

## Optimizing Health in Aging Societies

Laura L. Carstensen, PhD,<sup>1,\*</sup> Mary E. Rosenberger, PhD,<sup>1</sup> Ken Smith, MS,<sup>2</sup> and Sepideh Modrek, PhD<sup>3</sup>

<sup>1</sup>Psychology Department and Stanford Center on Longevity, Stanford University, California. <sup>2</sup>Stanford Center on Longevity, Stanford University, California. <sup>3</sup>Stanford School of Medicine, Stanford University, California.

\*Address correspondence to Laura L. Carstensen, PhD, Carstensen Life-span Development Lab, Department of Psychology, 450 Serra Mall, Stanford University, Stanford, CA 94305-2130. E-mail: [laura.carstensen@stanford.edu](mailto:laura.carstensen@stanford.edu).

Manuscript received February 10, 2015; accepted February 20, 2015.

**Decision Editor:** Robert B. Hudson, PhD

**Key words:** Public health, Behavior change, mHealth.

Aging societies reflect a triumph of science and technology over premature death. In less than a century, technological and medical advances—coupled with large-scale public health efforts that improved sanitation, purified waterways, and increased safety—led to substantial improvements in the health of the U.S. population. The first half of the twentieth century witnessed gains in life expectancy largely due to reductions in infant and maternal mortality. Success was astounding. In a single century, infant mortality decreased by 90% and maternal mortality decreased by 99%. In the second half of the century, life expectancy continued to increase in adulthood, largely due to medical advances, in the treatment of cardiovascular disease. All told, nearly 30 years were added to average life expectancy in a single century. Increases continue today, with 3 months added to life expectancy *at 65* every year.

The magnitude of these changes is a testament to the potential of culture to alter physical functioning. Compared to our ancestors at the turn of the twentieth century, we are taller, stronger, and heartier. Our brains process information faster; and we live a lot longer. Agricultural advances insured a steady food supply. Electricity became ubiquitous and enabled refrigeration and heating. Efficient disposal of waste—garbage collection—and water purification starkly decreased exposure to pathogens in everyday life. Pasteurization and food fortification improved dietary intakes. Medical advances identified the causes of diseases and how they were spread. Immunization programs began to eradicate diseases that plagued earlier generations.

As children survived, fertility fell and these two phenomena together reshaped the distribution of age in the populations (Becker & Barro, 1988). With fewer children and longer lives, entire societies began to age. In 2012, for the first time in history, the U.S. population included more people over 60 than under 15 years old. The once-universal pyramid shapes of age distributions—which characterized populations in every country around the world—are being rectangularized throughout the western world, reflecting the fact that *most* people, not just an exceptional few, are living into old age.

Improvements in health have been extended into old age. In the United States, for the last 50 years, each cohort that has arrived at old age has been healthier than the one before it (Manton, Gu, & Lowrimore, 2008). Cohort comparisons show striking improvements even into advanced ages. One recent study compared the functioning of the 1905 and 1915 Danish birth cohorts when each cohort was in their early 90s (Christensen et al., 2013). The latter born cohort, separated by only 10 years, was associated with strikingly better outcomes on cognitive tests and functional health in old age. Keep in mind that genetically speaking, we are highly similar to our ancestors 10,000 years ago. Improvements in health and cognition speak to the profound influence that environmental and cultural factors can have on human health. We have every reason to celebrate these historical accomplishments, yet in critical areas, our successes have led to unintended consequences. As the 2015 White House conference on aging addresses the core

concept of healthy aging, it is essential that participants be mindful of new challenges brought about by our past successes.

Aging societies present several novel challenges. Diseases of old age, like Alzheimer's disease, have broad societal implications. In the absence of a cure, the burden of dementia will pose substantial economic hardships above and beyond the suffering of its victims and families (Hurd, Martorell, Mullen, Delavande, & Langa, 2013). Other diseases of old age, like cancer, osteoporosis, arthritis, chronic obstructive pulmonary disease, and congestive heart failure will increasingly affect larger proportions of citizens; and diseases, like diabetes, which tend to worsen over time, will play out for longer periods than observed in the past.

To some extent, the increase in chronic disease reflects the simple fact that more people are surviving acute diseases. Whereas a century ago, influenza and gastrointestinal disease ranked among the most common causes of death, today heart disease and cancer top the list. The increase in chronic diseases, however, also reflects changes in lifestyles (Martin & Schoeni, 2014). Somewhat ironically, many of the same advances that contributed to improvements in population health, such as the year-round availability of food and a reduction in the physical demands of work, are now threatening health in childhood and early adulthood. Processed, high calorie foods, initially developed and distributed to combat malnutrition, are contributing to obesity. Inexpensive "fast-food" has replaced fresh food, especially in poor communities that lack resources to grow or purchase high nutrient foods. The U.S. Centers for Disease Control and prevention (CDC) reported that in 2012, about half of all adults had one or more chronic conditions, and 7 of the top 10 causes of death were chronic diseases (CDC). Type II diabetes, once referred to as "adult-onset" diabetes, is now observed in young children, and because diabetes progresses with age, these children may experience a severity of the disease never before observed. To put the scale of these changes in perspective, consider that a century ago, 40% of prospective military recruits failed to meet minimum weight requirements. Today roughly the same percentage is obese. Since 1959, there has been a 111% increase in the percentage of age-eligible male civilians who exceed the Army's body fat limits (Cawley & Maclean, 2012). Indeed, excessive body fat is the most common reason for medical disqualification of military recruits. In other words, obesity threatens national security. We urge the organizers and the participants in the White House conference to be mindful of these present and looming risks to our population's health and fitness.

Many experts today believe that in a single generation, obesity may erase all of the health gains made in the last 50 years. A recent article by Jay Olshansky and his colleagues

published in the *New England Journal of Medicine* maintained that "life expectancy for the average American could decline by as much as 5 years unless aggressive efforts are made to slow rising rates of obesity" (Olshansky et al.). Obesity is strongly associated with hypertension, diabetes, arthritis, and a number of other conditions that decrease quality of life; morbid obesity (defined as more than 100 pounds overweight) even shortens lives (Sturm, 2007). The consequences of obesity are sufficiently serious that in 2013, the American Medical Association classified it as a disease in its own right (American Medical Association, 2013). It is associated with a 40% increase in duration of disability and thousands of dollars in increased health care costs (Hammond & Levine, 2010). At a national level, the CDC estimates that the United States spends 86% of its health care dollars on chronic diseases, with \$147 billion attributed to the effects of obesity (CDC, Chronic Disease Prevention and Health Promotion).

The bottom line is that we need to change the way we live. The largest contributors to chronic disease are lifestyle choices made over the entire life span, including environmental exposures starting in childhood, improper balance of sedentary time and physical activity, and poor diet. Increasing numbers of older citizens means that larger proportions of the population will, in the foreseeable future, experience physical infirmities; and, of course, virtually all people experience illness prior to death. In addition to medical treatments that target disease, the focus must expand to encompass behavior change aimed at disease *prevention*.

## Behavior Change: What We Have Learned and Where We Are Going

Even with decades of research on strategies aimed at fostering healthy behaviors, there remain few generalizable and effective strategies that effectively change behavior in enduring ways. The earliest interventions assumed that individuals armed with knowledge would make choices that maximized their long-term benefits. It is now clear that knowledge alone is relatively ineffective in bringing about behavior change. Most Americans know, for example, that exercise and healthy eating are good for health but there is scant evidence that such knowledge leads to improvements in behavioral practices. Even when individuals have the best intentions, they often fall short in reaching their goals (Webb & Sheeran, 2006).

Another long-standing approach to behavior change has been environmental modification. The vast public health gains made in the last century were due to improvements in environmental circumstances or incentives that facilitate relatively subconscious changes. A classic study conducted

by Jeremy Morris in London in 1953 examined differences in health outcomes between bus conductors (who stand all day) with bus drivers (who sit) (Morris, Heady, Raffle, Roberts, & Parks, 1953). Using trouser size as the dependent measure, Morris revealed stark differences as a function of activity levels at work. The most effective interventions are likely to include ubiquitous changes that are encompassed in daily life. Because adults spend a great deal of time in workplaces and children in schools, these sites offer excellent targets for change. Population-level environmental interventions, varying from increasing access to sidewalks (Singh, Siahpush, & Kogan, 2010), banning smoking at restaurants and bars (Siegel, Albers, Cheng, Hamilton, & Biener, 2008), to healthier food options at schools, worksites, and convenience stores (Frenk), all facilitate healthy choices in a variety of daily settings, and both public and private sectors are increasingly exploring and implementing these types of interventions.

In the last 10 years, the increasing availability of mobile technologies has created a new avenue to influence health behaviors. The broad use of smart phones is less than 10 years old, yet it has completely changed our ability to both measure behavior and respond to it at the very moment users are making health decisions. Mobile phone-based health technology, known colloquially as mHealth, changes how individuals interact with health care. mHealth creates opportunities for tracking behavior, communicating with health professionals, and even running diagnostic tests outside of the hospital. Devices that measure a number of physiological parameters or behaviors are now becoming commonplace and can be referred to as the general category of “wearables”. Wearables can track physical activity, sedentary behavior, and sleep; creating a daily record of activity and recovery that was previously extremely difficult to measure, and rarely done outside of the laboratory. Wearables are more objective and generate more detailed data than previous research that relied heavily on self-report, which is subject to recall bias, forgetfulness, and attitudes toward physical activity (Haskell, 2012). With more precise measurement of activity behavior recommendations for physical activity can be tailored to individuals across the life span and particularly for the aging population.

In addition to monitoring behavior and health, we need to effectively address behavior modification to prevent lifestyle diseases (e.g., diabetes, coronary heart disease, and certain types of cancer). One simple behavioral aspect of mHealth is tracking daily activities, similar to “food diaries,” “weight charts” or “activity logs.” In some people tracking itself may change behavior; it also leads to unlimited opportunities for providing feedback from tracking in personalized and meaningful ways. Of course, the approach is not

without concerns. Monitoring entails privacy concerns: physicians monitoring patients may be seen as a nuisance, insurance companies setting rates based on behavior may be objectionable too. Thus, policy makers will likely have a role in regulating the use of mHealth data; ideally, balancing interventions that improve health against privacy concerns.

Compressing morbidity by prevention of disease through lifestyle changes will benefit from social science. Technologies like mHealth and wearables are important to personalize and scale interventions, but we must view these as tools that enable a solution, not as the solution itself. Some express concern that the older individuals in our population will be unable to adjust and adapt to new technologies, but we view this primarily as a challenge to designers. Seniors have shown a willingness to adopt technology when it provides real value and when interfaces are well designed. A prime example is Skype, which has enjoyed significant levels of use by older people as they use it to communicate with family, and in particular grandchildren.

Given the scope of the challenges in changing a wide range of health-related behaviors, we will need to motivate a number of small lifestyle changes through a variety of techniques across a wide range of ages. Adapting interventions that integrate classic educational approaches with individualistic approaches, such as mHealth, and population-level environmental approaches, that aim to modify an individual’s choice set, will likely have the best overall chances of success.

## Moving Forward

The near doubling of life expectancy is among the greatest achievements in history. Our best chance of realizing the potential gift that longevity represents lies in science and technology; and these potentials are indeed breathtaking. We need to turn to science and technology once again as we confront an entirely new set of challenges stemming from lives that last longer than our ancestors ever could have imagined. Medical science is promising cures for diseases. Biologists are on the cusp of understanding and modifying the basic processes that making aging the key risk factor for a vast array of diseases. With a proper investment in science, the nation can see a dramatic reduction in diseases and potentially even greater increases in life expectancy.

If we are to fully realize the gift of longer life, we need a population that is actively engaged with families, workplaces, and neighborhoods throughout their lives. The sobering news at this point in history is that gains to fitness have not only ceased, they are reversing. Without behavioral changes, America’s young people today may be among the first generations to see morbidity rise and life expectancy fall. Chronic diseases and infirmities do not need to

afflict future generations in mid-life. We must not equate these conditions with “aging” any more than our ancestors accepted rickets and pellagra as normal parts of life. Effectively addressing conditions that involve behavioral choices and lifestyles demands an investment in behavioral science in addition to biomedical science. One key to optimizing health in the population will be a focus on changes that appeal to different populations at different stages of life. Engaging in conversations with children about fitness and obesity, marketing healthy lifestyles to older as well as younger adults, rethinking attitudes about food, and developing appealing alternatives to traditional high calorie “comfort” foods, will be required at all levels of population health if we are to solve these challenging problems.

Although there is no reason to ignore the role of personal decisions and life styles, there is substantial evidence that this alone will be ineffective for population health. We need to reconsider the current paradigm, focused heavily on individual responsibility, and implement integrated population-wide strategies to improve health and fitness. Just as our ancestors made advances that were accessible to the entire population, we need to address differences by socioeconomic status and demand that national prevention efforts address both disparities in health and access to health care (including health technologies) simultaneously.

The health challenges we face today are not limited to finding cures for diseases of old age, we must also improve fitness throughout life. Current threats to health are distinct and arguably more difficult to address than the ones that faced our ancestors. Producing and distributing food to a population was a simpler challenge than influencing behavioral and lifestyle choices that occur on a daily basis and impair health gradually over many years. With sustained attention, public and private partnerships, improvements in the nutritional content the food supply, modifications to neighborhoods, park, schools, and workplaces, we can reverse the trends in obesity and improve fitness at all stages of life. The 2015 White House conference on aging is an excellent venue in which to highlight the risks of increasing obesity and decreasing national fitness levels across all ages within the larger public discourse.

## Funding

This work was provided by the National Institute on Aging through the grant R37 AG008816 with Dr. Carstensen as the principle investigator.

## References

- American Medical Association. (2013). *AMA adopts new policies on second day of voting at annual meeting*. Annual Meeting of the American Medical Association, Chicago, IL. [Internet; cited January 30, 2015]. Retrieved from <http://www.ama-assn.org/ama/pub/news/news/2013/2013-06-18-new-ama-policies-annual-meeting.page>
- Becker, G. S., & Barro, R. J. (1988). A reformulation of the economic theory of fertility. *The Quarterly Journal of Economics*, 103, 1–25.
- Cawley, J., & Maclean, J. C. (2012). Unfit for service: The implications of rising obesity for US military recruitment. *Health Economics*, 21, 1348–1366. doi:10.1002/hec.1794
- Centers for Disease Control and Prevention. (2015). Death and mortality. NCHS FastStats Web site. Retrieved January 28, 2015, from <http://www.cdc.gov/nchs/faststats/deaths.htm>
- Centers for Disease Control and Prevention. Chronic Disease Prevention and Health Promotion. (2015). CDC Home Web site. Retrieved January 28, 2015, from <http://www.cdc.gov/chronicdisease/>
- Christensen, K., Thinggaard, M., Oksuzyan, A., Steenstrup, T., Andersen-Ranberg, K., Jeune, B., McGue, M., & Vaupel, J. W. Physical and cognitive functioning of people older than 90 years: a comparison of two Danish cohorts born 10 years apart. *The Lancet*, 382, 1507–1513.
- Frenk, D. J. (2013). The obesity prevention source. Retrieved February 8, 2015, from <http://www.hsph.harvard.edu/obesity-prevention-source/obesity-causes/food-environment-and-obesity/>
- Hammond, R. A., & Levine, R. (2010). The economic impact of obesity in the United States. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, 3, 285–295. doi:10.2147/DMSOTT.S7384
- Haskell, W. (2012). Physical activity by self-report: A brief history and future issues. *Journal of Physical Activity & Health* 9(Suppl 1), S5–S10. [Internet; cited January 30, 2015 ]. Retrieved from [http://www.americankinesiology.org/AcuCustom/Sitename/Documents/DocumentItem/02\\_haskell\\_JPAH\\_20110152.pdf](http://www.americankinesiology.org/AcuCustom/Sitename/Documents/DocumentItem/02_haskell_JPAH_20110152.pdf)
- Hurd, M., Martorell, P., Mullen, K., Delavande, A., & Langa, K. (2013). The monetary costs of dementia in the United States. *New England Journal of Medicine*, 368, 1326–1334. doi:10.1056/NEJMsa1204629
- Manton, K. G., Gu, X., & Lowrimore, G. R. (2008). Cohort changes in active life expectancy in the U.S. elderly population: Experience from the 1982–2004 National Long-Term Care Survey. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, 63, P269–P281. doi:10.1093/geronb/63.5.S269
- Martin, L. G., & Schoeni, R. F. (2014). Trends in disability and related chronic conditions among the forty-and-over population: 1997–2010. *Disability and Health Journal*, 7, S4–S14. doi:10.1016/j.dhjo.2013.06.007
- Morris, J. N., Heady, J. A., Raffle, P. A. B., Roberts, C. G., & Parks, J. W. (1953). Coronary heart-disease and physical activity of work. *Lancet*, 262, 1053–1057. doi:10.1016/S0140-6736(53)91495-0 [Internet; cited May 5, 2014]. Retrieved from [http://www.thelancet.com/journals/a/article/PIIS0140-6736\(53\)90665-5/fulltext](http://www.thelancet.com/journals/a/article/PIIS0140-6736(53)90665-5/fulltext)
- Olshansky, S. J., Passaro, D. J., Hershow, R. C., Layden, J., Carnes, B. A., Brody, J., ... Ludwig, D. S. (2005). A potential decline in life expectancy in the United States in the 21st century. *New England Journal of Medicine*, 352, 1138–1145. doi:10.1056/NEJMsr043743

- Siegel, M., Albers, A. B., Cheng, D. M., Hamilton, W. L., & Biener, L. (2008). Local restaurant smoking regulations and the adolescent smoking initiation process. *Archives of Pediatrics & Adolescent Medicine*, 162, 477. doi:10.1001/archpedi.162.5.477
- Singh, G. K., Siahpush, M., & Kogan, M. D. (2010). Neighborhood socioeconomic conditions, built environments, and childhood obesity. *Health Affairs*, 29, 503–512. doi:10.1377/hlthaff.2009.0730
- Sturm, R. (2007). Increases in morbid obesity in the USA: 2000–2005. *Public Health*, 121, 492–496. doi:10.1016/j.puhe.2007.01.006
- Webb, T. L., & Sheeran, P. (2006). Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological Bulletin*, 132, 249–268. doi:10.1037/0033-2909.132.2.249