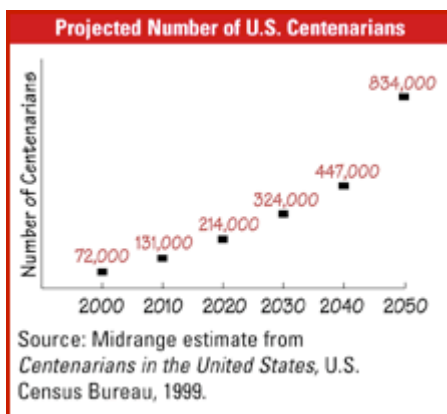


# Living to 100: What's the Secret?

Forget about Generation X and Generation Y. Today, the nation's most intriguing demographic is Generation Roman numeral C—folks age 100 and over. In the United States, the number of centenarians doubled in the 1980s and did so again in the 1990s. The total now exceeds 70,000. By 2050, according to midrange projections, there could be over 800,000 Americans who celebrate the century mark. Studies show the same trend in other industrialized countries and recently in China. Indeed, demographers are now counting the number of *supercentenarians*, people age 110 and over.

The swelling population of people age 100 and over has given researchers an opportunity to answer some of the most fundamental questions about human health and longevity: What does it take to live a long life? How much do diet, exercise, and other lifestyle factors matter compared with “good” genes? And, perhaps most importantly, what is the quality of life among the “old old”? Does getting older inevitably mean getting sicker, or can people remain productive, social, and independent on their 100th birthday and beyond?



## Centenarian Studies

There are a dozen or so centenarian studies. A health-advice book has been published based on findings from the centenarian study in Okinawa, where the average life expectancy, 81.2 years, is the highest in the world. There are active centenarian studies in Italy, Sweden, and Denmark. For the most part, results from these studies belie the myth that the oldest old are doddering and dependent. Some harsh demographic selection may come into play. Frail individuals die sooner, leaving only a relatively robust group still alive. In fact, one of the rewards of

living a long life is that, for the most part, the “extra” years are healthy years.

Physical activity is a recurring theme: the people in these studies are walkers, bikers, and golfers. In Okinawa, centenarians do tai chi and karate. People who live to 100 and beyond exercise their brains, too, by reading, painting, and playing musical instruments. Some continue to work, an indication that our love affair with retirement may be a mixed blessing.

## 100 is still old

This isn't to say that centenarians escape unscathed. Although 75% of the people in the New England study were well enough to live at home and take care of themselves at age 95, this number dropped to 30% by age 102. About two-thirds of centenarians suffer from some form of dementia. Danish investigators, who have taken a decidedly less sunny view of extreme old age than their New England counterparts, published a study reporting that many of the centenarians in their study had cardiovascular disease (72%), urinary incontinence (60%), osteoarthritis of a major joint (54%), and dementia (51%).

And life expectancy is short at 100. On average, centenarians will only live another year or two, although that might change as the size of the age group increases.

It is notable, however, that the period of serious illness and disability for the exceptionally long-lived tends to be brief. Aging experts say that *compressing morbidity* in this way should be our goal. The Stanford researcher who coined the term, James F. Fries, has compared the ultimate in compressed morbidity to the “wonderful one-hoss shay” described in Oliver Wendell Holmes’s poem “The Deacon’s Masterpiece.” The shay in the poem is a carriage built so carefully by the deacon that no single part breaks down for 100 years. Then it collapses “all at once, and nothing first / Just as bubbles do when they burst.” Notwithstanding the Danish study, centenarians approach this ideal, as they tend to live well into their nineties free of serious diseases such as cancer and Alzheimer’s.

## Good Genes

Traits that run in families are not necessarily genetic. After all, families often share the same eating habits, activity levels, and other so-called environmental factors that influence health. Still, similarities within families are often a good clue of a strong genetic influence, and longevity does seem to run in families. The New England Centenarian Study, for example, has found that its subjects were four times more likely to have a sibling who lived past age 90 than people with an average life span.

Now the search is on for genetic attributes. Researchers have previously identified some forms of a gene called apolipoprotein E that increase the risk for cardiovascular disease and Alzheimer’s disease. Studies have shown that those dangerous variants are rare among centenarians. Scientists have had success building long life into some animals. They’ve genetically engineered worms to live six times longer. Certain mice genes have been mutated so the animals live 30% longer than normal.

No one has found such a mutation in people. But several years ago, Thomas Perls, director of the New England study, and Louis Kunkel, a molecular geneticist at Children’s Hospital in Boston, believe they got closer by identifying a section of chromosome 4 that may predispose people to long life. They made their discovery by scanning the genes of 137 sets of very old siblings—one person age 98 or older with a brother who was at least age 91 or a sister who

## The Gender Gap

Female centenarians outnumber males by a 9:1 ratio. The longest documented life was that of a French woman, Jeanne Calment, who died in 1997 at age 122. And throughout most of the world, women, on average, live longer than men. Some researchers say it is estrogen that gives women the longevity edge. Others theorize that menstruation and systems related to childbirth better equip women to rid their bodies of toxins. Women also tend to be more social than men, and social connections are believed to be critical to weathering old age.

Yet the men who reach their 100th birthday are, on the whole, healthier than the women. They are far less likely to have dementia or other serious medical problems. Thomas Perls, head of the New England Centenarian Study, calls these men “aging superstars.”

Longevity statistics favoring women suggest that there may be some protective genes lurking on the X chromosome, the sex chromosome that women have two copies of and men only one. Another possibility: genetics are relatively neutral but social conditions favor long life for women.

was at least age 95. The siblings shared this distinctive section of chromosome 4.

## Health Conditions

But genes aren't the whole story. Public health advances like sanitation and routine vaccination have greatly improved the odds for long life. Indeed, it may be the intersection of genes with ever-changing health conditions that really determines how long we live. Today's centenarians may have survived so long partly because they had genes that protected them against infectious diseases prevalent in the early 20th century. Tomorrow's centenarians may need to have a different kind of genetic advantage attuned to 21st century circumstances.

Medical interventions are starting to make a demographic difference, particularly with respect to mortality from cardiovascular disease. Most centenarians still die from heart disease, but they might have died much sooner without the medicines we now have to control cholesterol levels and hypertension.

## Diet and Other Choices

Diet and other healthy habits play a role, too. Okinawans lose their actuarial edge when they move to Western countries and, presumably, adopt a more Western lifestyle. Italian researchers reported that healthy centenarians had exceptionally high blood levels of vitamins A and E compared with healthy younger adults. The study didn't address, however, what causes high levels. Still, the authors theorized that vitamin-rich blood may both strengthen the immune system of these centenarians and defend them against damage done by *oxygen free radicals*, the reactive molecules that some researchers believe are the principal cause of aging.

It's not a centenarian study, but a large, long-term study of Seventh-Day Adventists in California that has produced some valuable information about longevity because the Adventists, on average, live several years longer than their fellow Californians. By some reckonings, they even outlive the Okinawans. There is no reason to believe the Adventists have any special genes, so other factors probably explain their longevity. Researchers broke down their health habits in a statistical analysis published in the July 9, 2001, *Archives of Internal Medicine*. A great deal of physical activity, frequent consumption of nuts, not eating meat, and medium body weight each was found to add about 1.5–2.5 years of life.

Centenarians may well have a genetic head start on most of us, but in his 1999 book *Living to 100*, Perls argues that we can make choices that may help us catch up. Of course, we don't have complete free will over these choices; behavior of almost all kinds has a genetic component. Still, there are some lessons to be learned from the do's and don'ts of centenarians:

- They don't smoke or drink heavily.
- Those who had smoked didn't do so for long.
- They gained little or no weight during adulthood.  
Being overweight makes people more vulnerable to many life-threatening illnesses, including heart disease, diabetes, cancer, and stroke.
- They don't overeat.  
Okinawan centenarians consume 10%–20% fewer calories per day than typical

Americans. And in animal studies, calorie-restricted diets have consistently increased the life span. The old Okinawans consume less fat, too. About 26% of their energy intake comes from fat, compared with 30% or more for Americans. And more of that fat is beneficial—omega-3 fatty acids and the unsaturated fats found in vegetable oils.

- They eat many fruits and vegetables.  
The Okinawans have an average of seven servings a day.
- They get regular physical activity for as long as they are able.  
Strength-building activities, such as climbing stairs or lifting small weights, are especially beneficial because they help slow the age-related loss of muscle mass.
- They challenge their minds.  
Stimulating mental activity may help prevent age-related thinking and memory problems by stimulating communication between brain cells. Particularly among elderly men, decreased cognitive performance is strongly associated with mortality.
- They have a positive outlook.  
Perls says centenarians seem to have personalities that shed stress easily. An inability to control emotional stress has been linked to memory loss and heart disease.
- They are friendly and maintain close ties with family and friends.  
Not surprisingly, positive relationships are associated with lower rates of depression. And lower rates of depression may result in lower rates of heart disease.

Many researchers think that people could add up to a decade to their lives if they emulated the centenarians. And, from what we know so far, they aren't doing anything mysterious. They're simply following the standard health commandments: don't smoke, keep trim, get exercise, manage stress, and avoid social isolation.



**Harvard Health Publications**  
HARVARD MEDICAL SCHOOL

Harvard Health Publications  
Harvard Medical School  
10 Shattuck Street, Suite 612  
Boston, MA 02115-6011

## **Harvard Health Letter**

*Editor in Chief:* Anthony L. Komaroff, M.D.  
*Editor:* Peter Wehrwein

Copyright by the President and fellows of  
Harvard College. All rights reserved.

For more information or a complete listing of  
publications and resources available from  
Harvard Health Publications, visit us online at

**[www.health.harvard.edu](http://www.health.harvard.edu)**