



Antioxidants and Health



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Antioxidants are man-made or natural substances that may prevent or delay some types of cell damage. Diets high in vegetables and fruits, which are good sources of antioxidants, have been found to be healthy; however, research has not shown antioxidant supplements to be beneficial in preventing diseases. Examples of antioxidants include vitamins C and E, selenium, and carotenoids, such as beta-carotene, lycopene, lutein, and zeaxanthin. This fact sheet provides basic information about antioxidants, summarizes what the science says about antioxidants and health, and suggests sources for additional information.

Key Points

- Vegetables and fruits are rich sources of antioxidants. There is good evidence that eating a diet that includes plenty of vegetables and fruits is healthy, and official U.S. Government policy urges people to eat more of these foods. Research has shown that people who eat more vegetables and fruits have lower risks of several diseases; however, it is not clear whether these results are related to the amount of antioxidants in vegetables and fruits, to other components of these foods, to other factors in people’s diets, or to other lifestyle choices.
- Rigorous scientific studies involving more than 100,000 people combined have tested whether antioxidant supplements can help prevent chronic diseases, such as cardiovascular diseases, cancer, and cataracts. In most instances, antioxidants did not reduce the risks of developing these diseases.
- Concerns have not been raised about the safety of antioxidants in food. However, high-dose supplements of antioxidants may be linked to health risks in some cases. Supplementing with high doses of beta-carotene may **increase** the risk of lung cancer in smokers. Supplementing with high doses of vitamin E may **increase** risks of prostate cancer and one type of stroke.
- Antioxidant supplements may interact with some medicines.
- Tell all of your health care providers about any complementary health approaches you use. Give them a full picture of what you do to manage your health. This will help ensure coordinated and safe care.

Antioxidants and Health

About Free Radicals, Oxidative Stress, and Antioxidants

Free radicals are highly unstable molecules that are naturally formed when you exercise and when your body converts food into energy. Your body can also be exposed to free radicals from a variety of environmental sources, such as cigarette smoke, air pollution, and sunlight. Free radicals can cause “oxidative stress,” a process that can trigger cell damage. Oxidative stress is thought to play a role in a variety of diseases including cancer, cardiovascular diseases, diabetes, Alzheimer’s disease, Parkinson’s disease, and eye diseases such as cataracts and age-related macular degeneration.

Antioxidant molecules have been shown to counteract oxidative stress in laboratory experiments (for example, in cells or animal studies). However, there is debate as to whether consuming large amounts of antioxidants in supplement form actually benefits health. There is also some concern that consuming antioxidant supplements in excessive doses may be harmful.

Vegetables and fruits are healthy foods and rich sources of antioxidants. Official U.S. Government policy urges people to eat more vegetables and fruits. Concerns have not been raised about the safety of any amounts of antioxidants in food. For more information on antioxidants in foods, visit the U.S. Department of Agriculture Web page on antioxidants and phytonutrients at www.nutrition.gov/whats-food/antioxidants-phytonutrients.

Use of Antioxidant Supplements in the United States

A 2009 analysis using data from the National Health and Nutrition Examination Survey (1999–2000 and 2001–2002) estimated the amounts of antioxidants adults in the United States get from foods and supplements. Supplements accounted for 54 percent of vitamin C, 64 percent of vitamin E, 14 percent of alpha- and beta-carotene, and 11 percent of selenium intake.

Safety

- High-dose antioxidant supplements may be harmful in some cases. For example, the results of some studies have linked the use of high-dose beta-carotene supplements to an increased risk of lung cancer in smokers and use of high-dose vitamin E supplements to increased risks of hemorrhagic stroke (a type of stroke caused by bleeding in the brain) and prostate cancer.
- Like some other dietary supplements, antioxidant supplements may interact with certain medications. For example, vitamin E supplements may increase the risk of bleeding in people who are taking anticoagulant drugs (“blood thinners”). There is conflicting evidence on the effects of taking antioxidant supplements during cancer treatment; some studies suggest that this may be beneficial, but others suggest that it may be harmful. The National Cancer Institute recommends that people who are being treated for cancer talk with their health care provider before taking supplements.

For more information about the safety of dietary supplements, see the National Center for Complementary and Integrative Health (NCCIH) fact sheet *Using Dietary Supplements Wisely* at nccih.nih.gov/health/supplements/wiseuse.htm.

Antioxidants and Health

What the Science Says

Several decades of dietary research findings suggested that consuming greater amounts of antioxidant-rich foods might help to protect against diseases. Because of these results, there has been a lot of research on antioxidant supplements. Rigorous trials of antioxidant supplements in large numbers of people have not found that high doses of antioxidant supplements prevent disease. This section describes the preliminary research findings, the results of the clinical trials, and possible explanations for the differences in study results.

Observational and Laboratory Studies

Observational studies on the typical eating habits, lifestyles, and health histories of large groups of people have shown that those who ate more vegetables and fruits had lower risks of several diseases, including cardiovascular disease, stroke, cancer, and cataracts. Observational studies can provide ideas about possible relationships between dietary or lifestyle factors and disease risk, but they cannot show that one factor causes another because they cannot account for other factors that may be involved. For example, people who eat more antioxidant-rich foods might also be more likely to exercise and less likely to smoke. It may be that these factors, rather than antioxidants, account for their lower disease risk.

Researchers have also studied antioxidants in laboratory experiments. These experiments showed that antioxidants interacted with free radicals and stabilized them, thus preventing the free radicals from causing cell damage.

Clinical Trials of Antioxidants

Because the results of such research seemed very promising, large, long-term studies—many of which were funded by the National Institutes of Health (NIH)—were conducted to test whether antioxidant supplements, when taken for periods of at least a few years, could help prevent diseases such as cardiovascular diseases and cancer in people. In these studies, volunteers were randomly assigned to take either an antioxidant or a placebo (an identical-looking product that did not contain the antioxidant). The research was conducted in a double-blind manner (neither the study participants nor the investigators knew which product was being taken). Studies of this type—called clinical trials—are designed to provide clear answers to specific questions about how a substance affects people's health.

Among the earliest of these studies were three large NIH-sponsored trials of high-dose supplements of beta-carotene, alone or in combination with other nutrients. These trials, completed in the mid-1990s, all showed that beta-carotene did not protect against cancer or cardiovascular disease. In one trial, beta-carotene supplements increased the risk of lung cancer in smokers, and in another trial, supplements containing both beta-carotene and vitamin A had the same effect.

More recent studies have also found that in most instances antioxidant supplements did not help to prevent disease. For example:

- The Women's Health Study, which included almost 40,000 healthy women at least 45 years of age, found that vitamin E supplements did not reduce the risk of heart attack, stroke, cancer, age-related macular degeneration, or cataracts. Although vitamin E supplements were associated with fewer deaths from cardiovascular causes, they did not reduce the overall death rate of study participants.

Antioxidants and Health

- The Women’s Antioxidant Cardiovascular Study found no beneficial effects of vitamin C, vitamin E, or beta-carotene supplements on cardiovascular events (heart attack, stroke, or death from cardiovascular diseases) or the likelihood of developing diabetes or cancer in more than 8,000 female health professionals, aged 40 years or older, who were at high risk for cardiovascular disease. Antioxidant supplements also did not slow changes in cognitive function among women in this study who were aged 65 or older.
- The Physicians’ Health Study II, which included more than 14,000 male physicians aged 50 or older, found that neither vitamin E nor vitamin C supplements reduced the risk of major cardiovascular events (heart attack, stroke, or death from cardiovascular disease), cancer, or cataracts. In fact, vitamin E supplements were associated with an increased risk of hemorrhagic stroke in this study.
- The Selenium and Vitamin E Cancer Prevention Trial (SELECT)—a study of more than 35,000 men aged 50 or older—found that selenium and vitamin E supplements, taken alone or together, did not prevent prostate cancer. A 2011 updated analysis from this trial, based on a longer followup period of study participants, concluded that vitamin E supplements increased the occurrence of prostate cancer by 17 percent in men who received the vitamin E supplement alone compared with those who received placebo. There was no increase in prostate cancer when vitamin E and selenium were taken together.

Unlike the studies described above, the Age-Related Eye Disease Study (AREDS), led by the National Eye Institute and cosponsored by other components of NIH, including NCCIH, found a beneficial effect of antioxidant supplements. This study showed that a combination of antioxidants (vitamin C, vitamin E, and beta-carotene) and zinc reduced the risk of developing the advanced stage of age-related macular degeneration by 25 percent in people who had the intermediate stage of this disease or who had the advanced stage in only one eye. Antioxidant supplements used alone reduced the risk by about 17 percent. In the same study, however, antioxidants did not help to prevent cataracts or slow their progression.

- A followup study, AREDS2, found that adding omega-3 fatty acids (fish oil) to the combination of supplements did not improve its effectiveness. However, adding lutein and zeaxanthin (two carotenoids found in the eye) improved the supplement’s effectiveness in people who were not taking beta-carotene and those who consumed only small amounts of lutein and zeaxanthin in foods.

Why Don’t Antioxidant Supplements Work?

Most clinical studies of antioxidant supplements have not found them to provide substantial health benefits. Researchers have suggested several reasons for this, including the following:

- The beneficial health effects of a diet high in vegetables and fruits or other antioxidant-rich foods may actually be caused by other substances present in the same foods, other dietary factors, or other lifestyle choices rather than antioxidants.
- The effects of the large doses of antioxidants used in supplementation studies may be different from those of the smaller amounts of antioxidants consumed in foods.
- Differences in the chemical composition of antioxidants in foods versus those in supplements may influence their effects. For example, eight chemical forms of vitamin E are present in foods. Vitamin E supplements, on the other hand, typically include only one of these forms—alpha-tocopherol. Alpha-tocopherol also has been used in almost all research studies on vitamin E.

Antioxidants and Health

- For some diseases, specific antioxidants might be more effective than the ones that have been tested. For example, to prevent eye diseases, antioxidants that are present in the eye, such as lutein, might be more beneficial than those that are not found in the eye, such as beta-carotene.
- The relationship between free radicals and health may be more complex than has previously been thought. Under some circumstances, free radicals actually may be beneficial rather than harmful, and removing them may be undesirable.
- The antioxidant supplements may not have been given for a long enough time to prevent chronic diseases, such as cardiovascular diseases or cancer, which develop over decades.
- The participants in the clinical trials discussed above were either members of the general population or people who were at high risk for particular diseases. They were not necessarily under increased oxidative stress. Antioxidants might help to prevent diseases in people who are under increased oxidative stress even if they don't prevent them in other people.

If You Are Considering Antioxidant Supplements

- Do not use antioxidant supplements to replace a healthy diet or conventional medical care, or as a reason to postpone seeing a health care provider about a medical problem.
- If you have age-related macular degeneration, consult your health care providers to determine whether supplements of the type used in the AREDS trial are appropriate for you.
- If you are considering a dietary supplement, first get information on it from reliable sources. Keep in mind that dietary supplements may interact with medications or other supplements and may contain ingredients not listed on the label. Your health care provider can advise you. If you are pregnant or nursing a child, or if you are considering giving a child a dietary supplement, it is especially important to consult your (or your child's) health care provider.
- Tell all of your health care providers about any complementary or integrative health approaches you use. Give them a full picture of what you do to manage your health. This will help ensure coordinated and safe care.

NCCIH- and NIH-Funded Research

Researchers supported by NCCIH and other components of NIH are conducting a variety of studies using antioxidant supplements.

Topics of recent NCCIH research on antioxidants include:

- The ways in which two chemical forms of vitamin E affect inflammation
- The biological effects of selenium on immune function
- The effects of a range of doses of alpha-lipoic acid on oxidative stress
- The effects of alpha-lipoic acid and acetyl-L-carnitine on inflammation in people with sickle cell disease.

NCCIH also funds a center of excellence for research on antioxidant therapies, which is conducting studies on the effects of antioxidants on various diseases and on aging.

Antioxidants and Health

Other components of NIH are also sponsoring research on antioxidants. Recent topics include:

- The effects of antioxidant therapy in Alzheimer’s disease
- The roles of oxidation and antioxidants in breast cancer risk
- Whether antioxidants from pomegranate can help prevent or treat prostate cancer
- Whether anthocyanins (a group of antioxidants from berries) can help prevent esophageal cancer.

For More Information

NCCIH Clearinghouse

The NCCIH Clearinghouse provides information on NCCIH and complementary and integrative health approaches, including publications and searches of Federal databases of scientific and medical literature. The Clearinghouse does not provide medical advice, treatment recommendations, or referrals to practitioners.

Toll-free in the U.S.: 1-888-644-6226

TTY (for deaf and hard-of-hearing callers): 1-866-464-3615

Web site: nccih.nih.gov

E-mail: info@nccih.nih.gov

PubMed®

A service of the National Library of Medicine, PubMed contains publication information and (in most cases) brief summaries of articles from scientific and medical journals.

Web site: www.ncbi.nlm.nih.gov/pubmed

NIH Clinical Research Trials and You

NIH has created a Web site, NIH Clinical Research Trials and You, to help people learn about clinical trials, why they matter, and how to participate. The site includes questions and answers about clinical trials, guidance on how to find clinical trials through ClinicalTrials.gov and other resources, and stories about the personal experiences of clinical trial participants. Clinical trials are necessary to find better ways to prevent, diagnose, and treat diseases.

Web site: www.nih.gov/health/clinicaltrials/

Research Portfolio Online Reporting Tools Expenditures & Results (RePORTER)

RePORTER is a database of information on federally funded scientific and medical research projects being conducted at research institutions.

Web site: projectreporter.nih.gov/reporter.cfm

Antioxidants and Health

MedlinePlus

To provide resources that help answer health questions, MedlinePlus (a service of NLM) brings together authoritative information from NIH as well as other Government agencies and health-related organizations.

Web site: www.medlineplus.gov

Antioxidants: www.nlm.nih.gov/medlineplus/antioxidants.html

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Antioxidants and Health

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