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Aging in America in the Twenty-first Century: Demographic Forecasts from the MacArthur Foundation Research Network on an Aging Society

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Context: The aging of the baby boom generation, the extension of life, and progressive increases in disability-free life expectancy have generated a dramatic demographic transition in the United States. Official government forecasts may, however, have inadvertently underestimated life expectancy, which would have major policy implications, since small differences in forecasts of life expectancy produce very large differences in the number of people surviving to an older age. This article presents a new set of population and life expectancy forecasts for the United States, focusing on transitions that will take place by midcentury.

Methods: Forecasts were made with a cohort-components methodology, based on the premise that the risk of death will be influenced in the coming decades by accelerated advances in biomedical technology that either delay the onset and age progression of major fatal diseases or that slow the aging process itself.

Findings: Results indicate that the current forecasts of the U.S. Social Security Administration and U.S. Census Bureau may underestimate the rise in life expectancy at birth for men and women combined, by 2050, from 3.1 to 7.9 years.

Conclusions: The cumulative outlays for Medicare and Social Security could be higher by $3.2 to $8.3 trillion relative to current government forecasts. This article discusses the implications of these results regarding the benefits and costs of an aging society and the prospect that health disparities could attenuate some of these changes.

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DEMOGRAPHY IS DESTINY, OR IS IT? EVENTS IN HUMAN HISTORY have had an undeniable effect on the present, and they will have a rippling effect through time, but important elements of the way in which we age as individuals and as populations are within our control. From 1946 through 1964, the world's population added approximately 400 million more people during the post–World War II baby boom, an event of historic relevance to humanity. That is, the baby boomers and the following generations have fundamentally altered our age structure (Olshansky, Carnes, and Cassel 1993; United Nations 2001), with profound current and forthcoming societal consequences.

In response to the need for science-based understanding and public policy as a reaction to unprecedented trends in life extension and population aging, the MacArthur Foundation recently established the national Research Network on an Aging Society. This newly formed group of interdisciplinary-minded scientists has been charged over the next few years with identifying the magnitude of the effect of aging on individual- and population-level trends in function and longevity for our society and subgroups, and with facilitating public policy that enhances the opportunities and mitigates the challenges posed by the consequences of individual and population aging.

To establish a baseline for its work, the Network formulated a new set of population and mortality forecasts for the United States up to 2050 to assess the effects of anticipated developments in the biomedical sciences. The forecasts also gauge the degree to which these developments will influence life expectancy and population aging in the United States through the middle of the twenty-first century, especially the years 2030 and 2050.[1] To provide context for our forecasts, we compared the demographic implications of our assumptions with those generated from recent forecasts made by the U.S. Social Security Administration (SSA) and the U.S. Census Bureau.

Official Government Forecasts

The Social Security Administration (2008b) independently makes forecasts of the size and age structure of the U.S. population each year, and the U.S. Census Bureau (2008) does so periodically. In its latest forecast in 2008, the SSA used data from the National Center for Health Statistics (NCHS) and Medicare on historical trends in death rates by age, sex, and underlying cause as the basis for choosing what are referred to as *ultimate annual rates of improvement* in these age-sex-cause-specific death rates. From now until 2032, the SSA assumes that total mortality will decline annually by 0.86 percent at all ages (from 0 through 100+). From 2032 to 2082, the SSA assumes that for those under age sixty-five, total mortality will fall each year by 0.73 percent and that at ages sixty-five and older, it will fall each year by 0.65 percent. The SSA therefore assumes that rates of mortality improvement will slow throughout this century owing to the constant percentage reductions in death rates, yielding smaller annual absolute declines, and owing to an explicit shift toward smaller percentage reductions in death rates after 2032.

The Census Bureau's 2008 forecasts made assumptions about the future course of mortality for three mutually exclusive subgroups: Hispanics, non-Hispanic blacks, and all other non-Hispanic races. Using the death rates generated from the NCHS's vital statistics and the Census Bureau's estimates of the population from 1984 to 2003, the Census Bureau used a time series analysis to generate complete life tables for each of these population subgroups. Although the Census Bureau did not provide details regarding its forecasting assumptions, it did confirm that by 2075, the risk of death for all population subgroups would converge into the "non-Hispanic all other races" group.

Data and Methods

We used a cohort-components method of forecasting requiring separate assumptions about fertility, mortality, and migration.[2] Software for the forecasts was provided by the Census Bureau (Hollmann, Mulder, and Kallan 2008). In order to use reliable decennial census data for the resident population of the United States (U.S. Census Bureau 2008), we chose the year 2000 as the launch year for our forecast and obtained numerators for death rates in 2000 from the Vital Statistics of the United States (National Bureau of Economic Research 2008). We first made forecasts of the U.S. population by gender and age (single-year-of-age from ages 0 to 100 and older) up to 2030. The results for 2030 then served as the launch data for another projection (by single-year-of-age from ages 0 to 100 and older) up to 2050. Population and mortality/life expectancy estimates for all intermediate years (between 2000 and 2030 and between

2030 and 2050) are available at the MacArthur Research Network's website (http://agingsocietynetwork.org/demographic-forecasts).

For the forecasting time frame and mortality scenarios, the total fertility rate (TFR) was held constant at 2.1. Forecast results based on TFR assumptions of 1.5, 2.0, and 2.2, holding all other vital rates constant, are available at the MacArthur Research Network's website (http://agingsocietynetwork.org/demographic-forecasts).

Net migration was held constant at one million annually, which was identical to the SSA's current forecasting assumption. The SSA provided the single-year-of-age estimates of the age distribution of net migrants used in these forecasts (Goss 2008).

We forecast single-year-of-age death rates by sex for the U.S. population using two scenarios, both of which were designed to estimate, in different ways, how anticipated advances in biomedical technology would most likely accelerate reductions in mortality between now and 2050. Scenario A assumes that advances in efforts to combat major fatal diseases (e.g., medical technology, modified behavioral risk factors, aggressive management of symptoms) will occur at an *accelerated pace* over the fifty-year projected time frame. This assumption is based on the underlying view that medical technology will improve more rapidly in the first half of this century than it did in the last half of the twentieth century. Scenario A accomplishes this by using a methodology (described later) that relies on secular trends in delayed mortality by age (Olshansky 1987). By contrast, the SSA assumes that rates of improvement in U.S. mortality will slow in the coming decades.

The U.S. population has demonstrated that it takes approximately twenty to thirty years to achieve the equivalent of a five-year delay in intrinsic (Carnes and Olshansky 1997) (aging-related) mortality (Olshansky 1987). Aging-related death rates have been defined as total mortality minus accidents, homicide, and suicide (Olshansky 1987). Although this is acknowledged as being an imperfect empirical definition of intrinsic mortality, there is ample evidence from human and animal studies to justify using it (Carnes and Olshansky 1997). Since linear increases in life expectancy require accelerating reductions in death rates (Olshansky, Carnes, and Désesquelles 2001), the more rapid advances in medical technology anticipated in the coming decades could be expected to yield one five-year delay in intrinsic mortality for the population aged fifteen and older in the thirty-year time frame from 2000 to 2030, and another five-year delay in the twenty-year time frame from 2030 to 2050.

For example, a five-year delay in mortality over the twenty years from 2030 to 2050 means that the forecasted death rate for people aged eighty-five in the year 2050 would be equivalent to the observed risk of death of people aged eighty in 2030. The forecasted death rate for people aged eighty-four in the year 2050 would be equivalent to the observed risk of death of people aged seventy-nine in 2030, and so on. This "delay" in mortality is projected to occur at all ages for the population aged fifteen and older. A consistent relationship between the risk of death in adjacent age groups after puberty in long-lived populations is an attribute of human mortality that has never changed. Because most of the gains in life expectancy in the latter part of the twentieth century have been documented to be due to delays in intrinsic mortality (Olshansky 1987), the cause-delay methodology works very well for modeling secular changes in fatal diseases. To provide a range of forecasted delays in mortality, we also calculated what would occur to life expectancy and population growth with three- and seven-year delays in intrinsic mortality, and with three-, five-, and seven-year delays using total mortality (see MacArthur Research Network's website: http://agingsocietynetwork.org/demographic-forecasts). All of the mortality delay assumptions in scenario A apply to the population aged fifteen and older. Death rates for those under age fifteen were held constant because mortality at these ages are so low that prospective changes would have a negligible effect on life expectancy (Olshansky, Carnes, and Cassel 1990). Extrinsic mortality (total mortality minus intrinsic mortality) at age fifteen and older was held constant at the levels prevailing in 2000. This forecasting approach is generally based on the current disease-specific model, in which medical advances are thought to be accelerating, but their mortality-reducing effects are concentrated on specific diseases largely independent of one another.

Scenario B assumes that forthcoming advances in the biomedical sciences will lead to interventions that slow the rate of biological aging and have a systemic dampening effect on all fatal and disabling diseases simultaneously (Butler et al. 2008). Experimental studies involving animal models have demonstrated that decelerated aging has already been achieved in the laboratory (Miller et al. 2005; Selman et al. 2008). For example, experiments have shown that by manipulating certain genes, altering reproduction, reducing caloric intake, modulating levels of hormones that affect growth and maturation, and altering the action of insulin, the duration of life of invertebrates and mammals can be extended (Tatar, Bartke, and Antebi 2003; Weindruch and Sohal 1997). Recently published research suggests that some compounds, such as the antifungal rapamycin (now used to prevent organ rejection in transplant patients) may have the inadvertent property of extending life, even when used in older animals (Harrison et al. 2009). We contend, as do many other scientists, that people alive today will be the beneficiaries of these interventions (Butler et al. 2008; Martin, Bergman, and Barzilai 2007; Miller 2002; Sierra et al. 2009).

The aging of some species already has been decelerated using experimental means in the laboratory through a decline of the *slope* associated with the trajectory of their age-specific death rates (de Magalhaes, Cabral, and Magalhaes 2005). Until reliable biomarkers for aging are found, a decline in the slope of age-specific death rates is a defensible metric of decelerated aging. By contrast, scenario A reduced death rates by means of a uniform displacement of the entire mortality schedule to later ages (Olshansky and Ault 1986) (for a comparison of observed and projected death rates under scenarios A and B, see table 1 and figures 1 and 2). Because we believe that interventions that slow aging in people are likely to be available and fully efficacious before midcentury, we assumed that the slope of the intrinsic mortality curve observed in 2000 at ages fifteen and older for both males and females will be reduced by 10, 20, 30, or 40 percent by 2050, a change in slope that is comparable to the improvements already observed in animal models (de Magalhaes, Cabral, and Magalhaes 2005). In the remainder of this article, we present the results of the delayed aging model (scenario B) based on the assumption that a slope change of 20 percent in intrinsic mortality is fully under way by 2050. Both the mortality schedules by age and sex resulting from this "decelerated aging" assumption in the intermediate years and the other three slope-change scenarios are available at the MacArthur Research Network's website (http://agingsocietynetwork.org/demographic-forecasts).

Results

Life Expectancy Forecasts

If death rates are reduced by 2050 because of continued and accelerated gains made against major fatal diseases (scenario A), life expectancy at

TABLE 1
Network Forecasting Assumptions

Mortality	Fertility (Total Fertility Rate – TFR)	Net Migration (Annual)
	1.5; 2.0; **2.1**; 2.2	**1 million**
Scenario A		
Total Mortality 3, **5**, 7-year delay		
Intrinsic Mortality 3, **5**, 7-year delay		
Scenario B		
Total Mortality 10%, **20%**, 30%, 40% slope reduction		
Intrinsic Mortality 10%, **20%**, 30%, 40% slope reduction		

Note: Forecasting assumptions in boldface are presented as results in this article. All other forecasting results based on remaining permutations of mortality, fertility, and migration will be made available on the MacArthur Research Network's website (http://agingsocietynetwork.org/demographic-forecasts).

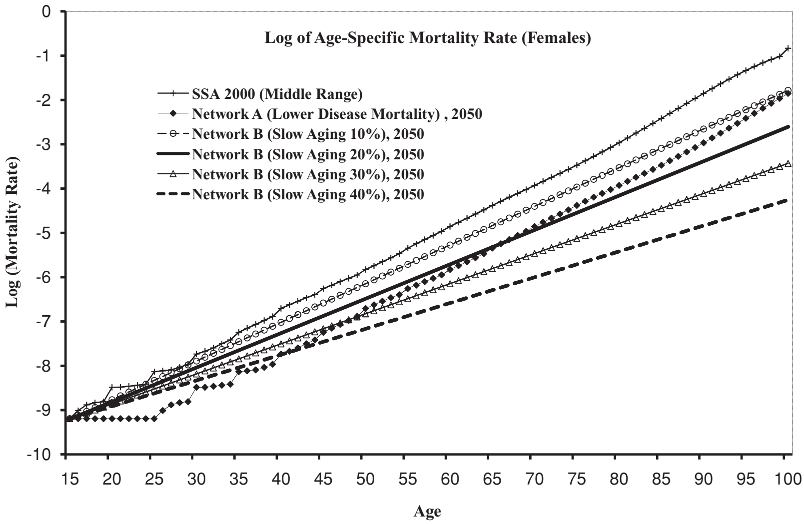

FIGURE 1. Observed (2000) and Forecasted Age-Specific Death Rates for 2050 under Network Scenario A (5-Year Delay) and Network Scenario B (10 to 40% Slope Reduction) for U.S. Females.

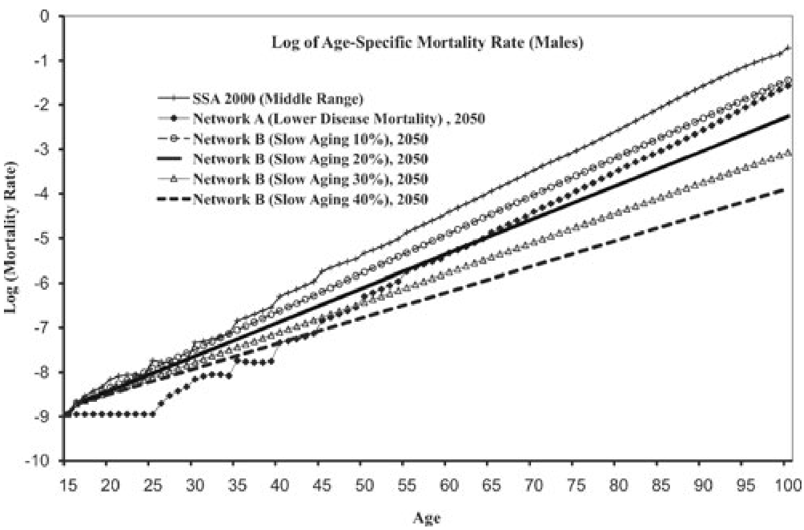

FIGURE 2. Observed (2000) and Forecasted Age-Specific Death Rates for 2050 under Network Scenario A (5-Year Delay) and Network Scenario B (10 to 40% Slope Reduction) for U.S. Males.

birth [e(0)] would rise to 83.2 for males and 89.2 for females by 2050 (see table 2). These forecasts are 3.6 percent higher than the Census Bureau's forecasts and 5.2 percent higher than the SSA's forecasts. If death rates were reduced by 2050 by efforts to slow aging (scenario B), then e(0) would rise to 85.9 and 93.3 for males and females, respectively, (table 2), figures that are 7.3 percent higher than the Census Bureau's and 8.8 percent higher than the SSA's. The Social Security Administration's middle-range forecasts indicate that in 2050 e(0) will be 80.0 and 83.4 years for males and females, respectively (table 2). The Census Bureau (CB) forecasts that in 2050 e(0) for males and females will be 80.9 and 85.3 years, respectively.

Cumulative Person-Years-of-Life (PYL)

Underestimates of future life expectancy have important public policy implications because small differences in forecasted survival rates by midcentury result in extremely large differences in the number of people expected to survive into retirement ages. Each one-year difference in life expectancy forecast for 2050 would produce a difference of approximately 53 million cumulative PYL lived by people aged sixty-five and older between 2000 and 2050 (figure 3); a difference of approximately 51.6 million cumulative PYL lived by people reaching future adjusted Social Security normal retirement ages (65 between year 2000 and 2007, 66 between year 2008 and 2024, and 67 afterward); and a difference of approximately 22 million cumulative PYL lived by people aged eighty-five and older. Cumulative PYL is the summation of the annual additional years of life lived (drawn from the population forecasts) associated with each one-year projected increase in life expectancy at birth, across all population projections from 2000 to 2050 for cohorts aged sixty-five and older and eighty-five and older while holding fertility [TFR = 2.1] and migration [net migration = 1 million] constant (i.e., cumulative PYL in this example is the independent effect of forecasts of life expectancy on future population size). Since our forecasts under scenario A yield life expectancies in 2050 for men and women combined that are an average of 4.5 years higher than the SSA's estimate and 3.1 years higher than the Census Bureau's, we predict that the United States could have an excess of 164 million to 239 million cumulative PYL lived at ages sixty-five and older throughout the

TABLE 2
U.S. Social Security Administration, U.S. Census Bureau, and the Network Observed (2000) and Projected (2030, 2050) Life Expectancy at Birth and at Ages 65 and 85 for U.S. Males and Females

	2000	2030				2050			
		SSA	CB	Network A (lower disease mortality)	Network B (slow aging)	SSA	CB	Network A (lower disease mortality)	Network B (slow aging)
	Life Expectancy at Birth								
Males	74.0	78.0	78.4	79.4	80.4	80.0	80.9	83.2	85.9
Females	79.4	81.8	83.1	85.1	86.3	83.4	85.3	89.2	93.3
Total	76.7	79.9	80.8	82.3	83.4	81.7	83.1	86.2	89.6
	Life Expectancy at Age 65								
Males	15.9	18.2	19.0	20.2	21.8	19.3	20.6	23.4	27.1
Females	19.0	20.3	21.7	23.7	25.5	21.4	23.2	27.4	32.4
Total	17.4	19.2	20.4	22.0	23.7	20.4	21.9	25.4	29.8
	Life Expectancy at Age 85								
Males	5.2	6.0	6.8	7.6	9.2	6.5	7.6	9.7	13.6
Females	6.4	7.1	8.0	9.5	11.5	7.6	8.9	12.3	17.8
Total	5.8	6.6	7.4	8.6	10.4	7.1	8.3	11.0	15.7

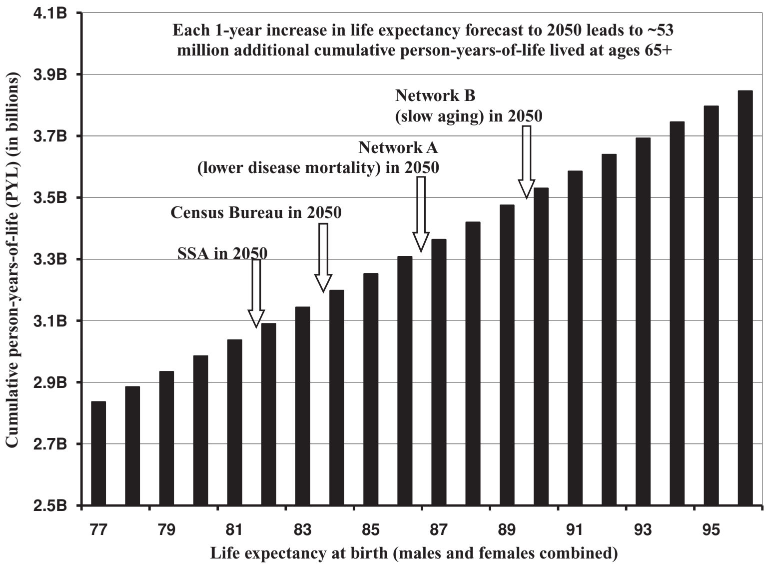

FIGURE 3. Cumulative Person-Years-of-Life Lived from 2000 to 2050 at Ages 65 and Older with Each 1-Year Forecasted Difference in e(0) to 2050 (United States).

projected time frame, or, between now and 2050 an excess of 160 million to 232 million cumulative PYL lived at future adjusted Social Security normal retirement ages. According to scenario B, by 2050 there would be an excess of 345 million to 419 million cumulative PYL lived at ages sixty-five and older and 335 million to 408 million cumulative PYL lived at future adjusted Social Security normal retirement ages.

Population Forecasts

Our forecasts indicate that the size of the U.S. population would rise from the current level of 304.2 million observed in 2008 (U.S. Census Bureau 2008) to between about 411 million and 418 million in 2050, regardless of whether the anticipated mortality declines result from advances against major fatal diseases and their risk factors or from a deceleration in the rate of biological aging. These forecasts also indicate that the population in the retirement ages of sixty-five and older would rise from 38.7 million observed in 2008 (U.S. Census Bureau 2008) to between 99 million and 108 million by 2050, and that the population aged eighty-five

TABLE 3
U.S. Social Security Administration, U.S. Census Bureau, and the Network Observed (2000) and Projected (2030, 2050) U.S. Population (Total, 65+, 85+)

	2000	2030	2050
Total Population	281.4		
SSA	-	371.0	410.7
CB	-	373.5	439.0
Network			
A (lower disease mortality)	-	363.2	410.5
B (slow aging)	-	365.0	417.9
Population Aged 65+	35.0		
SSA	-	70.4	80.8
CB	-	72.1	88.5
Network			
A (lower disease mortality)	-	75.9	99.3
B (slow aging)	-	78.3	107.7
Population Aged 85+	5.4		
SSA	-	7.4	15.1
CB	-	8.7	19.0
Network			
A (lower disease mortality)	-	10.3	27.0
B (slow aging)	-	12.1	34.7

and older would rise from 5.4 million in 2008 to between 27 million and 35 million by 2050 (table 3). By contrast, the SSA forecasts for 2050 indicate that the total U.S. population will be 411 million; the population aged sixty-five and older will be 81 million; and the population aged eighty-five and older will be 15 million. The Census Bureau forecasts that by 2050, 88.5 million people will be aged sixty-five and older; 19 million people will be aged eighty-five and older; and 601,000 people will be aged one hundred and older (under scenario A, an estimate of the number of centenarians that is more than double the SSA's forecast but about one-third the number we forecast could be alive by midcentury). Almost all the 19 million more people in the United States in 2050 in the Census Bureau's forecasts compared with the SSA's are the result of differences in the number of people expected to reach ages sixty-five and older. The Census Bureau anticipates that by 2050 the U.S. population will reach 439 million; the SSA projects a population size of 410.7 million in that year; and the Network forecasts between about 410 million and 418 million in 2050, depending on the mortality assumption used.

Conclusions

Few things influence a population more than its age structure. A demographic transition began in the twentieth century that in hindsight will be seen as a seminal moment in our history: the extension of life fell within the grasp of human ingenuity. Scientists are struggling to understand the consequences of this transition because it is not yet over. Consequently, we cannot know with certainty how much longer we can live, how much older the population can become, and what the full economic, medical, and social impacts of population aging will be (Kirkwood 2008).

On the one hand, the rapid aging of the population and the continued extension of life may lead to catastrophic economic and health conditions in the United States as age entitlement programs such as Medicare and Social Security are severely strained or even collapse under the weight of the baby boom generation (Peterson 1999). The emergence of counterproductive intergenerational tension and discord would likely be another detrimental by-product of this scenario. These problems would be exacerbated if health care fails to keep up with the rising tide of retirees demanding increasingly more advanced and expensive medical technology to extend life even further, and if the job market fails to adapt to the ongoing upward shift in the country's age structure. Such economic dysfunction would have destabilizing effects on many of our core institutions: the family, education, the workforce, retirement, employer/employee relations, political parties, the structure and function of government, and even the design and function of our cities and living and working environments.

On the other hand, the extension of life increases one of the most valued of all commodities: human capital (Bloom and Canning 2000). Longer lives will surely create new and expanding markets in health care and leisure (Butler et al. 2004), and they also will produce a more experienced workforce. The baby boom generation will both demand and create an array of novel ways for older persons to remain productive and participate in the creation of a more equitable society.

The MacArthur Foundation Research Network on an Aging Society initiated these forecasts of mortality, life expectancy, and population growth in the United States as a way to provide baseline estimates of where this country appears to be headed. The years 2030 and 2050 were chosen as reference points because they fall within a time frame that could be affected by public policy enacted within the next few years, and because forecasts involving cohorts that are alive today have a known past that can reduce some of the uncertainty about the future.

Network forecasts suggest that between now and 2050, official U.S. government agencies may be underestimating male and female life expectancy at birth in 2050 by as much as 3.1 and 4.5 years, respectively, and by as much as 7.9 years if mortality is improved by delayed aging. We believe the reason for this underestimation is that government agencies assume the improvements in mortality in the coming decades will decelerate, whereas we forecast that a combination of control of behavioral risk factors and new advances in medical technology that slow aging will accelerate reductions in death rates. Because small differences in projected levels of life expectancy produce very large differences in the number of people who will survive to older ages in the coming decades, underestimates of e(0) ranging from 3.1 to 7.9 years suggest that both the benefits and costs of an aging population could be much larger than official forecasts indicate. If life expectancy at birth in the United States reaches one hundred years by 2060, as some predict (Oeppen and Vaupel 2002), by midcentury there would be an excess of one trillion cumulative PYL lived at ages sixty-five and older. This assumption about future life expectancy in the United States for men and women combined is from nine to eighteen years higher than the most optimistic scenarios anticipated by the SSA, Census Bureau, or even our forecasts; and if an extra one trillion cumulative PYL came to pass, it would have a profoundly negative effect on age-based entitlement programs and global pension schemes.

These forecasts have dramatic fiscal implications, particularly for Social Security and Medicare. In 2007, Medicare spent approximately $9,487 per beneficiary over age sixty-five (Pelosi 2008). We are forecasting a cumulative 164 million to 419 million additional person-years-of-life for persons aged sixty-five and older between now and 2050. Assuming that 98 percent of this population will have Medicare coverage—and, very conservatively, assuming no real growth in health care spending—this suggests additional Medicare spending through 2050 from around $1.5 trillion to $3.9 trillion. (Historical growth rates in Medicare have ranged in the 1–2 percent range above real growth [White 2008].)

Similar calculations for Social Security indicate that per capita benefits were $11,967 for recipients of old-age and survivor insurance (Social Security Administration 2008a, 2008c). Assuming that 90 percent of the age-eligible population continues to receive benefits and taking into account the change in the eligibility age from 65.1 in 2007 to 67 in 2025, our forecasts point to additional Social Security outlays of $1.7 trillion to $4.4 trillion due exclusively to unaccounted-for anticipated improvements in life expectancy. These estimates suggest that federal outlays for these two programs together could be underestimated by $3.2 trillion to $8.3 trillion (2007 dollars) relative to current government forecasts.

It is important to recognize that not everyone in the United States will benefit from advances in biomedical technology equally or at the same time, nor are such advances expected to occur instantaneously. Instead, health and longevity benefits most likely will be phased in over time. The forecasts presented here were designed with this in mind by assuming a gradation of benefits that do not achieve until 2050 their full effect on either the delay in mortality or the deceleration of aging.[3] This assumption is similar to the Census Bureau's, that the mortality risk among all subgroups of the U.S. population will eventually converge by 2075. If death rates decline faster than anticipated under either of the scenarios presented here or if both scenarios occur simultaneously, then the absolute number of people living beyond age sixty-five will rise even further, as will their consequent impact on Social Security and Medicare.

An important element of the MacArthur Research Network's forecasts is the distinction between the forces of declining mortality that are driven by the current disease-specific model, in which one disease is attacked at a time, and the delayed-aging model, in which intrinsic diseases and disorders (both fatal and nonfatal) are simultaneously postponed. This study is the first to demonstrate how slowing aging in people could influence the future course of mortality, life expectancy, and population growth in a single country: the United States. Some people have speculated that successful efforts to slow aging would lead to both challenging and catastrophic circumstances, such as the rapid aging of the population, overpopulation, an extension of old age, new ethical concerns, and disruptions in social institutions (Kass 2003). Depending on how long aging is delayed, network forecasts demonstrate that many of these concerns are unwarranted because delayed aging is likely to yield increases in life expectancy and population size that are not dramatically different from those expected from ongoing efforts to delay major fatal diseases. As an example of the relative magnitude of the mortality and life expectancy benefits resulting from delayed aging, consider that a small 6.5 percent slope reduction in current age-specific death rates in the U.S. population aged fifteen and older would yield mortality declines that are equivalent to a cure for cancer.

Interventions that slow aging in people would produce increases in longevity and population size that are larger than those achieved by the disease-specific model. But if the effects of interventions for humans are consistent with those reported for other species, they would offer the added bonus of compressing morbidity, disability, frailty, and mortality into a shorter duration of time near the end of life (Vergara et al. 2004). The development of the scientific means to decelerate the rate of aging, if pursued as a new model of health promotion and disease prevention in the twenty-first century (Butler et al. 2008), would not only achieve the goals of the current medical model—the extension of healthy life—but would do so more swiftly, with greater efficiency, and at a lower cost (Bloom and Canning 2000). A realistic view of the future would entail elements of both scenarios A and B occurring simultaneously.

Although there currently are substantial differences in life expectancy in the United States according to race and social class (Meara, Richards, and Cutler 2008; Singh and Siahpush 2006), an underlying premise of the forecasting scenarios described here is that by midcentury, all segments of the U.S. population would benefit equally. Worrisome trends in health (and limits on health care spending) are emerging, however, that could attenuate or even reverse the anticipated rise in life expectancy in the coming decades in unequal measure, by differences in social class (Singh and Siahpush 2006) and by a rising risk of cardiovascular disease (Olshansky and Persky 2008), diabetes (Wild et al. 2004), obesity (Olshansky et al. 2005; Wang et al. 2008), and other serious health conditions now found among younger cohorts in the United States and elsewhere. For example, if recent trends in childhood and adult-onset obesity are not reversed in the United States, it is possible that the life expectancy of some subgroups of the population could fall within the next few decades (Olshansky et al. 2005). The forecasts presented here do not repudiate that line of reasoning.

We offer these forecasts with the optimistic assumption that the morbidity and mortality consequences of many of these harmful health conditions are avoidable and that they should and will be identified as high-priority targets for aggressive intervention as our nation's current and future health policy is being developed and implemented. These Network forecasts are based on the premise that the health and longevity challenges now faced by the U.S. population (e.g., smoking and the rise of obesity) will be resolved by midcentury. But this indeed is an optimistic assumption that is largely consistent with the underlying premise of a number of other forecasts indicating that life expectancy will continue to rise in this century through lifestyle modifications and biomedical interventions (Bongaarts and Feeney 2002; Li and Lee 2005; Oeppen and Vaupel 2002; Tuljapurkar, Li, and Boe 2000; Wilmoth 1998). The Network's forecasts are different in that for the first time in the scientific literature, the effects of delayed aging have been empirically modeled and applied to forecasts of life expectancy and population size for a national population. The Network's future research will, in part, be devoted to documenting how the health and size of the U.S. population would change by midcentury if we fail to reduce or eliminate prevailing health and mortality disparities or if we fail to modulate trends in life-shortening behavioral risk factors.

In sum, the extension of life and population aging are world-changing events that will have profound impacts on generations to come. It is our contention that official government forecasts of survival, life expectancy, and aging for the U.S. population may have been significantly underestimated. The demographic trends anticipated here will exacerbate the economic, social, and health challenges posed by a growing elderly population. But if the extension of life achieved in the coming decades can be converted into healthy productive years, then these challenges could be counterbalanced by an equal measure of opportunity and the emergence of a productive and equitable aging society.

Endnotes

1. We know that behavioral risk factors will play an important role in the future course of longevity in the United States. The Network begins with the premise that the primary risk factors for smoking, obesity, and other major behavioral risk factors will be controlled by midcentury. In a future Network paper on the prevailing health disparities in the United States, we will discuss in detail how the health and longevity of the U.S. population would be affected if efforts to favorably modulate these behavioral risk factors fail.
2. Both the SSA and the Census Bureau use a cohort-components method of forecasting population size. We chose to replicate this method here (using exactly the same software as that used by the Census Bureau) as a way to eliminate confounding factors that could influence the outcome of the forecasts. Other important methods of forecasting have been developed in statistical

demography (e.g., Bongaarts 2005) and have been documented to improve long-range forecasts. Our emphasis is on total population size and the survival characteristics of living cohorts for short-range forecasts, so the Census Bureau software is suitable for our purposes.

3. No inference should be made about the level or trajectory of age-specific death rates, life expectancy, level of health care spending, or the rate of advancement in technology after the year 2050 from the assumptions and conclusions in this article regarding the first half of this century.

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