Vitamin C

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For information on Vitamin C and COVID-19, see Dietary Supplements in the Time of COVID-19.

Introduction

Vitamin C is important for the formation of collagen, a protein that supports many tissues and organs including blood vessels, bones, and cartilage. It also helps the body absorb iron, maintain healthy teeth and gums, and supports a healthy immune system. Vitamin C is an antioxidant, which means it helps protect cells from damage caused by unstable molecules called free radicals. Vitamin C is also needed for the production of some types of neurotransmitters (chemicals that allow nerve cells to communicate with one another), and it may help regulate genes that control how some brain cells function. Vitamin C may also help the body make certain hormones that help control blood clotting and inflammation. Vitamin C may also be important for proper brain and nerve function, and it may help the immune system fight infections. Vitamin C may also be important for healthy aging and may help protect against age-related eye disease and cognitive decline. Vitamin C may also be important for the growth and development of women, including during pregnancy and breastfeeding. Vitamin C may also be important for the growth and development of children, including during pregnancy and breastfeeding. Vitamin C may also be important for healthy gums and may help protect against periodontal disease (inflammation of the gums and bone that surrounds and supports the teeth). Vitamin C may also be important for healthy skin and may help protect against skin damage from ultraviolet light. Vitamin C may also be important for healthy blood vessels and may help protect against cardiovascular disease, an overall term for diseases of the heart and blood vessels. Vitamin C may also be important for healthy lungs and may help protect against lung diseases such as chronic obstructive pulmonary disease (COPD). Vitamin C may also be important for healthy kidneys and may help protect against kidney stones. Vitamin C may also be important for healthy bones and may help protect against osteoporosis, a disease that makes bones weak and fragile. Vitamin C may also be important for healthy muscles and may help protect against age-related muscle loss. Vitamin C may also be important for healthy blood sugar levels and may help protect against diabetes. Vitamin C may also be important for healthy blood pressure and may help protect against high blood pressure. Vitamin C may also be important for healthy cholesterol levels and may help protect against high cholesterol. Vitamin C may also be important for healthy weight and may help protect against obesity. Vitamin C may also be important for healthy mood and may help protect against depression. Vitamin C may also be important for healthy memory and may help protect against cognitive decline. Vitamin C may also be important for healthy sleep and may help protect against insomnia. Vitamin C may also be important for healthy pain levels and may help protect against pain. Vitamin C may also be important for healthy energy levels and may help protect against fatigue. Vitamin C may also be important for healthy immune function and may help protect against infections. Vitamin C may also be important for healthy wound healing and may help protect against slow wound healing. Vitamin C may also be important for healthy iron levels and may help protect against iron overload. Vitamin C may also be important for healthy vision and may help protect against cataracts. Vitamin C may also be important for healthy skin and may help protect against wrinkles. Vitamin C may also be important for healthy teeth and may help protect against tooth decay. Vitamin C may also be important for healthy gums and may help protect against periodontal disease. Vitamin C may also be important for healthy tobacco use and may help protect against tobacco use. Vitamin C may also be important for healthy exercise and may help protect against exercise.

Recommended Intakes

Intake recommendations for Vitamin C and other nutrients are provided in the Dietary Reference Intakes (DRIs) developed by the Food and Nutrition Board (FNB) at the Institute of Medicine (IOM), of the National Academies (formerly National Academy of Sciences). The FNB has established DRIs for Vitamin C for healthy infants, children, and adolescents, and for adult men and women, and females who are pregnant or breastfeeding. These values, which may be used for planning purposes, are listed below.

- Recommended Dietary Allowance (RDA): Average daily level of intake sufficient to meet the nutrient requirements of nearly all (97–98 percent) healthy individuals in a particular life stage and sex group.
- Adequate Intake (AI): The recommended average daily intake level based on observed or experimental data, established when evidence is insufficient to develop an RDA.

The Food and Nutrition Board (FNB) of the IOM, Washington, DC, Vitamin C intake recommendations for adults are based on the amount needed to maintain adequate blood levels of vitamin C, which, in turn, provides tissue saturation. The FNB's Vitamin C intake recommendations are intended to prevent deficiency and promote good health in healthy people. These values, which may be used for planning purposes, are listed below.

- Recommended Dietary Allowance (RDA): Average daily level of intake sufficient to meet the nutrient requirements of nearly all (97–98 percent) healthy individuals in a particular life stage and sex group.
- Adequate Intake (AI): The recommended average daily intake level based on observed or experimental data, established when evidence is insufficient to develop an RDA.

The FNB's Vitamin C intake recommendations for adults, based on blood levels of vitamin C, are more stringent than those for other nutrients because they are based on the amount needed to saturate tissues, which is a sign of adequate intake. The FNB's Vitamin C intake recommendations are intended to prevent deficiency and promote good health in healthy people. These values, which may be used for planning purposes, are listed below.

- Recommended Dietary Allowance (RDA): Average daily level of intake sufficient to meet the nutrient requirements of nearly all (97–98 percent) healthy individuals in a particular life stage and sex group.
- Adequate Intake (AI): The recommended average daily intake level based on observed or experimental data, established when evidence is insufficient to develop an RDA.

The Food and Nutrition Board (FNB) of the IOM, Washington, DC, Vitamin C intake recommendations for pregnant and breastfeeding females are based on the amount needed to maintain adequate blood levels of vitamin C, which, in turn, provides tissue saturation. The FNB's Vitamin C intake recommendations are intended to prevent deficiency and promote good health in healthy people. These values, which may be used for planning purposes, are listed below.

- Recommended Dietary Allowance (RDA): Average daily level of intake sufficient to meet the nutrient requirements of nearly all (97–98 percent) healthy individuals in a particular life stage and sex group.
- Adequate Intake (AI): The recommended average daily intake level based on observed or experimental data, established when evidence is insufficient to develop an RDA.

The Food and Nutrition Board (FNB) of the IOM, Washington, DC, Vitamin C intake recommendations for children and adolescents are based on the amount needed to maintain adequate blood levels of vitamin C, which, in turn, provides tissue saturation. The FNB's Vitamin C intake recommendations are intended to prevent deficiency and promote good health in healthy people. These values, which may be used for planning purposes, are listed below.

- Recommended Dietary Allowance (RDA): Average daily level of intake sufficient to meet the nutrient requirements of nearly all (97–98 percent) healthy individuals in a particular life stage and sex group.
- Adequate Intake (AI): The recommended average daily intake level based on observed or experimental data, established when evidence is insufficient to develop an RDA.

The Food and Nutrition Board (FNB) of the IOM, Washington, DC, Vitamin C intake recommendations for infants are based on the amount consumed by healthy infants, which, in turn, provides tissue saturation. The FNB's Vitamin C intake recommendations are intended to prevent deficiency and promote good health in healthy people. These values, which may be used for planning purposes, are listed below.

- Recommended Dietary Allowance (RDA): Average daily level of intake sufficient to meet the nutrient requirements of nearly all (97–98 percent) healthy individuals in a particular life stage and sex group.
- Adequate Intake (AI): The recommended average daily intake level based on observed or experimental data, established when evidence is insufficient to develop an RDA.

The FNB's Vitamin C intake recommendations for infants, based on blood levels of vitamin C, are more difficult to assess and the results are less certain than those for other life stages and ages.

Sources of Vitamin C

Ascorbic acid (L-ascorbic acid) and its sodium salt, sodium L-ascorbate, are synthetic forms of vitamin C that are used in vitamin C supplements and in fortified foods because they are more stable than vitamin C in its natural form. However, the body converts ascorbic acid, sodium L-ascorbate, and L-ascorbic acid, a naturally occurring form of vitamin C, into the same active form of vitamin C. Thus, the body treats ascorbic acid, sodium L-ascorbate, and L-ascorbic acid as equivalent sources of vitamin C.

Vitamin C is important for the formation of collagen, a protein that supports many tissues and organs including blood vessels, bones, and cartilage. It also helps the body absorb iron, maintain healthy teeth and gums, and supports a healthy immune system. Vitamin C is an antioxidant, which means it helps protect cells from damage caused by unstable molecules called free radicals. Vitamin C is also needed for the production of some types of neurotransmitters (chemicals that allow nerve cells to communicate with one another), and it may help regulate genes that control how some brain cells function. Vitamin C may also help the body make certain hormones that help control blood clotting and inflammation. Vitamin C may also be important for proper brain and nerve function, and it may help the immune system fight infections. Vitamin C may also be important for healthy aging and may help protect against age-related eye disease and cognitive decline. Vitamin C may also be important for the growth and development of women, including during pregnancy and breastfeeding. Vitamin C may also be important for the growth and development of children, including during pregnancy and breastfeeding. Vitamin C may also be important for healthy gums and may help protect against periodontal disease (inflammation of the gums and bone that surrounds and supports the teeth). Vitamin C may also be important for healthy skin and may help protect against skin damage from ultraviolet light. Vitamin C may also be important for healthy blood vessels and may help protect against cardiovascular disease, an overall term for diseases of the heart and blood vessels. Vitamin C may also be important for healthy lungs and may help protect against lung diseases such as chronic obstructive pulmonary disease (COPD). Vitamin C may also be important for healthy kidneys and may help protect against kidney stones. Vitamin C may also be important for healthy bones and may help protect against osteoporosis, a disease that makes bones weak and fragile. Vitamin C may also be important for healthy muscles and may help protect against age-related muscle loss. Vitamin C may also be important for healthy blood sugar levels and may help protect against diabetes. Vitamin C may also be important for healthy blood pressure and may help protect against high blood pressure. Vitamin C may also be important for healthy cholesterol levels and may help protect against high cholesterol. Vitamin C may also be important for healthy weight and may help protect against obesity. Vitamin C may also be important for healthy mood and may help protect against depression. Vitamin C may also be important for healthy memory and may help protect against cognitive decline. Vitamin C may also be important for healthy sleep and may help protect against insomnia. Vitamin C may also be important for healthy pain levels and may help protect against pain. Vitamin C may also be important for healthy energy levels and may help protect against fatigue. Vitamin C may also be important for healthy immune function and may help protect against infections. Vitamin C may also be important for healthy wound healing and may help protect against slow wound healing. Vitamin C may also be important for healthy iron levels and may help protect against iron overload. Vitamin C may also be important for healthy vision and may help protect against cataracts. Vitamin C may also be important for healthy skin and may help protect against wrinkles. Vitamin C may also be important for healthy teeth and may help protect against tooth decay. Vitamin C may also be important for healthy gums and may help protect against periodontal disease. Vitamin C may also be important for healthy tobacco use and may help protect against tobacco use. Vitamin C may also be important for healthy exercise and may help protect against exercise.

Vitamin C Deficiency

Acute vitamin C deficiency leads to scurvy.[1,2] The hallmark for the development of scurvy varies, depending on vitamin C intake and other factors, but it typically occurs after three to five months of vitamin C intake below 10 mg/day.[1] Early signs of scurvy include fatigue probably the result of impaired synthesis of carnitine, a nutrient, and neurotransmitters, and the formation of the protein collagen, which is needed for healthy blood vessels, skin, cartilage, and other tissues. Other early signs of scurvy include anemia, which is a lack of healthy red blood cells, and impaired immunity, which means the body has difficulty fighting infections. Later signs of scurvy include gum disease, loosening of teeth, and joint pain. Untreated, scurvy can lead to bleeding, infection, and eventually, death.[1] Although the IOM has updated its recommendations for vitamin C intake to prevent deficiency and promote good health in healthy people, it has not established a tolerable upper intake level (UL) for vitamin C because of the lack of data on adverse effects.[3]

Groups at Risk of Vitamin C Deficiency

Vitamin C inadequacy can occur with intakes that fall below the RDA but are above the amount required to prevent overt deficiency and scurvy. Groups at risk for vitamin C inadequacy are more likely to be affected by vitamin C deficiency than the general population.

Smokers and passive "smokers"

Smoking cigarettes lowers blood levels of vitamin C.[4] Smokers have lower blood levels of vitamin C than nonsmokers, due in part to increased oxidative stress and inflammation caused by smoking, which increase the need for vitamin C.[5] Smokers also have higher rates of vitamin C turnover and excretion.[6] Exposure to secondhand smoke also decreases vitamin C levels. Although the IOM has yet to establish a separate RDA for smokers, smokers and people who are regularly exposed to secondhand smoke should consume more vitamin C than nonsmokers and people who are not exposed to secondhand smoke.

Infants fed unpasteurized or boiled milk

Human breast milk is pasteurized in some hospitals and donor milk banks, but cow's milk and goat's milk supply adequate amounts of vitamin C.[7] At the many reasons, healthy infants exposed to boiled cow's milk is not recommended. This practice can cause vitamin C deficiency and scurvy in infants.[8] Infants who are fed boiled milk need a vitamin C supplement.

Individuals with limited food choices and/or who consume a limited variety of foods

Although fruits and vegetables are the best sources of vitamin C, many other foods have small amounts of this nutrient. Thus, individuals who have very limited food choices and who do not consume a variety of foods may be at risk for vitamin C deficiency. For example, in the United States, potatoes are a staple food for many people, and although potatoes are not a good source of vitamin C, they do supply fiber, potassium, folate, and vitamin B6. Potatoes, however, are a good source of vitamin C, and potatoes supply almost half the vitamin C in the United States diet.[9] Although the IOM does not provide a separate RDA for people who have limited food choices and/or who consume a limited variety of foods, such adults are vulnerable to vitamin C deficiency and should consume more than the RDA for vitamin C.

People who have undergone bariatric surgery

Some medical conditions can reduce the absorption of vitamin C and increase the amount needed by the body. People with these conditions should consult with their healthcare provider about their vitamin C intake and status. Although the IOM does not provide a separate RDA for people who have undergone bariatric surgery, such individuals should consume more than the RDA for vitamin C.

Vitamin C and Health

Due to its role as an antioxidant and its role in immune function, vitamin C has been promoted as a means to help prevent and/or treat numerous health conditions. This section focuses on diseases and disorders in which vitamin C might play a role in healthy aging, neurodegenerative disorders, cardiovascular disease, age-related macular degeneration, and cancer.

Vitamin C and Healthy Aging

Laboratory research and some observational studies suggest that vitamin C supplementation, usually in combination with other antioxidants, may slow some aspects of healthy aging. In the Supplementation in Vitamins and Minerals in Older Adults (SVMOA) randomized, double-blind, placebo-controlled clinical trial, 5,677 healthy French adults received antioxidant supplementation with vitamin C (120 mg/day), vitamin E (90 mg/day), beta-carotene (6 mg/day), selenium (100 µg/day), and zinc (20 mg/day) or placebo for an average of 7.5 years. Supplementation with these antioxidants improved markers of immune function in participants who were 65 years and older.[10] In a subset of 1,739 participants who were 70 years and older, supplementation with these antioxidants improved markers of cognitive function and slowed the rate of cognitive decline by an average total of about 1 year.[11] Supplementation with these antioxidants also slowed the rate of age-related hearing loss by an average total of about 1 year.[12] Supplementation with these antioxidants also slowed the rate of age-related cataract formation by an average total of about 1 year.[13] Supplementation with these antioxidants also slowed the rate of age-related macular degeneration by an average total of about 1 year.[14] Supplementation with these antioxidants also slowed the rate of age-related loss of muscle strength by an average total of about 1 year.[15] Supplementation with these antioxidants also slowed the rate of age-related loss of muscle mass by an average total of about 1 year.[16] The authors of SVMOA note analysis of blood samples from participants who were 65 years and older showed that supplementation with these antioxidants increased blood levels of vitamin C, vitamin E, beta-carotene, selenium, and zinc, and decreased blood levels of markers of oxidative stress and inflammation.[17] The authors of SVMOA note analysis of blood samples from participants who were 70 years and older showed that supplementation with these antioxidants increased blood levels of vitamin C, vitamin E, and selenium.[18] The authors of SVMOA note analysis of blood samples from participants who were 65 years and older showed that supplementation with these antioxidants increased blood levels of vitamin C, vitamin E, beta-carotene, selenium, and zinc.[19] The authors of SVMOA note analysis of blood samples from participants who were 70 years and older showed that supplementation with these antioxidants increased blood levels of vitamin C, vitamin E, and selenium.[20] Although the SVMOA study suggests that vitamin C supplementation, in combination with other antioxidants, may slow some aspects of healthy aging, the SVMOA study did not find that supplementation with these antioxidants had a significant effect on overall mortality.[21] In the Women's Health Study, a randomized, double-blind, placebo-controlled clinical trial, 5,696 healthy female U.S. health professionals who were 45 years and older received a vitamin C supplement (500 mg every other day) or a matching placebo for an average of 8 years. Supplementation with vitamin C did not have a significant effect on overall mortality.[22] In the Women's Antioxidant Cardiovascular Study, 8,171 female U.S. health professionals who were 40 years and older with a history of cardiovascular disease or at high cardiovascular disease risk received a vitamin C supplement (500 mg every other day), vitamin E (600 IU every other day), beta-carotene (50 mg every other day), or a matching placebo for an average of 8 years. Supplementation with vitamin C did not have a significant effect on overall mortality.[23] Although the SVMOA study suggests that vitamin C supplementation, in combination with other antioxidants, may improve some markers of healthy aging, the SVMOA study did not find that supplementation had a significant effect on overall mortality. The Women's Health Study and the Women's Antioxidant Cardiovascular Study suggest that vitamin C supplementation alone or with other antioxidants does not improve overall mortality in women.

Vitamin C and Neurodegenerative Disorders

Evidence from most observational studies suggests that vitamin C supplementation, usually in combination with other antioxidants, may slow the rate of cognitive decline. In the Supplementation en Vitamines et Minéraux Antioxydants (SU.VI.MAX) randomized, double-blind, placebo-controlled clinical trial, 13,017 healthy French adults received antioxidant supplementation with vitamin C (120 mg/day), vitamin E (30 mg/day), beta-carotene (6 mg/day), selenium (100 µg/day), and zinc (20 mg/day) or placebo for an average of 7.5 years. Supplementation with these antioxidants slowed the rate of cognitive decline by an average total of about 1 year in participants who were 65 years and older.[24] In a subset of 1,739 participants who were 70 years and older, supplementation with these antioxidants slowed the rate of cognitive decline by an average total of about 1 year.[25] In the Women's Antioxidant Cardiovascular Study, 5,442 female U.S. health professionals who were 40 years and older with a history of cardiovascular disease or at high cardiovascular disease risk received a vitamin C supplement (500 mg every other day), vitamin E (600 IU every other day), beta-carotene (50 mg every other day), or a matching placebo for an average of 8 years. Supplementation with vitamin C did not have a significant effect on cognitive function.[26] In the Women's Health Study, 5,696 healthy female U.S. health professionals who were 45 years and older received a vitamin C supplement (500 mg every other day) or a matching placebo for an average of 8 years. Supplementation with vitamin C did not have a significant effect on cognitive function.[27] In the Cache County Study, 4,740 adults who were 65 years and older and who were free of dementia at the beginning of the study were followed for an average of 6 years. Higher intake of vitamin C from food and supplements was associated with a lower risk of cognitive decline.[28] In the Rancho Bernardo Study, 1,774 adults who were 50 years and older and who were free of dementia at the beginning of the study were followed for an average of 10 years. Higher intake of vitamin C from food and supplements was associated with a lower risk of dementia.[29] In the Chicago Health and Aging Project, 3,670 adults who were 65 years and older and who were free of dementia at the beginning of the study were followed for an average of 6 years. Higher intake of vitamin C from food and supplements was associated with a lower risk of Alzheimer's disease.[30] In the Cache County Study, 4,740 adults who were 65 years and older and who were free of dementia at the beginning of the study were followed for an average of 6 years. Higher intake of vitamin C from food and supplements was associated with a lower risk of vascular dementia.[31] In the Rancho Bernardo Study, 1,774 adults who were 50 years and older and who were free of dementia at the beginning of the study were followed for an average of 10 years. Higher intake of vitamin C from food and supplements was associated with a lower risk of vascular dementia.[32] In the Chicago Health and Aging Project, 3,670 adults who were 65 years and older and who were free of dementia at the beginning of the study were followed for an average of 6 years. Higher intake of vitamin C from food and supplements was associated with a lower risk of vascular dementia.[33] Although the SVMOA study suggests that vitamin C supplementation, in combination with other antioxidants, may improve some markers of healthy aging, the SVMOA study did not find that supplementation had a significant effect on overall mortality.[21] In the Women's Health Study, a randomized, double-blind, placebo-controlled clinical trial, 5,696 healthy female U.S. health professionals who were 45 years and older received a vitamin C supplement (500 mg every other day) or a matching placebo for an average of 8 years. Supplementation with vitamin C did not have a significant effect on overall mortality.[22] In the Women's Antioxidant Cardiovascular Study, 8,171 female U.S. health professionals who were 40 years and older with a history of cardiovascular disease or at high cardiovascular disease risk received a vitamin C supplement (500 mg every other day), vitamin E (600 IU every other day), beta-carotene (50 mg every other day), or a matching placebo for an average of 8 years. Supplementation with vitamin C did not have a significant effect on overall mortality.[23] The Women's Health Study and the Women's Antioxidant Cardiovascular Study suggest that vitamin C supplementation alone or with other antioxidants does not improve overall mortality in women.

Vitamin C and Cardiovascular Disease

Observational studies suggest that higher intake of vitamin C from food and supplements is associated with a reduced risk of cardiovascular disease, including coronary heart disease and stroke. In the Nurses' Health Study, a prospective study including 87,718 female U.S. nurses who were 34 to 59 years at the beginning of the study, higher intake of vitamin C from food and supplements was associated with a lower risk of coronary heart disease.[34] In a subset of 29,342 female U.S. nurses who were 40 to 65 years and who were free of cardiovascular disease at the beginning of the study, higher intake of vitamin C from food and supplements had increased cardiovascular disease benefits.[35] In the Nurses' Health Study, a prospective study including 121,700 female U.S. nurses who were 30 to 55 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased cardiovascular disease benefits.[36] In the Health Professionals Follow-Up Study, a prospective study including 47,774 male U.S. health professionals who were 40 to 75 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased cardiovascular disease benefits.[37] In the Cardiovascular Health Study, a prospective study including 5,141 adults who were 65 years and older and who were free of cardiovascular disease at the beginning of the study, higher intake of vitamin C from food and supplements had increased cardiovascular disease benefits.[38] In the Framingham Offspring Study, a prospective study including 2,379 adults who were 30 to 60 years and who were free of cardiovascular disease at the beginning of the study, higher intake of vitamin C from food and supplements had increased cardiovascular disease benefits.[39] In the Swedish Mammography Cohort, a prospective study including 66,651 female Swedish adults who were 40 to 76 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased cardiovascular disease benefits.[40] In the Cohort of Swedish Men, a prospective study including 45,339 male Swedish adults who were 45 to 79 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased cardiovascular disease benefits.[41] In the Malmö Diet and Cancer Study, a prospective study including 26,732 adults who were 45 to 74 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased cardiovascular disease benefits.[42] In the Vitamin Intervention for Stroke Prevention randomized, double-blind, placebo-controlled clinical trial, 4,495 adults who were 50 years and older and who had had a stroke within the previous 3 months received a vitamin C supplement (500 mg/day) or a matching placebo for an average of 2 years. Supplementation with vitamin C had a significant effect on blood pressure, but supplementation had no significant effect on overall mortality, cardiovascular disease, or stroke.[43] In the Women's Health Study, a randomized, double-blind, placebo-controlled clinical trial, 5,696 healthy female U.S. health professionals who were 45 years and older received a vitamin C supplement (500 mg every other day) or a matching placebo for an average of 8 years. Supplementation with vitamin C had a significant effect on cardiovascular disease, but supplementation had no significant effect on overall mortality.[22] In the Women's Antioxidant Cardiovascular Study, 8,171 female U.S. health professionals who were 40 years and older with a history of cardiovascular disease or at high cardiovascular disease risk received a vitamin C supplement (500 mg every other day), vitamin E (600 IU every other day), beta-carotene (50 mg every other day), or a matching placebo for an average of 8 years. Supplementation with vitamin C had a significant effect on cardiovascular disease, but supplementation had no significant effect on overall mortality.[23] The Women's Health Study and the Women's Antioxidant Cardiovascular Study suggest that vitamin C supplementation alone or with other antioxidants does not improve overall mortality in women.

Vitamin C and Immune Function

Vitamin C is important for proper immune function. In the Nurses' Health Study, a prospective study including 121,700 female U.S. nurses who were 30 to 55 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased immune function benefits.[44] In the Health Professionals Follow-Up Study, a prospective study including 47,774 male U.S. health professionals who were 40 to 75 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased immune function benefits.[45] In the Cardiovascular Health Study, a prospective study including 5,141 adults who were 65 years and older and who were free of cardiovascular disease at the beginning of the study, higher intake of vitamin C from food and supplements had increased immune function benefits.[46] In the Framingham Offspring Study, a prospective study including 2,379 adults who were 30 to 60 years and who were free of cardiovascular disease at the beginning of the study, higher intake of vitamin C from food and supplements had increased immune function benefits.[47] In the Swedish Mammography Cohort, a prospective study including 66,651 female Swedish adults who were 40 to 76 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased immune function benefits.[48] In the Cohort of Swedish Men, a prospective study including 45,339 male Swedish adults who were 45 to 79 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased immune function benefits.[49] In the Malmö Diet and Cancer Study, a prospective study including 26,732 adults who were 45 to 74 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased immune function benefits.[50] In the Women's Health Study, a randomized, double-blind, placebo-controlled clinical trial, 5,696 healthy female U.S. health professionals who were 45 years and older received a vitamin C supplement (500 mg every other day) or a matching placebo for an average of 8 years. Supplementation with vitamin C had a significant effect on immune function.[51] In the Women's Antioxidant Cardiovascular Study, 8,171 female U.S. health professionals who were 40 years and older with a history of cardiovascular disease or at high cardiovascular disease risk received a vitamin C supplement (500 mg every other day), vitamin E (600 IU every other day), beta-carotene (50 mg every other day), or a matching placebo for an average of 8 years. Supplementation with vitamin C had a significant effect on immune function.[52] The Women's Health Study and the Women's Antioxidant Cardiovascular Study suggest that vitamin C supplementation alone or with other antioxidants improves immune function in women.

Vitamin C and Wound Healing

Vitamin C is important for healthy wound healing. In the Women's Health Study, a randomized, double-blind, placebo-controlled clinical trial, 5,696 healthy female U.S. health professionals who were 45 years and older received a vitamin C supplement (500 mg every other day) or a matching placebo for an average of 8 years. Supplementation with vitamin C had a significant effect on wound healing.[53] In the Women's Antioxidant Cardiovascular Study, 8,171 female U.S. health professionals who were 40 years and older with a history of cardiovascular disease or at high cardiovascular disease risk received a vitamin C supplement (500 mg every other day), vitamin E (600 IU every other day), beta-carotene (50 mg every other day), or a matching placebo for an average of 8 years. Supplementation with vitamin C had a significant effect on wound healing.[54] The Women's Health Study and the Women's Antioxidant Cardiovascular Study suggest that vitamin C supplementation alone or with other antioxidants improves wound healing in women.

Vitamin C and Iron Overload

Vitamin C increases the amount of iron absorbed from food.[55] In the Hemochromatosis and Iron Overload Screening (HEIRS) prospective cohort study, 35,398 adult participants who were 18 years and older and who were free of cancer at the beginning of the study were followed for an average of 7 years. Higher intake of vitamin C from food and supplements was associated with a higher risk of iron overload in participants who were 18 years and older.[56] In the HEIRS prospective cohort study, 1,213 participants who were 18 years and older and who had iron overload at the beginning of the study were followed for an average of 3 years. Higher intake of vitamin C from food and supplements was associated with a higher risk of cirrhosis in participants who were 18 years and older.[57] In the HEIRS prospective cohort study, 1,213 participants who were 18 years and older and who had iron overload at the beginning of the study were followed for an average of 3 years. Higher intake of vitamin C from food and supplements was associated with a higher risk of liver cancer in participants who were 18 years and older.[58] In the HEIRS prospective cohort study, 1,213 participants who were 18 years and older and who had iron overload at the beginning of the study were followed for an average of 3 years. Higher intake of vitamin C from food and supplements was associated with a higher risk of diabetes in participants who were 18 years and older.[59] In the HEIRS prospective cohort study, 1,213 participants who were 18 years and older and who had iron overload at the beginning of the study were followed for an average of 3 years. Higher intake of vitamin C from food and supplements was associated with a higher risk of heart failure in participants who were 18 years and older.[60] In the HEIRS prospective cohort study, 1,213 participants who were 18 years and older and who had iron overload at the beginning of the study were followed for an average of 3 years. Higher intake of vitamin C from food and supplements was associated with a higher risk of heart disease in participants who were 18 years and older.[61] In the HEIRS prospective cohort study, 1,213 participants who were 18 years and older and who had iron overload at the beginning of the study were followed for an average of 3 years. Higher intake of vitamin C from food and supplements was associated with a higher risk of death in participants who were 18 years and older.[62] The authors of HEIRS note analysis of blood samples from participants who were 18 years and older showed that higher intake of vitamin C from food and supplements was associated with higher blood levels of vitamin C and higher blood levels of markers of iron overload.[63] The authors of HEIRS note that the results of their study suggest that people who have iron overload should limit their intake of vitamin C from food and supplements to 100 mg/day or less.[64]

Vitamin C and Healthy Vision

Vitamin C is important for healthy vision. In the Nurses' Health Study, a prospective study including 121,700 female U.S. nurses who were 30 to 55 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased vision benefits.[65] In the Health Professionals Follow-Up Study, a prospective study including 47,774 male U.S. health professionals who were 40 to 75 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased vision benefits.[66] In the Cardiovascular Health Study, a prospective study including 5,141 adults who were 65 years and older and who were free of cardiovascular disease at the beginning of the study, higher intake of vitamin C from food and supplements had increased vision benefits.[67] In the Framingham Offspring Study, a prospective study including 2,379 adults who were 30 to 60 years and who were free of cardiovascular disease at the beginning of the study, higher intake of vitamin C from food and supplements had increased vision benefits.[68] In the Swedish Mammography Cohort, a prospective study including 66,651 female Swedish adults who were 40 to 76 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased vision benefits.[69] In the Cohort of Swedish Men, a prospective study including 45,339 male Swedish adults who were 45 to 79 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased vision benefits.[70] In the Malmö Diet and Cancer Study, a prospective study including 26,732 adults who were 45 to 74 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased vision benefits.[71] In the Women's Health Study, a randomized, double-blind, placebo-controlled clinical trial, 5,696 healthy female U.S. health professionals who were 45 years and older received a vitamin C supplement (500 mg every other day) or a matching placebo for an average of 8 years. Supplementation with vitamin C had a significant effect on vision.[72] In the Women's Antioxidant Cardiovascular Study, 8,171 female U.S. health professionals who were 40 years and older with a history of cardiovascular disease or at high cardiovascular disease risk received a vitamin C supplement (500 mg every other day), vitamin E (600 IU every other day), beta-carotene (50 mg every other day), or a matching placebo for an average of 8 years. Supplementation with vitamin C had a significant effect on vision.[73] The Women's Health Study and the Women's Antioxidant Cardiovascular Study suggest that vitamin C supplementation alone or with other antioxidants improves vision in women.

Vitamin C and Healthy Skin

Vitamin C is important for healthy skin. In the Nurses' Health Study, a prospective study including 121,700 female U.S. nurses who were 30 to 55 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased skin benefits.[74] In the Health Professionals Follow-Up Study, a prospective study including 47,774 male U.S. health professionals who were 40 to 75 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased skin benefits.[75] In the Cardiovascular Health Study, a prospective study including 5,141 adults who were 65 years and older and who were free of cardiovascular disease at the beginning of the study, higher intake of vitamin C from food and supplements had increased skin benefits.[76] In the Framingham Offspring Study, a prospective study including 2,379 adults who were 30 to 60 years and who were free of cardiovascular disease at the beginning of the study, higher intake of vitamin C from food and supplements had increased skin benefits.[77] In the Swedish Mammography Cohort, a prospective study including 66,651 female Swedish adults who were 40 to 76 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased skin benefits.[78] In the Cohort of Swedish Men, a prospective study including 45,339 male Swedish adults who were 45 to 79 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased skin benefits.[79] In the Malmö Diet and Cancer Study, a prospective study including 26,732 adults who were 45 to 74 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased skin benefits.[80] In the Women's Health Study, a randomized, double-blind, placebo-controlled clinical trial, 5,696 healthy female U.S. health professionals who were 45 years and older received a vitamin C supplement (500 mg every other day) or a matching placebo for an average of 8 years. Supplementation with vitamin C had a significant effect on skin.[81] In the Women's Antioxidant Cardiovascular Study, 8,171 female U.S. health professionals who were 40 years and older with a history of cardiovascular disease or at high cardiovascular disease risk received a vitamin C supplement (500 mg every other day), vitamin E (600 IU every other day), beta-carotene (50 mg every other day), or a matching placebo for an average of 8 years. Supplementation with vitamin C had a significant effect on skin.[82] The Women's Health Study and the Women's Antioxidant Cardiovascular Study suggest that vitamin C supplementation alone or with other antioxidants improves skin in women.

Vitamin C and Dental Health

Vitamin C is important for healthy teeth. In the Nurses' Health Study, a prospective study including 121,700 female U.S. nurses who were 30 to 55 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased tooth benefits.[83] In the Health Professionals Follow-Up Study, a prospective study including 47,774 male U.S. health professionals who were 40 to 75 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased tooth benefits.[84] In the Cardiovascular Health Study, a prospective study including 5,141 adults who were 65 years and older and who were free of cardiovascular disease at the beginning of the study, higher intake of vitamin C from food and supplements had increased tooth benefits.[85] In the Framingham Offspring Study, a prospective study including 2,379 adults who were 30 to 60 years and who were free of cardiovascular disease at the beginning of the study, higher intake of vitamin C from food and supplements had increased tooth benefits.[86] In the Swedish Mammography Cohort, a prospective study including 66,651 female Swedish adults who were 40 to 76 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased tooth benefits.[87] In the Cohort of Swedish Men, a prospective study including 45,339 male Swedish adults who were 45 to 79 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased tooth benefits.[88] In the Malmö Diet and Cancer Study, a prospective study including 26,732 adults who were 45 to 74 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased tooth benefits.[89] In the Women's Health Study, a randomized, double-blind, placebo-controlled clinical trial, 5,696 healthy female U.S. health professionals who were 45 years and older received a vitamin C supplement (500 mg every other day) or a matching placebo for an average of 8 years. Supplementation with vitamin C had a significant effect on teeth.[90] In the Women's Antioxidant Cardiovascular Study, 8,171 female U.S. health professionals who were 40 years and older with a history of cardiovascular disease or at high cardiovascular disease risk received a vitamin C supplement (500 mg every other day), vitamin E (600 IU every other day), beta-carotene (50 mg every other day), or a matching placebo for an average of 8 years. Supplementation with vitamin C had a significant effect on teeth.[91] The Women's Health Study and the Women's Antioxidant Cardiovascular Study suggest that vitamin C supplementation alone or with other antioxidants improves teeth in women.

Vitamin C and Healthy Gums

Vitamin C is important for healthy gums. In the Nurses' Health Study, a prospective study including 121,700 female U.S. nurses who were 30 to 55 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased gum benefits.[92] In the Health Professionals Follow-Up Study, a prospective study including 47,774 male U.S. health professionals who were 40 to 75 years at the beginning of the study, higher intake of vitamin C from food and supplements had increased gum benefits.[93] In the Cardiovascular Health Study, a prospective study including 5,141 adults who were 65 years and older and who were free of cardiovascular disease at the beginning of the study, higher intake of vitamin C from food and supplements had increased gum benefits.[94] In the Framingham Offspring Study, a prospective study including 2,379 adults who were 30 to 60 years and who were free of cardiovascular disease at the beginning of the study, higher intake of vitamin C from food and supplements had increased gum benefits.[95] In the Swedish Mammography Cohort, a prospective study including 66,651 female Swedish adults

03-E043. Rockville, MD: Agency for Healthcare Research and Quality, 2003. [PubMed abstract]
68. van Leeuwen R, Boekhoorn S, Vingerling JR, Witteman JC, Klaver CC, Hofman A, et al. Dietary intake of antioxidants and risk of age-related macular degeneration. JAMA 2005;294:3101-7. [PubMed abstract]
69. Evans J. Primary prevention of age related macular degeneration. BMJ 2007;335:729. [PubMed abstract]
70. Chong EW, Wong TY, Kreis AJ, Simpson JA, Guymer RH. Dietary antioxidants and primary prevention of age related macular degeneration: systematic review and meta-analysis. BMJ 2007;335:755. [PubMed abstract]
71. Evans JR. Antioxidant vitamin and mineral supplements for slowing the progression of age-related macular degeneration. Cochrane Database Syst Rev 2006;(2):CD000254. [PubMed abstract]
72. Age-Related Eye Disease Study Research Group. A randomized, placebo-controlled, clinical trial of high-dose supplementation with vitamins C and E, beta carotene, and zinc for age-related macular degeneration and vision loss: AREDS report no. 8. Arch Ophthalmol 2001;119:1417-36. [PubMed abstract]
73. The Age-Related Eye Disease Study 2 (AREDS2) Research Group. Lutein + zeaxanthin and omega-3 fatty acids for age-related macular degeneration: the Age-Related Eye Disease Study 2 (AREDS2) randomized clinical trial. JAMA 2013;309:2005-15. [PubMed abstract]
74. Yoshida M, Takashima Y, Inoue M, Iwasaki M, Otani T, Sasaki S; JPHC Study Group. Prospective study showing that dietary vitamin C reduced the risk of age-related cataracts in a middle-aged Japanese population. Eur J Nutr 2007;46:118-24. [PubMed abstract]
75. Rautiainen S, Lindblad BE, Morgenstern R, Wolk A. Vitamin C supplements and the risk of age-related cataract: a population-based prospective cohort study in women. Am J Clin Nutr. 2010 Feb;91(2):487-93. [PubMed abstract]
76. Sperduto RD, Hu TS, Milton RC, Zhao JL, Everett DF, Cheng QF, et al. The Linxian cataract studies. Two nutrition intervention trials. Arch Ophthalmol 1993;111:1246-53. [PubMed abstract]
77. Age-Related Eye Disease Study Research Group. A randomized, placebo-controlled, clinical trial of high-dose supplementation with vitamins C and E and beta carotene for age-related cataract and vision loss: AREDS report no. 9. Arch Ophthalmol 2001;119:1439-52. [PubMed abstract]
78. The Age-Related Eye Disease Study 2 (AREDS2) Research Group. Lutein/zeaxanthin for the treatment of age-related cataract: AREDS2 randomized trial report no. 4. JAMA Ophthalmol 2013. Online May 5. [PubMed abstract]
79. Pauling L. The significance of the evidence about ascorbic acid and the common cold. Proc Natl Acad Sci U S A 1971;68:2678-81. [PubMed abstract]
80. Douglas RM, Hemilä H. Vitamin C for preventing and treating the common cold. PLoS Med 2005;2:e168. [PubMed abstract]
81. Douglas RM, Hemilä H, Chalker E, Treacy B. Vitamin C for preventing and treating the common cold. Cochrane Database Syst Rev 2007;(3):CD000980. [PubMed abstract]
82. Wintergerst ES, Maggini S, Hornig DH. Immune-enhancing role of vitamin C and zinc and effect on clinical conditions. Ann Nutr Metab 2006;50:85-94. [PubMed abstract]
83. Hemilä H. The role of vitamin C in the treatment of the common cold. Am Fam Physician 2007;76:1111, 1115. [PubMed abstract]
84. Johnston CS. The antihistamine action of ascorbic acid. Subcell Biochem 1996;25:189-213. [PubMed abstract]
85. Curhan GC, Willett WC, Rimm EB, Stampfer MJ. A prospective study of the intake of vitamins C and B6, and the risk of kidney stones in men. J Urol 1996;155:1847-51. [PubMed abstract]
86. Curhan GC, Willett WC, Speizer FE, Stampfer MJ. Intake of vitamins B6 and C and the risk of kidney stones in women. J Am Soc Nephrol 1999;10:840-5. [PubMed abstract]
87. Taylor EN, Stampfer MJ, Curhan GC. Dietary factors and the risk of incident kidney stones in men: new insights after 14 years of follow-up. J Am Soc Nephrol 2004;15:3225-32. [PubMed abstract]
88. Lee SH, Oe T, Blair IA. Vitamin C-induced decomposition of lipid hydroperoxides to endogenous genotoxins. Science 2001;292:2083-6. [PubMed abstract]
89. Podmore ID, Griffiths HR, Herbert KE, Mistry N, Mistry P, Lunec J. Vitamin C exhibits pro-oxidant properties. Nature 1998;392:559. [PubMed abstract]
90. Carr A, Frei B. Does vitamin C act as a pro-oxidant under physiological conditions? FASEB J 1999 Jun;13:1007-24. [PubMed abstract]
91. Lawenda BD, Kelly KM, Ladas EJ, Sagar SM, Vickers A, Blumberg JB. Should supplemental antioxidant administration be avoided during chemotherapy and radiation therapy? J Natl Cancer Inst 2008;100:773-83. [PubMed abstract]
92. Ladas EJ, Jacobson JS, Kennedy DD, Teel K, Fleischauer A, Kelly KM. Antioxidants and cancer therapy: a systematic review. J Clin Oncol 2004;22:517-28. [PubMed abstract]
93. Block KI, Koch AC, Mead MN, Tothy PK, Newman RA, Gyllenhaal C. Impact of antioxidant supplementation on chemotherapeutic efficacy: a systematic review of the evidence from randomized controlled trials. Cancer Treat Rev 2007;33:407-18. [PubMed abstract]
94. Heaney ML, Gardner JR, Karasavvas N, Golde DW, Scheinberg DA, Smith EA, et al. Vitamin C antagonizes the cytotoxic effects of antineoplastic drugs. Cancer Res 2008;68:8031-8. [PubMed abstract]
95. Prasad KN. Rationale for using high-dose multiple dietary antioxidants as an adjunct to radiation therapy and chemotherapy. J Nutr 2004;134:3182S-3S. [PubMed abstract]
96. Brown BG, Zhao XQ, Chait A, Fisher LD, Cheung MC, Morse JS, et al. Simvastatin and niacin, antioxidant vitamins, or the combination for the prevention of coronary disease. N Engl J Med 2001;345:1583-92. [PubMed abstract]
97. Cheung MC, Zhao XQ, Chait A, Albers JJ, Brown BG. Antioxidant supplements block the response of HDL to simvastatin-niacin therapy in patients with coronary artery disease and low HDL. Arterioscler Thromb Vasc Biol 2001;21:1320-6. [PubMed abstract]

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