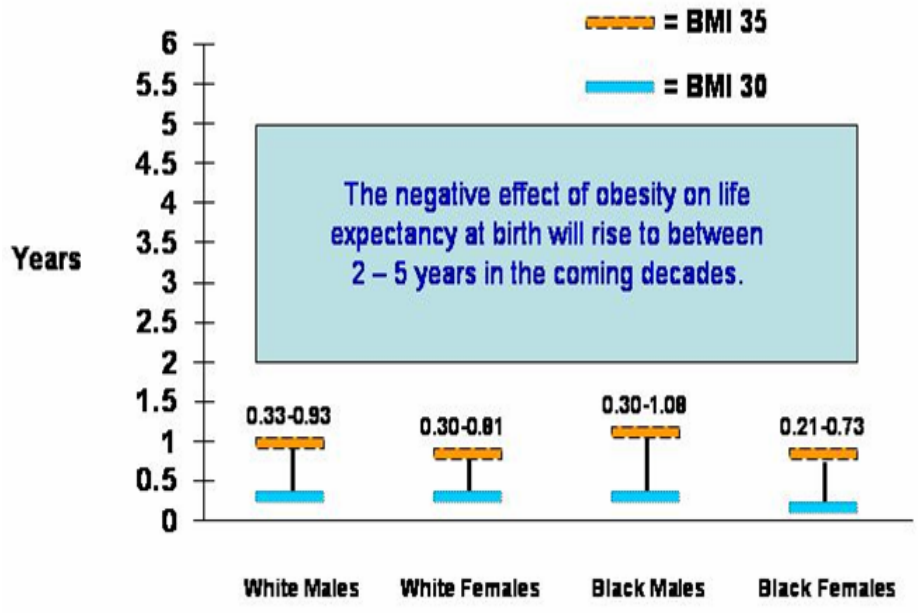

Figure 1. Life-shortening effect of obesity according to race and sex in the United States in 2000. This figure shows the potential gain in life expectancy at birth for the U.S. population in 2000, by race and sex, if obesity were eliminated. The range of estimates is shown between the bars on the basis 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. The upper panel represents a possible range of negative effects of obesity on period life expectancy at birth between now and 2050.

If left unchecked, the rising prevalence of obesity that has already occurred in the past 30 years will elevate the risks for a wide range of fatal and non-fatal conditions as these cohorts age. If the prevalence of obesity continues to rise, especially at younger ages, the negative impact on health and

longevity in the coming decades could be much worse. Given the unprecedented nature of this phenomenon, it is impossible to predict when obesity among the young will have its largest negative effect on life expectancy. Assuming successful interventions are not found, the first half of this century would be reasonable prediction because this is when the current at-risk populations will reach the ages of greatest vulnerability.

Discussion

The rise of childhood obesity in the United States is roughly equivalent in scope to the introduction of a behavioral habit that has a devastating but delayed effect on morbidity and mortality. If we were a nation of mostly non-smokers and within two decades discovered that the prevalence of smoking among children increased from negligible levels to between 20 to 30 percent, the short-term health effects would be minimal but the long-term effects would be devastating. This is the prospect that we face with today's obesity epidemic -- the most detrimental health and longevity effects will not be seen for decades -- a phenomenon that cannot be detected by the current methods used to forecast life expectancy or to evaluate the relationship between obesity and mortality (Flegal et al., 2005).

The delayed effect of obesity on death rates is the reason we question the recent Social Security Administration (SSA) forecasts that assume life expectancy will not only continue its historical march upward, but their assumption that the rate of increase in life expectancy will accelerate. In light of the obesity-driven trends in the health status of the U.S. population (especially the young), the bases for the SSA's recent decision to raise its midrange forecasts of life expectancy beyond the increases already anticipated for the next 70 years should be reconsidered (Figure 2).

Other realistic threats to these presumed increases in life expectancy also exist. Between 1980 and 1992 in the United States: 1) the age-adjusted rate of death from infectious diseases rose by 39 percent, an increase fueled mostly by the AIDS epidemic, 2) the overall rate of death from infectious diseases increased 4.8 percent per year from 1980-1995, 3) hospital-acquired infections increased, 4) hospital-acquired, antibiotic-resistant pathogens have entered the community and our food supply, and 5) recent decreases in mortality related to the human immunodeficiency virus have leveled off. Life expectancy would decrease substantially if a pandemic influenza strikes, as most infectious disease experts anticipate. Developing and developed nations are far more vulnerable to a global pandemic of influenza today than in 1918, owing to an aging population, bacterial resistance to antibiotics, and more

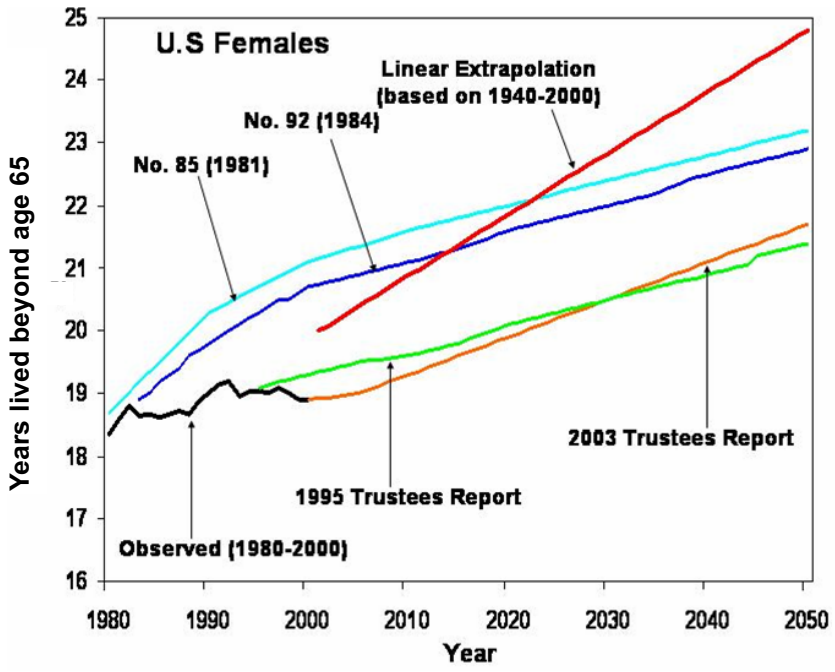

Figure 2. Observed and projected life expectancy at age 65 for U.S. females (1980 to 2050). Shown are observed changes, from 1980 to 2000, in expected remaining years of life at age 65 for females in the United States, projections of the expected remaining years of life at age 65 made by the SSA (Social Security Administration) in actuarial studies published in 1981 and 1984, and forecasts based on the SSA's 1995 and 2003 Trustees Reports. A forecast is shown of the expected remaining years of life at age 65 for females in the United States. This assumes the observed trend from 1940 to 2000 is extrapolated linearly from 2000 to 2050.

rapid transport of microbes, among other reasons (Olshansky et al., 1997). Although estimating the negative effects of epidemics on the future course of life expectancy is an inexact science, the ability of infectious diseases to wipe out a century's worth of gains in health and longevity in less than one generation is a documented fact.

Forces that exert upward pressure on life expectancy also exist. For example, advances in the medical treatment of major fatal diseases, including the complications of obesity, are certain to continue (Edwards et al., 2005). While an influenza pandemic seems inevitable, better global surveillance and new treatment protocols should reduce its negative effects on health and longevity. As scientists learn more about aging, interventions that slow the process may emerge. Extending the lives of the old, however, will have only a modest impact on life expectancy, while the protracted consequences of childhood obesity on health and longevity can exert a considerable downward pressure on life expectancy.

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 policy makers will respond to the impending dangers that obesity poses to both the quality and the length of life. However, the negative effect of unchecked obesity on health and longevity is substantial according to those statistics on health and mortality that can be observed for the generations currently alive.

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 the hardest hit by obesity, because it is within these subgroups that access to health care is limited and childhood and adult obesity has increased the fastest. If the negative effect of obesity on life expectancy continues to worsen, then the gains in health and longevity that have taken decades to achieve may be quickly reversed. The optimism of scientists and of policy-making bodies about the future course of life expectancy should be balanced by a realistic acknowledgment of the significant threats to the health and longevity of younger generations today that are already visible.

Dedication: The authors wish to dedicate this article to the memory of Douglas J. Passaro, M.D., who unexpectedly died in April 2005.

References and Further Readings

Allison DB, Fontaine KR, Manson J, Stevens J, van Itallie TB. Annual deaths attributable to obesity in the United States. *Journal of the American Medical Association (JAMA)* 282(16):1530-1538, 1999.

Ebbeling CB, Pawlak DB, Ludwig DS. Childhood obesity: public health crisis, common sense cure. *Lancet* 360:473-482, 2002.

Flegal KM, Graubard BI, Williamson DF, Gail MH. Excess deaths associated with underweight, overweight, and obesity. *Journal of the American Medical Association (JAMA)* 293(15):1861-1867, 2005.

Gregg EW, Cheng YJ, Cadwell BL, Imperatore G, Williams DE, Flegal KM, Venkat Narayan KM, Williamson DF. Secular trends in cardiovascular disease risk factors according to body mass index in US adults. *Journal of the American Medical Association (JAMA)* 293:1868-1874, 2005.

Hedley AA, Ogden CL, Johnson CL, Carroll MD, Curtin LR, Flegal KM. Prevalence of overweight and obesity among US children, adolescents, and adults, 1999-2002. *Journal of the American Medical Association (JAMA)* 291(23):2847-2850, 2004.

Ludwi DS, Ebbeling CB. Type 2 diabetes in children: primary care and public health considerations. *Journal of the American Medical Association (JAMA)* 286:1427-1430, 2001.

Olshansky SJ, Carnes BA, Rogers RA, Smith L. Infectious diseases: new and ancient threats to world health. *Population Bulletin* 52(2):1-58, 1997.

Olshansky SJ, Passaro D, Hershow R, Layden J, Carnes BA, Brody J, Hayflick L, Butler RN, Allison DB, Ludwig DS. A potential decline in life expectancy in the United States in the 21st century. *New England Journal of Medicine* 352:1103-1110, 2005.