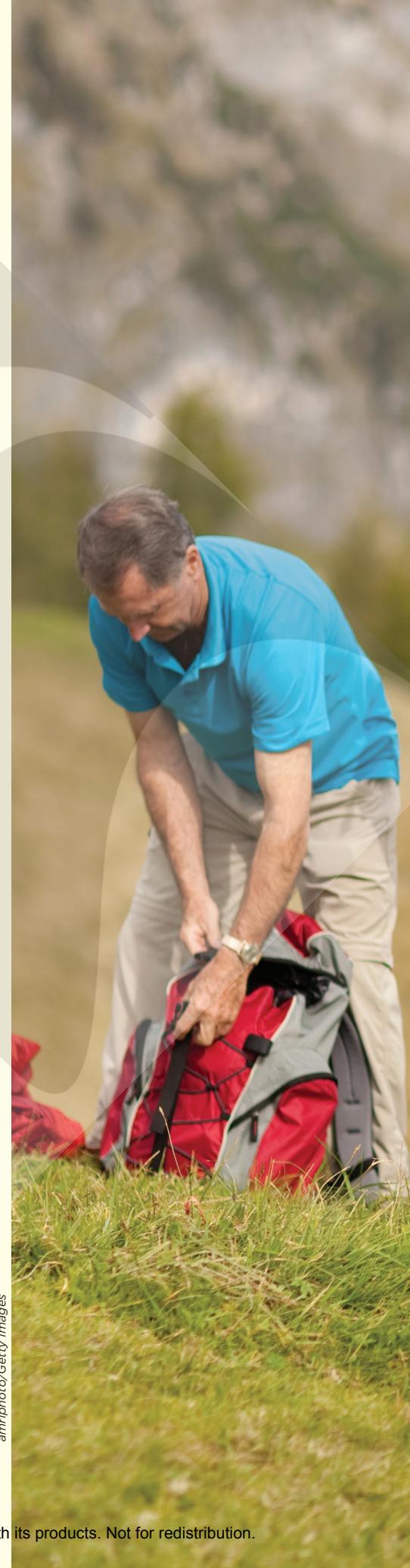


Nutrition and the Aging Adult

LEARNING OBJECTIVES

- ▶ Describe at least four age-related physiological changes (**Infographic G.1**)
- ▶ Describe changes in the age structure of the population in the United States in the next 25 years (**Infographic G.2**)
- ▶ Explain how skeletal muscle is needed to heal from illness and injury, the benefits of maintaining adequate muscle mass, and the benefits of exercise (**Infographic G.3 and Infographic G.9**)
- ▶ Discuss how physical, psychological, economic, and social factors may influence the ability of the aging adult to achieve the recommended nutrient intake (**Infographic G.4**)
- ▶ Describe three nutrition-related conditions that are common in older adults, their precipitating factors, and their potential consequences (**Infographic G.5**)
- ▶ Identify at least five nutrients of concern in the aging adult, and describe ways to obtain adequate intake of these nutrients (**Infographic G.6 and Infographic G.7**)
- ▶ Explain how longevity and lifespan might differ, and provide examples of how nutrition influences each (**Infographic G.8 and Infographic G.11**)
- ▶ Identify lifestyle and dietary characteristics that may delay the onset of age-related disease and extend longevity (**Infographic G.10**)

When Leonard Nimoy died in February 2015 at the age of 83, he was remembered most for his iconic role as the pointy-eared Mr. Spock on the television and movie series *Star Trek*. Part human, part Vulcan, Spock shared with his fellow Vulcans an intensely logical mindset. Vulcans had long since figured out how to prevent poverty, war, and other social problems. They were also masters of their own health, eating a vegetarian



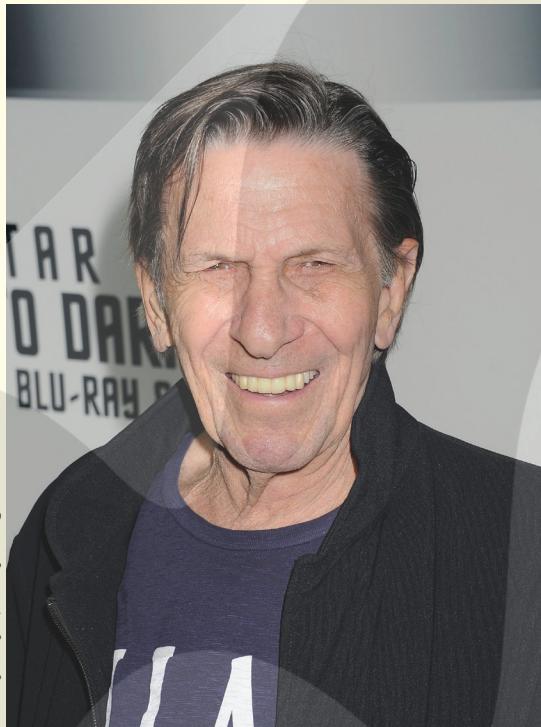
amriphoto/Getty Images



Live Long and Prosper

CAN YOU EAT YOUR WAY TO A LONGER, HEALTHIER LIFE?

The actor Leonard Nimoy was famous for delivering the Vulcan salute “Live long and prosper” in the Star Trek science fiction films and television show. He lived to age 83.



Jeffrey Mayer/Getty Images

diet and living to be 200 years old. Hence the traditional Vulcan salute “Live long and prosper.”

Nimoy himself managed to live seven years beyond the average life expectancy for a man in the United States and was mentally vigorous until the end, writing poetry and tweeting to his many followers. He might have lived even longer if he hadn’t smoked as a young man or had quit earlier. Nimoy died of complications from chronic obstructive pulmonary disease (COPD), which is often a late, smoldering consequence of smoking.

Star Trek is science fiction, of course, but the search for the secrets to a longer life is a very real focus of contemporary science, involving researchers in fields as diverse as genetics, cell biology, nutrition, psychology, and sociology. Geneticists working in laboratories around the world have already figured out how to double the lifespan of small animals such as mice and worms by altering their genes. Venture capitalists are currently

investing in companies such as the Bay Area-based Calico, whose explicit aim is to use biotechnologies to extend the human lifespan.

Calorie restriction without nutrient deficiency also increases the longevity of small animals and is one of the most studied interventions to delay aging in experimental animals. When calories are restricted from an early age by 30% (compared with a self-selected diet), longevity is increased by about 40% in a number of organisms—from yeast to laboratory mice and rats. Recent studies have also found that calorie restriction decreases the risk of chronic diseases and increases longevity in rhesus monkeys. Researchers do not expect people to restrict their diets in this manner, but scientists study calorie restriction because it has such a potent effect on aging. Recent studies in young and middle-aged men and women have found that less severe energy restriction (reducing calorie intake by about 20%) reduces the risk of diabetes and cardiovascular disease. This effect has been referred to as increasing our “health span,” which is the number of healthy years we live. Elders who have a healthy body weight should not contemplate this sort of energy restriction, because maintaining a healthy body weight through diet and physical activity is critical for healthy aging. It is hoped, however, that these studies will reveal details about the mechanisms of aging and allow the development of effective measures to slow the aging process.

Short of altering our genetic code or consuming some Vulcan-style elixir, are there ways that humans can increase their **longevity**, or lifespan, through behavioral measures? Many scientists answer a resounding “Yes.” But before we look at ways to increase longevity, let’s first describe the concepts of *aging* and *life expectancy*.



WHAT HAPPENS WHEN WE AGE?

The time we spend as children and young adults is characterized by the acquisition of new skills, physical growth and maturity, and psychological development. Although we continue to learn and enjoy new challenges

LONGEVITY

the length or duration of life; often refers to individuals whose lifespan is longer than the population average

throughout our lives, eventually, as we advance in years, the human body experiences some signs of deterioration or decline that we recognize as **aging**. Aging is the accumulation of diverse harmful changes that occur in cells and tissues that are responsible for decreased physical and mental capacity and an increased risk of disease and death. Aging is a complex multifaceted process that varies from person to person; however, over time, it affects the cells and all of the major organ systems of the body. **(INFOGRAPHIC G.1)**

The changes in the body associated with aging are due to changes in individual cells and the organs they make up. As cells age, cellular functioning slows. Also, in some organs, cells die and are not replaced, so the number of cells decreases. The number of cells in the liver and kidneys, for example, decreases as the body ages. However, even with this decline in cell number, most functions remain adequate because organs begin with more capacity than the body needs. For example, if half the liver is destroyed, the remaining tissue is more than enough to

AGING

the accumulation of diverse, harmful changes in cells and tissues with advancing age that is responsible for the increased risk of disease and death

INFOGRAPHIC G.1 **Physiological Changes Associated with Aging** *Although aging does put us at greater risk for health issues, many older adults can be healthy and active well into their advanced years.*

Cardiovascular system

- Blood pressure increases
- Efficiency of the heart decreases
- Elasticity of blood vessels decreases

Renal system

- Blood flow to the kidney decreases as blood vessels become smaller and thicker
- Decreased ability to concentrate urine and remove drugs from the body

Musculoskeletal system

- Muscle mass decreases
- Bone mass decreases
- Fat mass decreases

Nervous system

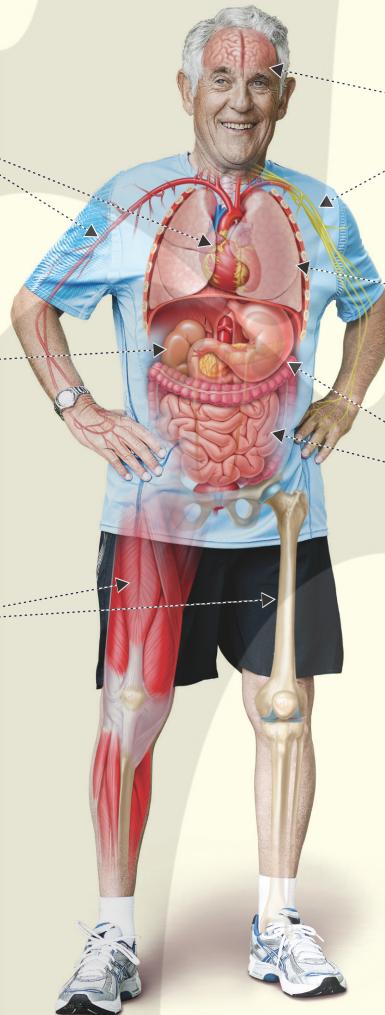
- Senses of smell and taste decrease
- Changes in sleep cycle
- Visual acuity diminishes

Respiratory system

- Decreased elasticity of the lungs
- Respiratory muscles lose strength and endurance

Gastrointestinal system

- Tooth loss may occur
- Mucus and saliva production decreases
- Decreased production of hydrochloric acid
- Decreased gastric and pancreatic enzyme production
- Slower peristalsis



How might age-related changes in the body influence the development of nutrition-related health problems? Give at least one example.

Photo credit: Jakob Helbig/Getty Images

LIFE EXPECTANCY

the average number of years individuals in a specific population are expected to live

LIFESPAN

the span of time between the birth and death of a person

maintain normal function. Thus, disease and illness, rather than normal aging, usually account for most of the loss of function in old age.

Over the years, a number of theories have been proposed to explain the process of aging. These theories are generally divided into two broad categories: (1) programmed theories that contend that aging follows a biological timetable and (2) damage or error theories that suggest that aging is caused by an accumulation of molecular and cellular damage.

Major programmed theories of aging include (1) *programmed longevity*—the switching on and off of specific genes that leads to aging; (2) the *endocrine theory*—age-related alterations in the regulation of the endocrine system (including stress hormones and insulin) control the rate of aging; and (3) the *immunological theory*—the immune system is preset to decline over time, which causes increased vulnerability to disease.

Some of the leading damage, or error, theories of aging are (1) *free radicals* cause oxidative damage to proteins, lipids, and DNA; (2) *protein cross-linking* (the chemical attachment of one protein to another) impairs protein function; (3) *DNA damage* results in mutations that cause cells to malfunction; and (4) *epigenetic changes* to DNA alters patterns of gene expression. (Refer to Chapter 1 for more on epigenetics). It should be appreciated that aging is a complex process that involves a number of these mechanisms, and many of these mechanisms are interconnected.

One body system that is significantly changed in the aging adult is the cardiovascular system (the heart and blood vessels). Blood flow to the body declines due to many factors, including atrophy of the heart muscle, calcification of the heart valves, loss of elasticity in the artery walls, and fatty deposits in the arteries. The reduced blood flow causes older adults to tire more easily than younger adults since less oxygen is being exchanged, which, in turn, reduces kidney and liver function and provides less nourishment to the cells. This means older people are more likely to experience side effects from drugs, have a slower rate of healing, and an impaired response to physiological stress. Even though

organ functions often remain adequate in aging, the decline in optimal function means that older people are less able to handle strenuous physical activity, extreme temperature changes in the environment, and illness.

LIFE EXPECTANCY AND LIFESPAN

An important distinction to be made when discussing aging and longevity is between *life expectancy* and *lifespan*. **Life expectancy** refers to the number of years a person can be expected to live based on the statistical average. This statistical average is calculated based on an overall population, often beginning from the time of birth, and includes those who die during or shortly after childbirth, those who die during adolescence and adulthood, and those who live well into old age. The average life expectancy from birth for a man in the United States today is 76.3 years; for a woman, it's 81.2 years.

Lifespan, on the other hand, is the number of years that any particular individual lives. Leonard Nimoy had a lifespan of 83 years, for example. The maximum number of years that any known person has lived is 122 years. Therefore, 122 is sometimes cited as the *maximum human lifespan*, although that will change as soon as someone lives longer.

Life expectancy has increased dramatically over the twentieth century. In 1900, life expectancy for a man was 46 years. Today, as you read previously, a man's life expectancy is more than 76 years. Statistics such as these can be a source of confusion. This does not mean that in 1900, most men dropped dead at age 46. The greatest difference between then and now is the change in the frequency of infant mortality, with many fewer children dying as a result of infectious and communicable diseases. Because those childhood deaths are included in the calculation of the average life expectancy, they greatly affect the overall measure. Decreases in infant mortality occurred because of improvements in sanitation (principally cleaner water), which reduced the incidence of communicable diseases such as cholera and the availability of vaccines to prevent diseases such as smallpox, polio, and measles.

For those surviving to adulthood, the gains in life expectancy have been more modest over the same period: about nine additional years for women and five additional years for men. If an individual lives to the age of 65, the current predicted life expectancy beyond that age is 20.5 years for women and 18 years for men. Major factors that are responsible for recent increases in the life expectancy of U.S. adults are a decrease in the prevalence of smoking and improved medical care that allows individuals who are affected with chronic diseases to live longer. By 2040, two factors—longer life spans and aging baby boomers (born between 1945 and 1964)—will combine to nearly double the population of Americans 85 years or older. By 2060, with more adults living to older ages, the population of Americans 65 and older is projected to more than double to about 98 million, accounting for approximately 24% of the U.S. population.

(INFOGRAPHIC G.2) Globally, the world population also continues to grow older with lower fertility rates and people living longer. Similar to projections in the United States,

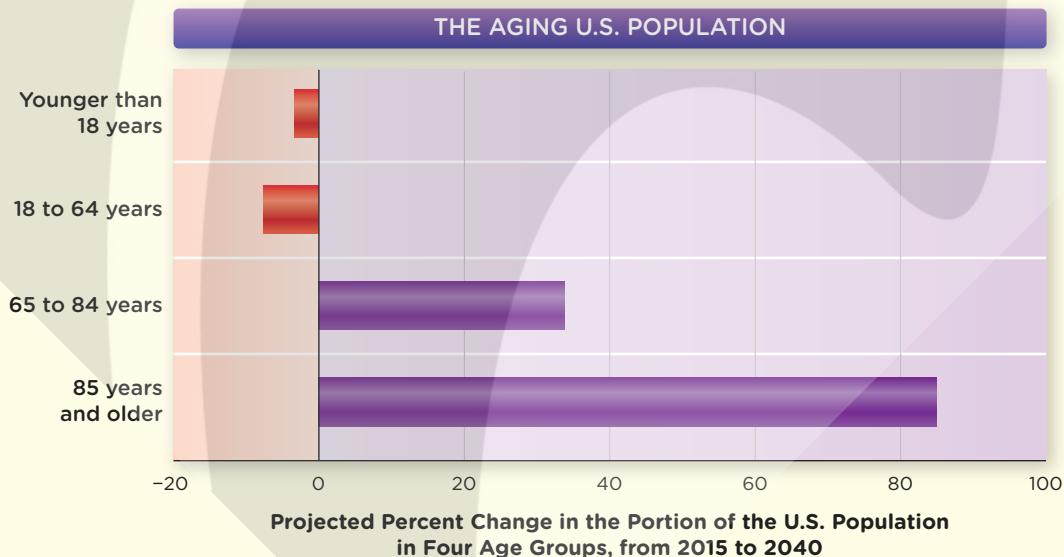
The Frenchwoman Jeanne Louise Calment, who lived to age 122, is the longest-lived human whose birth and death are verifiable in official records. Pictured here on her 116th birthday, she was famous for her sense of humor and her love of eating chocolate. She died in 1997.



Jean-Pierre REY/Getty Images

from 2025 to 2050, the older population is expected to almost double to 1.6 billion globally, representing over 20% of the world's population (compared with 8.5% in 2015).

INFOGRAPHIC G.2 The Aging U.S. Population Combined with the aging of the baby boomer generation, the increased longevity of the U.S. population will lead to an expansion of older age groups between 2015 and 2040.



? How could nationwide high-quality nutrition reduce the negative effects of an aging population in the United States?

Clearly, a number of factors can influence how long a person lives. The most obvious is disease. The biggest killers today are largely chronic diseases such as heart disease, cancer, and diabetes. Anything that increases one's odds of getting these diseases, such as smoking or obesity, will have a correspondingly negative impact on one's life expectancy. There are also more subtle influences. People with higher levels of education have a higher life expectancy than those with lower levels. Decreased life expectancy is also associated with being unmarried, having a low socioeconomic status, and being part of some racial groups.

BLUE ZONES

Let's return to the question of whether there are ways in which humans can increase their longevity through behavioral measures. The answer is yes. Support comes from the study of areas on our planet where humans experience increased longevity. Known as "Blue Zones," these are areas with a higher-than-average number of individuals who live to be at least 100 years old. Blue Zones have been identified in parts of Japan, Italy, Canada, Costa Rica, and the United States.

Zones of greatest longevity. The map indicates locations, the so-called "Blue Zones," where people tend to live long lives. The Blue Zone concept was popularized by journalist Dan Buettner in his book *The Blue Zones: 9 Power Lessons for Living Longer from the People Who've Lived the Longest*.



The concept of a Blue Zone comes from a 2004 study of especially long-lived individuals in the mountainous region of Sardinia, an island off the coast of Italy. Researchers then began identifying where longevity seemed to be highest and circling progressively narrower areas of higher and higher longevity on a world map, until a (blue) zone of maximum longevity was reached. The Blue Zone concept was popularized by journalist Dan Buettner in his book *The Blue Zones: 9 Power Lessons for Living Longer from the People Who've Lived the Longest*. Buettner traveled to far-flung regions of the world with the goal of identifying the common factors that contribute to these astounding feats of longevity.

Many of the so-called Blue Zones are isolated island or mountain communities, such as the archipelago of Okinawa in Japan and the highlands of the aforementioned Sardinia in Italy, where age-old customs remain intact and where migration in and out of the area is rare. However, the Seventh-day Adventist community, another of the so-called Blue Zones, is not found in a geographically restricted area, but that turns out to be an advantage for longevity researchers. Unlike the other Blue Zones, where the geographic isolation of gene pools might imply a genetic reason for increased longevity, the Adventists are linked only by behavior. They therefore provide one of the best populations in which to explore controllable factors such as nutrition and exercise that may influence longevity.

The Adventists are a conservative sect of Protestant Christianity that goes back to the 1860s. They believe in living according to Biblical principles and observe a day of rest (the Sabbath) on Saturday. Although not exactly a "zone," because they live all over the world (with a large population in California), this group shares a common way of living, born of their religious beliefs, that links them together. And according to researchers, they are among the longest-living populations on the planet, if not *the* longest.

"We found that Adventists were getting, on average, more than seven years of extra life expectancy, for men, and about four and

a half years for women as compared to other Californians,” says Gary Fraser, a cardiologist and epidemiologist at Loma Linda Medical School, who has studied the Adventists. “The magnitude of that difference surprised me because it’s quite major.”

What’s behind this allotment of extra years? Fraser’s group has identified several key behaviors and lifestyle choices that they believe give Adventists their propensity for longer lifespans. It turns out that Adventists do (and don’t do) a whole bunch of things that improve their life expectancy—some obvious, some less so. For instance, they don’t smoke. They also rarely drink alcohol. Because both smoking and excessive drinking are associated with a range of diseases, it’s not surprising that refraining from these things improves health and increases longevity. Moreover, many Adventists are vegetarians or vegans, and the Adventists in general emphasize fresh, minimally processed foods and tend to regularly consume nuts. (Refer to Spotlight C for more on plant-based diets.) These food choices, too, affect health, as we will see.

The first studies of the Adventists were conducted in the 1950s, and even back then, it was clear that Adventists tended to live longer than their non-Adventist neighbors. Through lifestyle choices, the Adventists experience a big boost in longevity. And if they can do it, researchers assert, then so can the rest of us. But it has only been in the past decade that scientists have begun to unravel the specific behavioral and lifestyle factors that are behind their longer lives.

Seventh-day Adventist populations are long-lived. Members of this community do not smoke and rarely drink alcohol.



No smoking



No alcohol

Harvesting food at low tide. The archipelago of Okinawa in Japan is known for a population with an abundance of centenarians. The woman in this photo, 89 years old, is gathering *asa* seaweed, a food often eaten by Okinawans.



David McLain/Aurora Photos

ENERGY NEEDS AND PHYSICAL ACTIVITY

Results of epidemiological research such as the Adventist studies show that nutrition plays a key role in maintaining the health of the aging adult and, therefore, in determining longevity and quality of life. For the most part, the nutritional needs of healthy older adults (51 years and older) are similar to those of healthy adults of younger ages, but there are a few key ways in which their nutritional needs differ. The most important one involves energy (caloric) needs.

As people age, they require fewer calories to maintain their weight and power their activities. That’s because total and resting energy expenditure decrease progressively with age. There are several contributing factors to this decline, but the biggest one is a decrease in physical activity—older adults are less physically active than younger folks. In turn, this reduced activity leads to reduced muscle mass, a phenomenon called **sarcopenia**, which further reduces resting energy expenditure, because muscle burns more calories than fat. (Refer to Chapter 11 for more on energy balance and

SARCOPENIA

age-related reduction in skeletal muscle mass

INFOGRAPHIC G.3 Active Aging *Being physically inactive can be bad for you, no matter your age or health condition. Remaining physically active will promote a higher quality of life throughout your advanced years.*



What difficulties could prevent seniors from being physically active, and how can these difficulties be overcome?

Photo credits (top to bottom): Tom Wang/Shutterstock, Monkey Business Images/Shutterstock, Monkey Business Images/Shutterstock

expenditure.) Some of the changes in muscle mass that occur with aging are independent of activity levels and relate to changes in hormone levels and cellular aging, both of which lead to predictable age-related changes in body composition and body fat distribution. But to a large extent, physical activity can offset losses in muscle mass.

(INFOGRAPHIC G.3)

Older adults need fewer calories to meet their typical energy expenditure, but their need for specific macronutrients and micronutrients does not decrease (and may even increase because of other physiological changes). As a consequence, older adults must make sure to consume a diet that is more nutritionally dense than the diet they may have eaten when they were younger. There is less room for empty calories.

SPECIAL NUTRITIONAL CONCERNS FOR OLDER ADULTS

Despite this need for nutrient-dense foods, many older adults experience bodily changes that impair their ability or desire to meet these requirements. For example, many older people experience a decline in the senses of smell (olfaction) and taste (gustation), which can make food less palatable and therefore affect appetite because food isn't as appealing as it once was. Aging causes a more dramatic decline in the sense of smell than it does in taste. More than 60% of individuals between the ages of 65 and 80 have a major loss of smell, increasing to more than 75% of those who are older than 80 years. A reduction in mucus production that traps and transfers odorants and a decrease in olfactory receptors and neurons that detect those odorants are thought to be major factors leading to this

age-related loss of smell. Not surprising, recent studies show an association between impairment in the sense of smell and poorer diet quality over time. Decreased sense of taste and smell in elderly individuals causes a chain reaction—appetite loss leads to nutrient deficiencies and energy reduction, which causes loss of muscle mass, which results in muscle weakness, greater frailty, and injury. Diminished taste is caused by age-related decreases in the number, size, and sensitivity of taste buds, which can also negatively impact food intake and diet quality.

With these declines in taste and smell, visual cues play an increasingly important role in stimulating appetite. It has been found that enhancing the dining room and the presentation of food increases food intake in nursing home residents. In addition to changes in taste and smell, loss of teeth and periodontal disease can compromise one's ability to chew, which can also make obtaining adequate nutrition a challenge.

(INFOGRAPHIC G.4)

Food and Drug Interactions

Nutritional status may be further compromised by the effects of medications

on appetite and nutrient absorption.

According to the Centers for Disease Control and Prevention, more than 90% of older Americans (65 years and older) use at least one prescription drug and 42% use five or more! This prevalence of drug use, both prescription and over-the-counter medications, combined with age-related alterations in physiological function, is a special concern for seniors. Healthcare providers must consider the implications of interactions among medications, food, and dietary supplements. (Refer to Spotlight D for coverage of dietary supplements.) Some drugs can affect the metabolism, absorption, or excretion of certain nutrients. For example, antacids can diminish the absorption of vitamin B₁₂. And some foods can influence the action and effectiveness of medications. Fresh grapefruit and grapefruit juice, for example, contain a compound that decreases the breakdown of some drugs in the small intestine and liver, increasing their concentrations in the blood and enhancing their effects. And for individuals taking anticoagulant medications (“blood thinners”), atypical intake of vitamin K—an especially large serving of spinach or kale,

INFOGRAPHIC G.4 **Challenges to Healthy Aging** *Many physiological, pathological, socioeconomic, and psychological factors contribute to decreased food intake in the elderly.*

Physiological Factors

- Decreased taste and smell
- Slower gastric emptying and prolonged satiety
- Reduced lean body mass and energy expenditure

Pathological Factors

- Poor dental health
- Difficulty swallowing
- Illness, dietary restrictions
- Dementia
- Medications/GI symptoms

Socioeconomic Factors

- Isolation
- Poverty
- Difficulty purchasing and preparing food

Psychological Factors

- Depression
- Loneliness
- Grief/loss



De Visu/Shutterstock

Consuming adequate amounts of vitamin B₁₂, folate, iron, calcium, and vitamin D may be difficult for some older adults. The requirements for calcium and vitamin D increase in older adults in general, and the absorption of vitamin B₁₂, folate, and iron decrease in many older adults.



Pick two of these factors, and explain how and why they could result in decreased food intake.

for example—can decrease the medication’s effectiveness.

Changes in the Digestive System

Age-related gastrointestinal changes may also occur, especially with regard to the bacterial composition of the gut, which can affect nutrient absorption. Diminished gastric acid secretion and slower motility in the small intestine can result in overgrowth of intestinal bacteria that interferes with absorption of nutrients. Reduced gastric acid production also causes malabsorption of naturally occurring vitamin B₁₂, because gastric acid must release the vitamin from food proteins for it to be absorbed. It is estimated that at least 25% of those older than 60 years are deficient or marginally deficient in vitamin B₁₂, and low B₁₂ levels are associated with cognitive impairment and dementia.

For this reason, it is strongly recommended that the elderly receive their vitamin B₁₂ from fortified foods or supplements. **(INFOGRAPHIC G.5)**

Along with an age-related weakening of the colon wall and low fiber intake, reduced gastric motility also contributes to the development of diverticular disease, which affects approximately 50% of people by the age of 65, with a higher incidence in older age groups. Changes in the digestive system can also reduce the production of stomach acid, which plays an important defensive role against the aging adult’s increased risk of foodborne illness.

Because of all these things, the elderly are particularly vulnerable to malnutrition. And that, in turn, can compromise their ability to live long and prosper. A recent systematic review of data from longitudinal studies

STAY TUNED

For more on foodborne illness, see Spotlight H Food Safety.

INFOGRAPHIC G.5 Selected Nutrition-Related Conditions Common in Older Adults

Adults *Certain conditions common in older adults may be improved or prevented through appropriate nutrition and physical activity.*

Age-related macular degeneration:

Leading cause of vision loss with aging. Consuming a high-dose supplement containing vitamins C and E, zinc, copper, and the phytochemicals lutein and zeaxanthin can slow its progression.

Sarcopenia: Involuntary loss of lean body mass in the elderly typically caused by reduced levels of physical activity; less than optimal protein intake may also be a contributing factor.

Bacterial overgrowth: Decreased gastrointestinal tract motility and hydrochloric acid production increase the bacterial population in the small intestine and may increase GI symptoms and reduce the absorption of some nutrients.

Osteoporosis: Lack of adequate weight-bearing exercise and inadequate intake of vitamin D and calcium lead to a loss of bone mass, increasing the risk of bone breakage.

Dementia: High-fat diets and obesity may increase the risk of dementia. Plant-based diets high in a variety of phytochemicals appear to reduce the risk. Adequate intake of vitamins B₆, B₁₂, and folate has been found to reduce age-related cognitive decline in some studies.

Impaired immune function: Aging causes a natural decline in immune function that may be exacerbated by protein, zinc, or vitamin D deficiencies; increased susceptibility to foodborne illnesses.

Atrophic gastritis: Caused by an autoimmune disorder that destroys cells in the stomach that produce gastric acid and intrinsic factor needed for absorption of vitamin B₁₂. Adequate gastric acid is also necessary for the efficient absorption of several minerals.

Diverticulosis: May affect 50% of adults older than 60. Develops when tiny pockets are formed when the lining of the colon protrudes outward through weak spots in the colon wall.

? Which of these conditions may be prevented or delayed by proper nutrition earlier in life?

Photo credit: STEEX/Getty Images

Joining a friend for lunch. Seniors who regularly eat with a companion may avoid the pitfalls of social isolation and more fully enjoy food.



Peter Titmuss/Alamy

reported that the prevalence of malnutrition in Europe and North America is as much as 60% for older adults in extended care facilities and as high as 65% in hospitalized older adults. Elderly living in the community tend to fare better, but many are still at risk for malnourishment, with slightly fewer than 40% being malnourished or at risk of malnourishment.

Depression and Nutritional Status

In addition to the varied physiological factors that affect the health and nutritional status of aging adults, psychosocial factors have an impact on their ability and motivation to obtain adequate and appropriate nourishment. Loss, loneliness, and lack of social support may result in increased risk of depression and suboptimal intake when eating alone. Research (and common sense) shows that individuals who are psychologically healthy, are resilient, and have a sense of purpose in their lives are more likely to age successfully and experience better quality of life and overall health. This echoes

the characteristics found in the Blue Zone populations.

NUTRIENT RECOMMENDATIONS FOR SENIORS

Because the physiological changes with increasing age can alter how the body absorbs and utilizes nutrients, the Daily Reference Intake values (DRIs) for certain vitamins and minerals are different for older adults. In particular, the requirements for calcium and vitamin D—both important for the prevention of osteoporosis—are higher in the age group. (Refer to Chapter 9 for a discussion on osteoporosis.) Calcium absorption is reduced in older adults, and vitamin D synthesis can be compromised because of reduced exposure to sunlight. The RDA for calcium is increased from 1000 mg to 1200 mg in women 51 and older and in men older than 70. The RDA for vitamin D increases from 600 IUs to 800 IUs in adults (men and women) over the age of 70. There is also a higher requirement for vitamin B₆ with age. A deficiency of this vitamin can lead to cognitive impairment,

whereas supplements have been shown to reduce the occurrence of late-life depression.

Protein intake is of particular concern, as one-third of older adults are not meeting the Recommended Dietary Allowance for protein. Furthermore, a number of studies demonstrate that slightly higher protein intakes (approximately 1.0–1.5 g/kg/d) in adults older than 65 years can effectively reduce the loss of lean body mass that occurs with age. This may improve functionality and reduce the risk of disability and death, particularly when combined with resistance exercise. Several studies have also shown that consuming 25–30 grams of protein at each meal slows age-associated loss of muscle mass and improves gains in muscle mass in response to resistance training in older individuals.

Fluid recommendations are the same for older adults, but because older adults may experience reduced thirst sensation and increased fluid loss through diminished kidney function and as a side effect of certain medications, they may have a harder time meeting the requirements. With an increased risk of dehydration, food guides for aging adults have added emphasis on sufficient fluid intake. **(INFOGRAPHIC G.6)**

Older individuals can benefit from plant-based and animal-based proteins such as these (shown: shrimp, tofu, kidney beans, hummus, chicken, and eggs). Intakes of 1–1.5 g/kg of body weight per day may reduce the loss of lean body mass in individuals over age 65.



StockFood/Getty Images

Resistance training builds and maintains muscle mass. *This 100-year-old woman lifts weights each morning and lives in an Adventist community in Loma Linda, California.*



David McLain/Getty Images

INFOGRAPHIC G.6 Healthy Eating for Older Adults *Making wise food choices can help prevent aging-related nutritional problems.*

GO FOR PROTEIN!



Protein Foods

Increasing protein intake slightly, to 1.0 – 1.2 g/kg body weight, may reduce the loss of lean body mass in older adults.

CONSUME FLUIDS REGULARLY!



Fluids

As we age, our kidneys have a reduced capacity to conserve water and the sensation of thirst diminishes. For this reason, it may be wise for the elderly to consume fluids when not thirsty.

REACH FOR CALCIUM-RICH FOODS!



Calcium

Decreased hydrochloric acid production decreases calcium absorption. To promote bone health, the RDA for calcium increases from 1000 mg to 1200 mg/day at age 51 for women and age 71 for men.

GRAB A GOOD SOURCE OF D!



Vitamin D

Because individuals often get outside less often as they age and the conversion of cholesterol to vitamin D is less efficient, the RDA for vitamin D increases 33% for both men and women at age 71.

GO BANANAS FOR B6!



Vitamin B₆

The RDA for vitamin B₆ increases at age 51. Low vitamin B₆ status in the elderly is associated with an increased risk of cognitive decline and depression.

CONSIDER FORTIFIED FOODS FOR B12!



Vitamin B₁₂

Reduced production of gastric acid is common in the elderly, which decreases the absorption of naturally occurring vitamin B₁₂. It is recommended that adults older than 60 years of age meet their needs for vitamin B₁₂ through fortified foods or supplements, which do not depend on gastric acid for absorption.

CHECK WITH YOUR DOCTOR ABOUT IRON!



Iron

The low gastric acid production that is common in the elderly reduces the absorption of non-heme iron, increasing the risk of anemia. However, high iron stores are more common in the elderly than is iron deficiency. For this reason, iron supplements are generally not recommended unless an individual has been diagnosed with iron deficiency.

LOOK FOR ZINC!



Zinc

Elderly individuals are often found to have moderate zinc deficiency from low intake and decreased absorption due to low gastric hydrochloric acid production. Low zinc status is correlated with impaired immune and cognitive function.

? *What four nutrients share at least one food that is a good source of all four of them? What is that food?*

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In addition to those nutrients that are specifically altered in the DRIs for older age groups, several other nutrients may provide benefits in some cases. These include zinc, which plays a supportive role in immunity, and omega-3 fatty acids, which may reduce symptoms of rheumatoid arthritis, slow the progression of *age-related macular degeneration*, and reduce the risk of Alzheimer's disease.

As life expectancy increases, age-related declines in cognitive function are projected to quadruple (approximately) the prevalence of dementia worldwide by the year 2050. Although increasing age is the strongest predictor of cognitive decline, various lifestyle factors—such as physical activity and diet—also play an important role. Smoking, obesity, and diets high in saturated fat appear to increase the risk of cognitive decline and dementia, whereas regular physical activity and plant-based diets with ample intakes of vegetables, berries, nuts, and whole grains are associated with decreased risk. Regular consumption of coffee, black and green teas, and cocoa, as well as moderate wine consumption, are also linked to a reduced risk of dementia. Diets that are rich in these foods and beverages provide not only abundant amounts of the antioxidant vitamins (C and E) but also a rich array of phytochemicals that are believed to protect against dementia. It is currently thought that most phytochemicals do not exert their protective effects through their often-promoted antioxidant functions, but they likely directly affect a variety of cellular processes that help preserve cognitive function. Finally, several studies have observed that regular fish consumption is also associated with a reduced risk of dementia, perhaps due to increased intakes of omega-3 fatty acids. (Refer to Chapter 5 for more on the role of omega-3 fatty acids in brain health.) It is important to emphasize that these dietary factors are protective when they are part of an overall diet pattern, as very few studies have found dietary supplements to be effective at preserving cognitive function or slowing the progression of dementia.

On the basis of current research, the best diet to delay age-related disease onset is one that provides sufficient but not excessive

calories; is low in saturated fat and high in whole grains, legumes, fruits, and vegetables; and maintains a lean body weight. In consideration of the unique nutritional and physical activity needs associated with advancing years, there is a MyPlate for Older Adults, developed by nutrition scientists at the Jean Mayer USDA Human Nutrition Research Center on Aging, to complement the federal government's MyPlate for adults. **(INFOGRAPHIC G.7)**

Although it makes intuitive sense that cutting out known risk factors for disease such as smoking and drinking would improve health (and it is fairly easy to show this empirically), dissecting the nutritional contributions to health and longevity is a bit more difficult. It requires large, carefully planned studies that are statistically powered to detect subtle effects of dietary variables.

The first study to look at the nutrition of Adventists was the *Adventist Health Study*, which began in 1976. This study analyzed the health-related behaviors of 34,192 Adventist men and women 30 years and older. (The individuals in this study were all non-Hispanic whites, although later studies have included Hispanics and African Americans as well.) Individual study participants filled out a detailed questionnaire, and the researchers made follow-up contact with them until 1988.

The Adventists' dietary choices were assessed by asking about how often they consumed 55 different foods or food groups. Exercise levels were assessed and scored with a battery of questions. Study participants were contacted each year to ascertain whether they had any hospitalizations or newly identified health conditions such as diabetes or cancer. Height and weight measures provided by participants were used to calculate body mass index (BMI). From this information, the study investigators then analyzed the relationship between individuals' behaviors and their risk of disease and death. The result? Certain behaviors practiced by a subset of Adventists were associated with clear benefits to health and longevity. Being physically active, eating many nuts, being vegetarian, and having a healthy BMI each provided approximately

INFOGRAPHIC G.7 MyPlate for Older Adults *The energy needs of older adults generally decline with age because of decreased metabolism and physical activity. However, requirements for vitamins and minerals remain the same or, in some cases, even increase. To meet these nutrient needs, it is important for older adults to choose nutrient-dense foods that provide high levels of vitamins and minerals per serving. Also visit <https://www.choosemyplate.gov/older-adults> for additional information.*

MyPlate for Older Adults

Fruits & Vegetables
Whole fruits and vegetables are rich in important nutrients and fiber. Choose fruits and vegetables with deeply colored flesh. Choose canned varieties that are packed in their own juices or low-sodium.

Healthy Oils
Liquid vegetable oils and soft margarines provide important fatty acids and some fat-soluble vitamins.

Herbs & Spices
Use a variety of herbs and spices to enhance flavor of foods and reduce the need to add salt.

Fluids
Drink plenty of fluids. Fluids can come from water, tea, coffee, soups, and fruits and vegetables.

Grains
Whole grain and fortified foods are good sources of fiber and B vitamins.

Dairy
Fat-free and low-fat milk, cheeses and yogurts provide protein, calcium and other important nutrients.

Protein
Protein rich foods provide many important nutrients. Choose a variety including nuts, beans, fish, lean meat and poultry.

Remember to Stay Active!

Tufts UNIVERSITY
JEAN MAYER USDA HUMAN NUTRITION RESEARCH CENTER ON AGING
HNRCA
AARP Foundation

? Older adults may lose interest in eating because of changes in their senses of taste and smell. What ways can you think of to overcome these eating challenges?

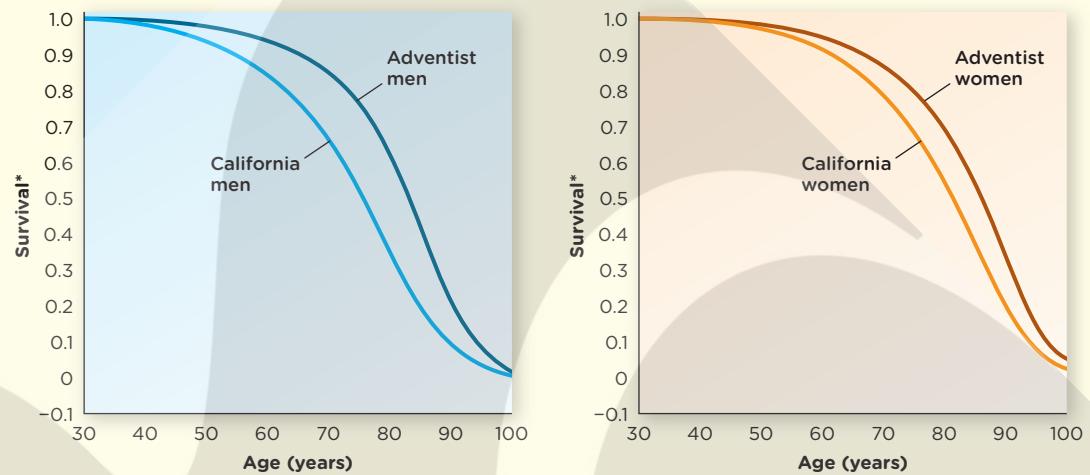
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1.5 to 2.5 years of extra expectancy. The boost to longevity was additive, with longevity increasing to a greater extent as Adventists practiced a greater number of these behaviors. The average life expectancy (at age 30) of Adventist men and women was 81.2 and 83.9 years, respectively. This corresponds to

an extra 7.3 years of life for Adventist men and an extra 4.4 years for Adventist women when compared with other Californians. When just the Adventist vegetarians were used as the basis of comparison, the difference was even more striking: Adventist vegetarian men and women had a life expectancy

INFOGRAPHIC G.8 Survival of Men and Women Adventists

Compared with Californians *Both male and female Seventh-day Adventists have longer life expectancies than the average Californian man and woman, possibly due to lifestyle choices such as abstaining from eating meat, smoking, and drinking.*



*Survival is the probability of living another year.

? How much more likely to survive is a 70-year-old Adventist man than a 70-year-old Californian man? What about a 70-year-old Adventist woman compared with a 70-year-old Californian woman?

that was 9.5 and 6.1 years, respectively, longer than their fellow Californians.

The authors of the study, published in 2001, conclude, “These results strongly suggest that behavioral choices influence the expected age at death by several years, even as much as a decade.” (INFOGRAPHIC G.8)

Why men experience more of a benefit is not entirely clear. There is some evidence that men, in general, tend to make worse dietary choices than women, so their nutritional deficits might be more easily corrected, explains Fraser.

The Adventist studies (there are now several) have unique advantages, not least of which is the fact that the study population is relatively homogeneous with regard to smoking and drinking (they abstain). This allows study investigators to isolate the nutritional variables that seem to affect health outcomes with a greater amount of certainty. “These people are very similar in other respects, except for the way that they eat,” Fraser explains.

MAINTAINING PHYSICAL STRENGTH FOR A LIFETIME

Nutrition is one important ingredient for a long and healthy life, but it’s not the only one. Equally important is staying active. This doesn’t have to be through deliberate exercise at a gym. Typical among people in the Blue Zones, including the Adventists, is a consistent pattern of remaining active well into later life through natural means. Whether through gardening or walking or swimming, older residents of Blue Zones maintain an active lifestyle that helps forestall the loss of muscle mass. And this turns out to be a crucial matter of health, for several reasons.

Adequate muscle mass is important for mounting an adequate response to various stresses and reducing the risk of several chronic diseases. Muscle serves as a reservoir of amino acids that can be used during periods of physiological stress such as illness, injury, or surgery to synthesize antibodies as part of an immune response. Adequate muscle mass is also essential for successful recovery from these conditions.



Exercise benefits all age groups. There are many ways to enjoy physical activity at any age. These women participate in water aerobics class in a Seventh-day Adventist Community in Loma Linda, California.



Peter Bohler/Redux

Maintaining adequate skeletal muscle mass (and preventing sarcopenia) also reduces the risk of developing type 2 diabetes, because muscle is the primary site of insulin-stimulated glucose uptake from blood and the major means of clearing excess glucose from the blood. Adequate skeletal muscle mass and strength allows for continued physical activity, which is required to maintain bone density and reduce the risk of osteoporosis. Finally, studies continue to confirm that maintenance of muscle mass and strength not only helps prevent falls and injury but also can help keep aging adults independent and promote longer, healthier lives. **(INFOGRAPHIC G.9)**

There is some evidence that physical activity not only makes a person feel better—boosting mental and physical fitness—but also can forestall some of the physiological effects of aging. Older adults who exercise have bodies that are in some senses physiologically younger than those who don't.

BLUE ZONE SECRETS

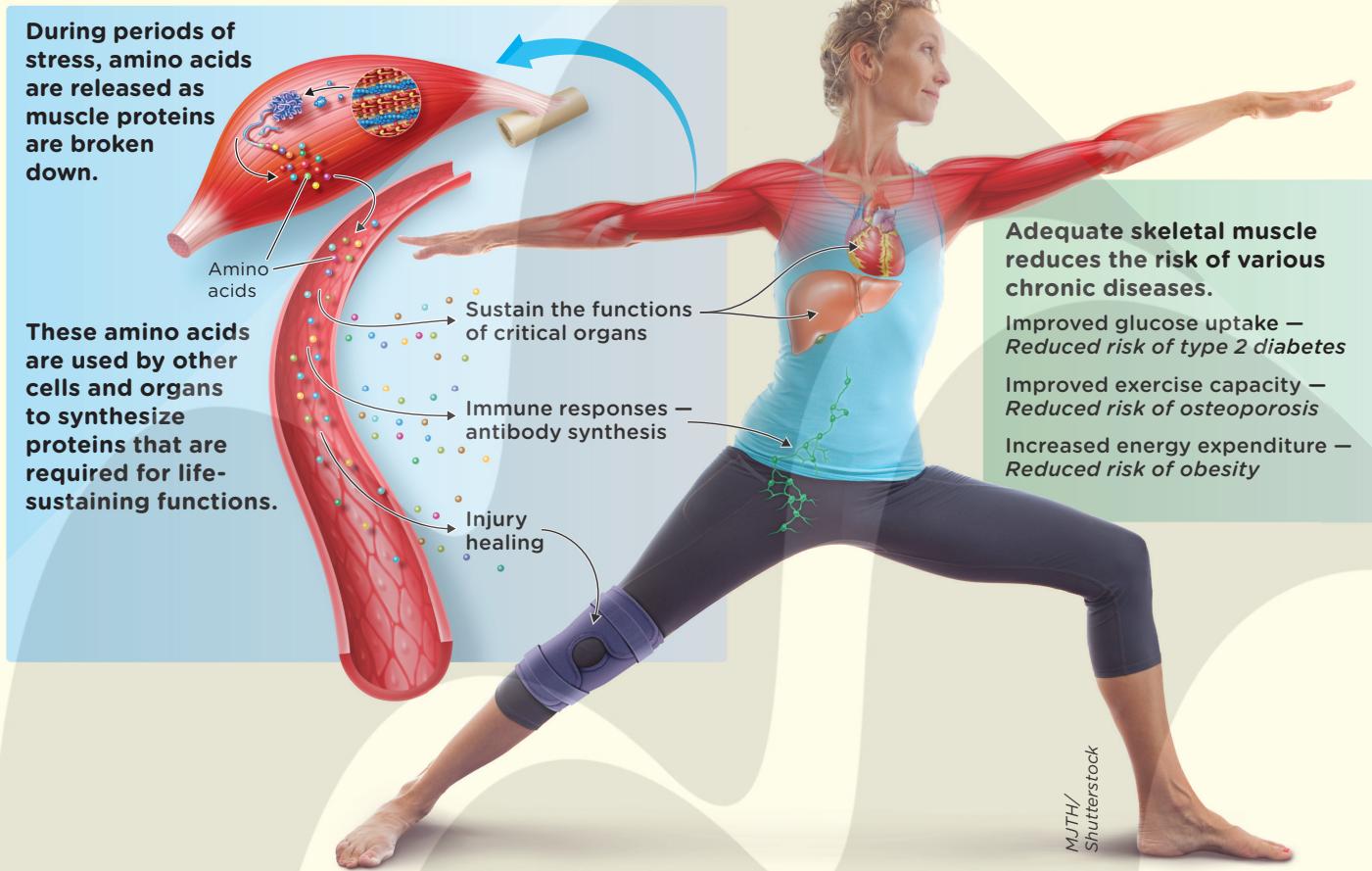
Eating nutritious foods and exercising seem obvious, but there are other features of Blue Zones that seem to contribute to longer life.

Most important of these are psychosocial variables such as being socially connected and having a “plan” or a “purpose.” Residents of Blue Zones are distinctive in the way they value their elders, making them important members of the community. As journalist Buettner said in his Ted Talk with regard to Sardinia, “The older you get, the more equity you have, the more wisdom you’re celebrated for.” Older people in Blue Zones also tend to find a clear reason to get up in the morning, even after they stop working. In Okinawa, for example, there is no word for “retirement.” Having a plan or purpose is not good just for mental health; it’s actually an independent contributor to longevity. “The dietary factors and physical activity and BMI seem to operate independently of the psychosocial factors,” Fraser observes.

Particular classes of foods also tend to be embraced in Blue Zone diets—in particular, legumes and nuts. The Japanese tend to eat a large amount of tofu, made from soybeans (a legume), whereas Adventists eat plenty of legumes and nuts.

Interestingly, this penchant for nuts was developed long before there were scientific studies supporting their value. “We were

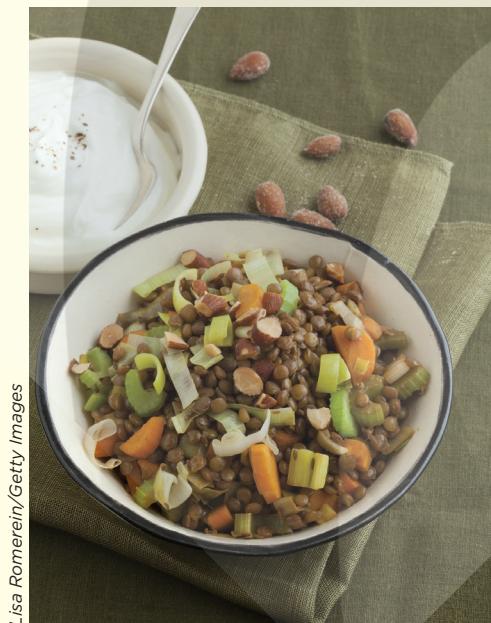
INFOGRAPHIC G.9 The Role of Skeletal Muscle in Health, Illness, and Injury *Adequate skeletal muscle mass is important for recovering from illness and injury and for reducing the risk of some chronic diseases.*



? *Why does protein malnutrition increase the risk of death following major surgery?*

A meal rich with lentils and nuts.

Seniors can benefit from a diet that contains more protein than the RDA of 0.8 gram per kilogram of body weight per day.



actually the first study to publish anything positive about nuts and that was back in the mid-1990s,” recalls Fraser, who notes that the people with higher nut consumption in their study seemed to be protected against coronary artery disease. They don’t know all the reasons for that, but other studies have shown that nuts tend to lower low-density lipoprotein cholesterol. They’re also high in fiber.

Fraser remembers that his and his colleagues’ conclusions about nuts were a bit controversial when they were first presented. “Most nutritionists at the time felt that nuts were a kind of snack food, and they often were salted, and they were fatty and so forth,” and those nutritionists were not recommending nuts for a good healthy diet. But Fraser had done a fellowship at the University of

Minnesota where some of the seminal work was done on the relationship of different fatty acids to blood cholesterol and heart disease, so he had reason to suspect that nuts would be healthful, because they are low in saturated fat and often high in monounsaturated fats. “We were a bit surprised to see the power that nuts had,” says Fraser. “Day-to-day, they decrease the risk of heart attacks by about 50 percent.” A quarter of Adventists reported eating nuts five or more times a week, according to the 1990s study. **(INFOGRAPHIC G.10)**

Many Blue Zones have become famous for the numbers of centenarians (people at least 100 years of age) in the population. Although that is one measure of longevity, it’s not necessarily the most important one for determining the overall health of a population.

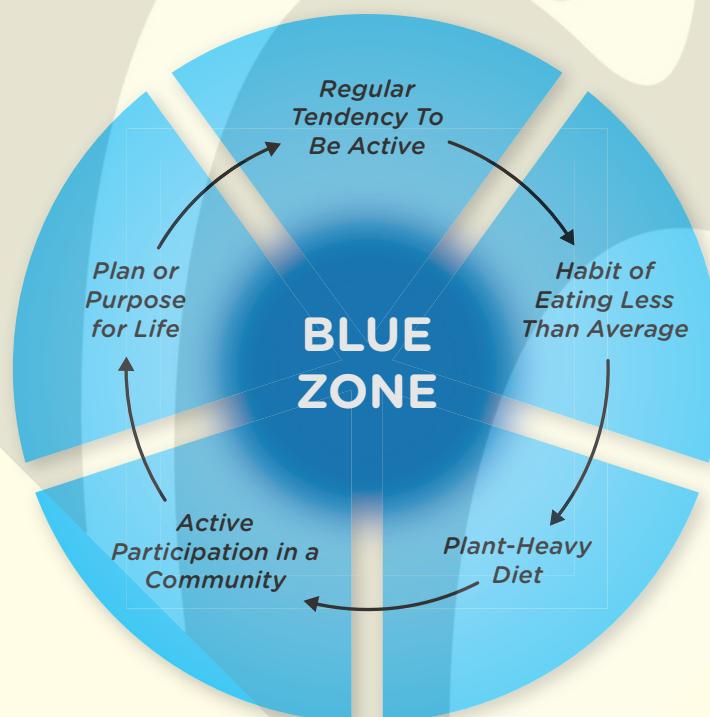
These very long-lived individuals represent a very small fraction of the total population, and they could conceivably be individuals with a genetic propensity that conveys longer life. The Adventist study is different because it looked at the benefit of healthful choices on life expectancy of the population as a whole.

“The fact that Adventist men live, on average, seven or so years longer than their Californian counterparts does inevitably mean that we’re going to have a higher proportion of centenarians, too,” explains Fraser. “But we believe it’s more meaningful to not focus on just one small extreme group but to talk about whether the life expectancy of the whole population is being moved.” The Adventists get a boost to life expectancy across the lifespan. **(INFOGRAPHIC G.11)**

What are the main lessons of the Adventist study for individuals wanting to increase their

INFOGRAPHIC G.10 Healthy Blue Zone Behaviors and Practices

People who live in Blue Zones around the world share a few common attributes that scientists believe may contribute to their increased longevity. Adopting these habits could extend the life expectancy of the rest of the world.



Which behaviors or practices of residents of Blue Zones are common in your own community? Which are uncommon?

INFOGRAPHIC G.11 Expected Length of Life (Californian Adventists Compared with International Populations)

Californian Adventists have a life expectancy greater than that of the populations of most nations, with only a select few (such as Iceland and Japan) that approach similar numbers. Californian Adventists who follow a vegetarian diet have even longer life expectancies.

Country (Year)	Length of Life (Years)			
	Men		Women	
	At Birth	At Age 65	At Birth	At Age 65
Australia (1990)	73.9	15.2	80.0	19.0
Canada (1985-1987)	73.0	14.9	79.7	19.1
Denmark (1989-1990)	72.0	14.1	77.7	17.9
Finland (1989)	70.9	13.8	78.9	17.7
Iceland (1989-1990)	75.7	16.1	80.3	19.3
Japan (1990)	75.9	16.2	81.3	19.9
New Zealand (1987-1989)	71.6	14.1	77.6	17.8
Norway (1990)	73.4	14.6	79.8	18.6
United Kingdom (1985-1987)	71.9	13.4	77.6	17.3
United States (1990)	73.0	14.9	79.7	19.1
California Adventists (1980-1988)*	78.5	19.1	82.3	21.6
<i>Vegetarians</i>	80.2	20.3	84.8	22.6

*Hazards for those aged 0-29 years are those from California State data, as data for these ages are not available for Adventists. Non-Adventist data are taken from international longevity comparisons (1992).



To what age was a Californian Adventist woman who was 65 years old in 1988 expected to live?

chances of living a long, full life? “I think our results provide pretty strong evidence that a plant-based diet has quite a lot of advantages, whether you’re looking at blood pressure or diabetes or life expectancy or coronary heart disease or certain cancers,” believes Fraser, who is himself a pescatarian (a vegetarian who eats fish).

Fraser doesn’t expect the non-Adventist population to become vegetarian any time soon, but he does think it’s reasonable to suggest that people cut back on meat consumption. “You can start to talk about things such as meatless days or emphasizing certain vegetable food groups,” he notes.

Largely because of their nutritional habits, the Adventists are some of the healthiest and longest-lived people on the planet. Their example shows fairly conclusively that making well-informed choices regarding nutrition can have large effects on health. In that sense, their dietary and exercise habits can serve as a model for other communities. If living long and prospering is one of your goals, then you might want to consider changing your lifestyle to more closely mirror that of the Adventists. To quote Mr. Spock, “It’s only logical.”



SPOTLIGHT G BRING IT HOME

Assisted living case study

Eleanor is an 84-year-old white female residing in an assisted living facility in North Dakota. She eats two meals each day in the dining hall and has a small kitchen with a refrigerator and microwave in her residence. She is able to place an order once a week for the delivery of foods and beverages from a local supermarket but has limited finances and limited space for food storage. Eleanor's recent visit to her primary care provider revealed mild dehydration and a weight loss of several pounds since her visit one year ago. (Eleanor's BMI is 20 kg/m².) Eleanor had previously been given a diagnosis of osteoporosis at age 78, with a recent bone scan showing progressive bone loss.

1. Identify at least five nutrition-related concerns from Eleanor's brief profile.
2. What possible challenges may be compromising Eleanor's ability to meet nutritional and fluid requirements?
3. What are some of Eleanor's risk factors for osteoporosis that may be contributing to bone loss?
4. Based on what you've learned about nutrition-related concerns and recommendations in the aging adult, list three to five specific food or dietary strategies for Eleanor.

TAKE IT FURTHER

The role of diet in healthy aging is of interest to the growing numbers of seniors and is the focus of many ongoing research projects in the scientific community. Visit PubMed at <http://www.ncbi.nlm.nih.gov/pubmed>. Using the search term *nutrition and aging*, browse through recent articles and studies. Choose one article that addresses a nutrient, dietary component, or nutritional consideration with regard to aging. Read the abstract, and briefly describe study findings or implications.

KEY IDEAS

Nutrition and physical activity play key roles in maintaining health and preventing chronic disease, as well as in potential longevity and quality of life, in the aging adult.

Physical, psychological, social, and economic factors can influence and potentially compromise the dietary intake and nutritional status of the older adult.

Energy needs in older adults generally decline because of decreased physical activity and metabolic rate; however, nutrient needs do not decrease (they may even increase), making it especially important to consume nutrient-dense foods.

Age-related changes in body composition and body fat distribution occur to varying degrees, but physical activity helps offset losses in skeletal muscle mass (sarcopenia).

Age-related gastrointestinal changes may occur, including the bacterial composition of the gut, diminished gastric acid secretion, and slower motility in the small intestine.

Nutrients of concern in older adults due to diminished intake or possible changes in absorption and utilization include protein, calcium, vitamin D, vitamin B₆, vitamin B₁₂, folate, iron, zinc, fiber, and omega-3 fatty acids.

Although fluid requirements are the same for older adults, the risk of dehydration is higher than in younger adults due to diminished thirst sensation, increased fluid loss, and side effects of certain medications.

Poor nutrition and physiological changes with advanced age, along with possible depressed immunity and a decreased ability to fight and recover from illness, surgery, or infection, can lead to suboptimal nutritional status or even malnutrition.

Nutrient inadequacies may contribute to cognitive decline with age. In addition, some studies show that certain dietary nutrients such as omega-3 fatty acids and some phytochemicals may reduce the risk of dementia.

Based on current research, the best diet to delay onset of age-related disease is one that avoids excess calorie intake and is low in saturated fat and high in whole grains, legumes, nuts, fruits, and vegetables.

NEED TO KNOW

Review Questions

- All of the following are TRUE regarding life expectancy, EXCEPT that it:
 - is based on a statistical average calculated on a population.
 - represents the number of years a person is expected to live.
 - represents the actual number of years an individual lives.
 - is a calculation that includes those who die during or shortly after birth.
- The DRI for _____ is higher for older adults than for their younger counterparts.
 - calories
 - iron
 - vitamin A
 - vitamin B₆
 - vitamin C
- The DRI for calcium:
 - decreases slightly with age with reduced physical activity and reduced lean mass.
 - increases from 1000 mg to 1200 mg for women 51 years and older.
 - increases from 1000 mg to 1200 mg in females only after age 70.
 - remains the same after age 30 when peak bone mass is achieved.
- Why might older adults be prone to vitamin D deficiency?
 - a suboptimal intake of vitamin D
 - reduced exposure to sunlight and ultraviolet light
 - diminished production of vitamin D in the skin
 - increased vitamin D dietary requirements
 - all of the above
- Sarcopenia can be defined as:
 - small, abnormally shaped red blood cells.
 - the condition of porous and brittle bones that occurs with age.
 - the age-related reduction in skeletal muscle mass.
 - elevated levels of disaccharides in the blood.
- The elderly at highest risk of malnutrition appear to be those who:
 - live at home.
 - live with family members.
 - are in acute-care facilities (hospitals).
 - are in long-term care facilities.
- Gastric acid production and secretion decreases with age, which potentially results in all of the following, EXCEPT:
 - the altered digestion and absorption of certain nutrients.
 - diminished growth of intestinal bacteria.
 - malabsorption of naturally occurring vitamin B₁₂ from food.
 - increased risk of foodborne illness.
- With regard to protein intake in the older adult, recent studies demonstrate that:
 - the DRI for protein increases by 50% after age 70.
 - the benefits of protein intake are best with lean animal foods.
 - there is no evidence of any benefit of protein intakes above the DRI of 0.8 g/kg body weight.
 - slightly increased protein intake can reduce loss of lean body mass.
- All of the following are TRUE with regard to fluid status in the older adult, EXCEPT:
 - diminished sensation of thirst.
 - diminished kidney function with increased fluid loss.
 - increased DRI for water after age 70.
 - increased risk for dehydration.
 - the use of certain medications that can increase fluid loss.
- Studies demonstrate that the best diet to delay age-related chronic disease includes which of the following characteristics?
 - avoids excess calories
 - is high in vegetables
 - is high in legumes
 - is low in saturated fat
 - all of the above