

SEE QUICKFACTS **FOR EASY-TO-READ FACTS ABOUT VITAMIN E.**

Vitamin E is found naturally in some foods, added to others, and available as a dietary supplement. "Vitamin E" is the collective name for a group of fat-soluble compounds with distinctive antioxidant activities [1].

Naturally occurring vitamin E exists in eight chemical forms (alpha-, beta-, gamma-, and delta-tocopherol and alpha-, beta-, gamma-, and delta-tocotrienol) that have varying levels of biological activity [1]. Alpha- (or α -) tocopherol is the only form that is recognized to meet human requirements. Serum concentrations of vitamin E (alpha-tocopherol) depend on the liver, which takes up the nutrient after the various forms are absorbed from the small intestine. The liver preferentially resecretes only alpha-tocopherol via the hepatic alpha-tocopherol transfer protein [1]; the liver metabolizes and excretes the other vitamin E forms [2]. As a result, blood and cellular concentrations of other forms of vitamin E are lower than those of alpha-tocopherol and have been the subjects of less research [3,4].

Antioxidants protect cells from the damaging effects of free radicals, which are molecules that contain an unshared electron. Free radicals damage cells and might contribute to the development of cardiovascular disease and cancer [5]. Unshared electrons are highly energetic and react rapidly with oxygen to form reactive oxygen species (ROS). The body forms ROS endogenously when it converts food to energy, and antioxidants might protect cells from the damaging effects of ROS. The body is also exposed to free radicals from environmental exposures, such as cigarette smoke, air pollution, and ultraviolet radiation from the sun. ROS are part of signaling mechanisms among cells.

Vitamin E is a fat-soluble antioxidant that stops the production of ROS formed when fat undergoes oxidation. Scientists are investigating whether, by limiting free-radical production and possibly through other mechanisms, vitamin E might help prevent or delay the chronic diseases associated with free radicals.

In addition to its activities as an antioxidant, vitamin E is involved in immune function and, as shown primarily by *in vitro* studies of cells, cell signaling, regulation of gene expression, and other metabolic processes [1]. Alpha-tocopherol inhibits the activity of protein kinase C, an enzyme involved in cell proliferation and differentiation in smooth muscle cells, platelets, and

monocytes [6]. Vitamin-E-replete endothelial cells lining the interior surface of blood vessels are better able to resist blood-cell components adhering to this surface. Vitamin E also increases the expression of two enzymes that suppress arachidonic acid metabolism, thereby increasing the release of prostacyclin from the endothelium, which, in turn, dilates blood vessels and inhibits platelet aggregation [6].

Recommended Intakes

Intake recommendations for vitamin E and other nutrients are provided in the Dietary Reference Intakes (DRIs) developed by the Food and Nutrition Board (FNB) at the Institute of Medicine of The National Academies (formerly National Academy of Sciences) [6]. DRI is the general term for a set of reference values used to plan and assess nutrient intakes of healthy people. These values, which vary by age and gender, include:

- Recommended Dietary Allowance (RDA): average daily level of intake sufficient to meet the nutrient requirements of nearly all (97%–98%) healthy people.
- Adequate Intake (AI): established when evidence is insufficient to develop an RDA and is set at a level assumed to ensure nutritional adequacy.
- Tolerable Upper Intake Level (UL): maximum daily intake unlikely to cause adverse health effects [6].

The FNB's vitamin E recommendations are for alpha-tocopherol alone, the only form maintained in plasma. The FNB based these recommendations primarily on serum levels of the nutrient that provide adequate protection in a test measuring the survival of erythrocytes when exposed to hydrogen peroxide, a free radical [6]. Acknowledging "great uncertainties" in these data, the FNB has called for research to identify other biomarkers for assessing vitamin E requirements.

RDAs for vitamin E are provided in milligrams (mg) and are listed in Table 1. Because insufficient data are available to develop RDAs for infants, AIs were developed based on the amount of vitamin E consumed by healthy breastfed babies.

At present, the vitamin E content of foods and dietary supplements is listed on labels in international units (IUs), a measure of biological activity rather than quantity. Naturally sourced vitamin E is called d-alpha-tocopherol; the

synthetically produced form is dl-alpha-tocopherol. Conversion rules are as follows:

- To convert from mg to IU: 1 mg of alpha-tocopherol is equivalent to 1.49 IU of the natural form or 2.22 IU of the synthetic form.
- To convert from IU to mg: 1 IU of alpha-tocopherol is equivalent to 0.67 mg of the natural form or 0.45 mg of the synthetic form.

Table 1 lists the RDAs for alpha-tocopherol in both mg and IU of the natural form; for example, 15 mg x 1.49 IU/mg = 22.4 IU. The corresponding value for synthetic alpha-tocopherol would be 33.3 IU (15 mg x 2.22 IU/mg).

Table 1: Recommended Dietary Allowances (RDAs) for Vitamin E (Alpha-Tocopherol) [6]

Age	Males	Females	Pregnancy	Lactation
0–6 months*	4 mg (6 IU)	4 mg (6 IU)		
7–12 months*	5 mg (7.5 IU)	5 mg (7.5 IU)		
1–3 years	6 mg (9 IU)	6 mg (9 IU)		
4–8 years	7 mg (10.4 IU)	7 mg (10.4 IU)		
9–13 years	11 mg (16.4 IU)	11 mg (16.4 IU)		
14+ years	15 mg (22.4 IU)	15 mg (22.4 IU)	15 mg (22.4 IU)	19 mg (28.4 IU)

*Adequate Intake (AI)

Sources of Vitamin E

Food

Numerous foods provide vitamin E. Nuts, seeds, and vegetable oils are among the best sources of alpha-tocopherol, and significant amounts are available in green leafy vegetables and fortified cereals (see Table 2 for a more detailed list) [7]. Most vitamin E in American diets is in the form of gamma-tocopherol from soybean, canola, corn, and other vegetable oils and food products [4].

Table 2: Selected Food Sources of Vitamin E (Alpha-Tocopherol) [7]

Food	Milligrams (mg) per serving	Percent DV*
Wheat germ oil, 1 tablespoon	20.3	100
Sunflower seeds, dry roasted, 1 ounce	7.4	37
Almonds, dry roasted, 1 ounce	6.8	34
Sunflower oil, 1 tablespoon	5.6	28
Safflower oil, 1 tablespoon	4.6	25
Hazelnuts, dry roasted, 1 ounce	4.3	22
Peanut butter, 2 tablespoons	2.9	15
Peanuts, dry roasted, 1 ounce	2.2	11
Corn oil, 1 tablespoon	1.9	10
Spinach, boiled, ½ cup	1.9	10
Broccoli, chopped, boiled, ½ cup	1.2	6
Soybean oil, 1 tablespoon	1.1	6
Kiwifruit, 1 medium	1.1	6
Mango, sliced, ½ cup	0.7	4
Tomato, raw, 1 medium	0.7	4
Spinach, raw, 1 cup	0.6	3

*DV = Daily Value. DVs were developed by the U.S. Food and Drug Administration (FDA) to help consumers compare the nutrient content of different foods within the context of a total diet. The DV for vitamin E is 30 IU (approximately 20 mg of natural alpha-tocopherol) for adults and children age 4 and older. However, the FDA does not require food labels to list vitamin E content unless a food has been fortified with this nutrient. Foods providing 20% or more of the DV are considered to be high sources of a nutrient, but foods providing lower percentages of the DV also contribute to a healthful diet.

The U.S. Department of Agriculture's (USDA's) [Nutrient Database](#) Web site lists the nutrient content of many foods, including, in some cases, the amounts of alpha-, beta-, gamma-, and delta-tocopherol. The USDA also provides a [comprehensive list of foods](#) containing vitamin E.

Dietary supplements

Supplements of vitamin E typically provide only alpha-tocopherol, although "mixed" products containing other tocopherols and even tocotrienols are available. Naturally occurring alpha-tocopherol exists in one stereoisomeric

form. In contrast, synthetically produced alpha-tocopherol contains equal amounts of its eight possible stereoisomers; serum and tissues maintain only four of these stereoisomers [6]. A given amount of synthetic alpha-tocopherol (listed on labels as "DL" or "dl") is therefore only half as active as the same amount (by weight in mg) of the natural form (labeled as "D" or "d"). People need approximately 50% more IU of synthetic alpha tocopherol from dietary supplements and fortified foods to obtain the same amount of the nutrient as from the natural form.

Most vitamin-E-only supplements provide ≥ 100 IU of the nutrient. These amounts are substantially higher than the RDAs. The 1999–2000 National Health and Nutrition Examination Survey (NHANES) found that 11.3% of adults took vitamin E supplements containing at least 400 IU [8].

Alpha-tocopherol in dietary supplements and fortified foods is often esterified to prolong its shelf life while protecting its antioxidant properties. The body hydrolyzes and absorbs these esters (alpha-tocopheryl acetate and succinate) as efficiently as alpha-tocopherol [6].

Vitamin E Intakes and Status

Three national surveys—the 2001–2002 NHANES [9], NHANES III (1988–1994) [9], and the Continuing Survey of Food Intakes by Individuals (1994–1996) [10]—have found that the diets of most Americans provide less than the RDA levels of vitamin E. These intake estimates might be low, however, because the amounts and types of fat added during cooking are often unknown and not accounted for [6].

The FNB suggests that mean intakes of vitamin E among healthy adults are probably higher than the RDA but cautions that low-fat diets might provide insufficient amounts unless people make their food choices carefully by, for example, increasing their intakes of nuts, seeds, fruits, and vegetables [6,9].

Vitamin E Deficiency

Frank vitamin E deficiency is rare and overt deficiency symptoms have not been found in healthy people who obtain little vitamin E from their diets [6]. Premature babies of very low birth weight (<1,500 grams) might be deficient in vitamin E. Vitamin E supplementation in these infants might reduce the risk of some complications, such as those affecting the retina, but they can also increase the risk of infections [11].

Because the digestive tract requires fat to absorb vitamin E, people with fat-malabsorption disorders are more likely to become deficient than people

without such disorders. Deficiency symptoms include peripheral neuropathy, ataxia, skeletal myopathy, retinopathy, and impairment of the immune response [6,12]. People with Crohn's disease, cystic fibrosis, or an inability to secrete bile from the liver into the digestive tract, for example, often pass greasy stools or have chronic diarrhea; as a result, they sometimes require water-soluble forms of vitamin E, such as tocopheryl polyethylene glycol-1000 succinate [1].

Some people with abetalipoproteinemia, a rare inherited disorder resulting in poor absorption of dietary fat, require enormous doses of supplemental vitamin E (approximately 100 mg/kg or 5–10 g/day) [1]. Vitamin E deficiency secondary to abetalipoproteinemia causes such problems as poor transmission of nerve impulses, muscle weakness, and retinal degeneration that leads to blindness [13]. Ataxia and vitamin E deficiency (AVED) is another rare, inherited disorder in which the liver's alpha-tocopherol transfer protein is defective or absent. People with AVED have such severe vitamin E deficiency that they develop nerve damage and lose the ability to walk unless they take large doses of supplemental vitamin E [14].

Vitamin E and Health

Many claims have been made about vitamin E's potential to promote health and prevent and treat disease. The mechanisms by which vitamin E might provide this protection include its function as an antioxidant and its roles in anti-inflammatory processes, inhibition of platelet aggregation, and immune enhancement.

A primary barrier to characterizing the roles of vitamin E in health is the lack of validated biomarkers for vitamin E intake and status to help relate intakes to valid predictors of clinical outcomes [6]. This section focuses on four diseases and disorders in which vitamin E might be involved: heart disease, cancer, eye disorders, and cognitive decline.

Coronary heart disease

Evidence that vitamin E could help prevent or delay coronary heart disease (CHD) comes from several sources. *In vitro* studies have found that the nutrient inhibits oxidation of low-density lipoprotein (LDL) cholesterol, thought to be a crucial initiating step for atherosclerosis [6]. Vitamin E might also help prevent the formation of blood clots that could lead to a heart attack or venous thromboembolism [15].

Several observational studies have associated lower rates of heart disease with higher vitamin E intakes. One study of approximately 90,000 nurses

found that the incidence of heart disease was 30% to 40% lower in those with the highest intakes of vitamin E, primarily from supplements [16]. Among a group of 5,133 Finnish men and women followed for a mean of 14 years, higher vitamin E intakes from food were associated with decreased mortality from CHD [17].

However, randomized clinical trials cast doubt on the efficacy of vitamin E supplements to prevent CHD [18]. For example, the Heart Outcomes Prevention Evaluation (HOPE) study, which followed almost 10,000 patients at high risk of heart attack or stroke for 4.5 years [19], found that participants taking 400 IU/day of natural vitamin E experienced no fewer cardiovascular events or hospitalizations for heart failure or chest pain than participants taking a placebo. In the HOPE-TOO followup study, almost 4,000 of the original participants continued to take vitamin E or placebo for an additional 2.5 years [20]. HOPE-TOO found that vitamin E provided no significant protection against heart attacks, strokes, unstable angina, or deaths from cardiovascular disease or other causes after 7 years of treatment. Participants taking vitamin E, however, were 13% more likely to experience, and 21% more likely to be hospitalized for, heart failure, a statistically significant but unexpected finding not reported in other large studies.

The HOPE and HOPE-TOO trials provide compelling evidence that moderately high doses of vitamin E supplements do not reduce the risk of serious cardiovascular events among men and women >50 years of age with established heart disease or diabetes [21]. These findings are supported by evidence from the Women's Angiographic Vitamin and Estrogen study, in which 423 postmenopausal women with some degree of coronary stenosis took supplements with 400 IU vitamin E (type not specified) and 500 mg vitamin C twice a day or placebo for >4 years [22]. Not only did the supplements provide no cardiovascular benefits, but all-cause mortality was significantly higher in the women taking the supplements.

The latest published clinical trial of vitamin E's effects on the heart and blood vessels of women included almost 40,000 healthy women ≥ 45 years of age who were randomly assigned to receive either 600 IU of natural vitamin E on alternate days or placebo and who were followed for an average of 10 years [23]. The investigators found no significant differences in rates of overall cardiovascular events (combined nonfatal heart attacks, strokes, and cardiovascular deaths) or all-cause mortality between the groups. However, the study did find two positive and significant results for women taking vitamin E: they had a 24% reduction in cardiovascular death rates, and those

≥65 years of age had a 26% decrease in nonfatal heart attack and a 49% decrease in cardiovascular death rates.

The most recent published clinical trial of vitamin E and men's cardiovascular health included almost 15,000 healthy physicians ≥50 years of age who were randomly assigned to receive 400 IU synthetic alpha-tocopherol every other day, 500 mg vitamin C daily, both vitamins, or placebo [24]. During a mean followup period of 8 years, intake of vitamin E (and/or vitamin C) had no effect on the incidence of major cardiovascular events, myocardial infarction, stroke, or cardiovascular mortality. Furthermore, use of vitamin E was associated with a significantly increased risk of hemorrhagic stroke.

In general, clinical trials have not provided evidence that routine use of vitamin E supplements prevents cardiovascular disease or reduces its morbidity and mortality. However, participants in these studies have been largely middle-aged or elderly individuals with demonstrated heart disease or risk factors for heart disease. Some researchers have suggested that understanding the potential utility of vitamin E in preventing CHD might require longer studies in younger participants taking higher doses of the supplement [25]. Further research is needed to determine whether supplemental vitamin E has any protective value for younger, healthier people at no obvious risk of CHD.

Cancer

Antioxidant nutrients like vitamin E protect cell constituents from the damaging effects of free radicals that, if unchecked, might contribute to cancer development [7]. Vitamin E might also block the formation of carcinogenic nitrosamines formed in the stomach from nitrites in foods and protect against cancer by enhancing immune function [26]. Unfortunately, human trials and surveys that have attempted to associate vitamin E intake with cancer incidence have found that vitamin E is not beneficial in most cases.

Both the HOPE-TOO Trial and Women's Health Study evaluated whether vitamin E supplements might protect people from cancer. HOPE-TOO, which followed men and women ≥55 years of age with heart disease or diabetes for 7 years, found no significant differences in the number of new cancers or cancer deaths between individuals randomly assigned to take 400 IU/day vitamin E or a placebo [20]. In the Women's Health Study, in which healthy women ≥45 years of age received either 600 IU vitamin E every other day or a placebo for 10 years, the supplement did not reduce the risk of developing any form of cancer [23].

Several studies have examined whether vitamin E intake and/or supplemental vitamin E affects the risk of developing prostate cancer. A prospective cohort study of >29,000 men found no association between dietary or supplemental vitamin E intake and prostate cancer risk [27]. However, among current smokers and men who had quit, vitamin E intakes of more than 400 IU/day were associated with a statistically significant 71% reduction in the risk of advanced prostate cancer. In a clinical trial involving 29,133 male smokers, men randomly assigned to take daily supplements of 50 IU synthetic vitamin E for 5–8 years had 32% fewer prostate cancers compared to subjects who did not take the supplements [28]. Based in part on the promising results of this study, a large randomized clinical trial, called the SELECT trial, began in 2001 to determine whether 7–12 years of daily supplementation with synthetic vitamin E (400 IU, as dl-alpha-tocopheryl acetate), with or without selenium (200 mcg, as L-selenomethionine), reduced the number of new prostate cancers in 35,533 healthy men age 50 and older. The trial was discontinued in October 2008 when an analysis found that the supplements, taken alone or together for about 5.5 years, did not prevent prostate cancer [29]. Results from an additional 1.5 years of follow-up from this trial (during which the subjects no longer received vitamin E or selenium), showed that the men who had taken the vitamin E had a 17 percent increased risk of prostate cancer compared to men only taking placebos, a statistically significant difference [30]. The risk of developing prostate cancer was also slightly increased in subjects taking vitamin E plus selenium or selenium alone, but the differences were not statistically significant. No differences were found among groups in the incidence of lung or colorectal cancers or all cancers combined. Study staff members will continue to monitor participants' health for up to 5 more years. The National Cancer Institute web site provides [additional information on the SELECT trial](#).

One study of women in Iowa provides evidence that higher intakes of vitamin E from foods and supplements could decrease the risk of colon cancer, especially in women <65 years of age [31]. The overall relative risk for the highest quintile of intake (>35.7 IU/day) compared to the lowest quintile (<5.7 IU/day) was 0.32. However, prospective cohort studies of 87,998 women in the Nurses' Health Study and 47,344 men in the Health Professionals Follow-up Study failed to replicate these results [32]. Although some research links higher intakes of vitamin E with decreased incidence of breast cancer, an examination of the impact of dietary factors, including

vitamin E, on the incidence of postmenopausal breast cancer in >18,000 women found no benefit from the vitamin [33].

The American Cancer Society conducted an epidemiologic study examining the association between use of vitamin C and vitamin E supplements and bladder cancer mortality. Of the almost one million adults followed between 1982 and 1998, adults who took supplemental vitamin E for 10 years or longer had a reduced risk of death from bladder cancer [34]; vitamin C supplementation provided no protection.

Evidence to date is insufficient to support taking vitamin E to prevent cancer. In fact, daily use of large-dose vitamin E supplements (400 IU) may increase the risk of prostate cancer.

Eye disorders

Age-related macular degeneration (AMD) and cataracts are among the most common causes of significant vision loss in older people. Their etiologies are usually unknown, but the cumulative effects of oxidative stress have been postulated to play a role. If so, nutrients with antioxidant functions, such as vitamin E, could be used to prevent or treat these conditions.

Prospective cohort studies have found that people with relatively high dietary intakes of vitamin E (e.g., 30 IU/day) have an approximately 20% lower risk of developing AMD than people with low intakes (e.g., <15 IU/day) [35,36]. However, two randomized controlled trials in which participants took supplements of vitamin E (500 IU/day d-alpha-tocopherol in one study [37] and 111 IU/day dl-alpha-tocopheryl acetate combined with 20 mg/day beta-carotene in the other [38]) or a placebo failed to show a protective effect for vitamin E on AMD. The Age-Related Eye Disease Study (AREDS), a large randomized clinical trial, revealed that participants with early-stage AMD could slow the progression of their disease by taking a daily supplement of vitamin E (400 IU dl-alpha-tocopheryl acetate), vitamin C (500 mg), beta-carotene (15 mg), zinc (80 mg), and copper (2 mg) for an average of 6.3 years compared to participants taking a placebo [39].

Several observational studies have revealed a potential relationship between vitamin E supplements and the risk of cataract formation. One prospective cohort study found that lens clarity was superior in participants who took vitamin E supplements and those with higher blood levels of the vitamin [40]. In another study, long-term use of vitamin E supplements was associated with slower progression of age-related lens opacification [41]. However, in the randomized AREDS study, the use of the vitamin E-containing supplement

package had no apparent effect on the development or progression of cataracts over 7 years [42].

Overall, the available evidence is inconsistent with respect to whether vitamin E supplements, taken alone or in combination with other antioxidants, can reduce the risk of developing AMD or cataracts. However, the formulation of vitamin E, other antioxidants, zinc, and copper used in AREDS holds promise for slowing the progression of AMD in people with early-stage disease. Additional information about the dietary supplements used in AREDS is available. AREDS 2, a followup study, will determine whether a modified combination of dietary supplements can further slow the progression of vision loss from AMD.

Cognitive decline

The brain has a high oxygen consumption rate and abundant polyunsaturated fatty acids in the neuronal cell membranes. Researchers hypothesize that if cumulative free-radical damage to neurons over time contributes to cognitive decline and neurodegenerative diseases, such as Alzheimer's disease, then ingestion of sufficient or supplemental antioxidants (such as vitamin E) might provide some protection [43]. This hypothesis was supported by the results of a clinical trial in 341 patients with Alzheimer's disease of moderate severity who were randomly assigned to receive a placebo, vitamin E (2,000 IU/day dl-alpha-tocopherol), a monoamine oxidase inhibitor (selegiline), or vitamin E and selegiline [43]. Over 2 years, treatment with vitamin E and selegiline, separately or together, significantly delayed functional deterioration and the need for institutionalization compared to placebo. However, participants taking vitamin E experienced significantly more falls.

Vitamin E consumption from foods or supplements was associated with less cognitive decline over 3 years in a prospective cohort study of elderly, free-living individuals aged 65–102 years [44]. However, a clinical trial in primarily healthy older women who were randomly assigned to receive 600 IU d-alpha-tocopherol every other day or a placebo for ≤ 4 years found that the supplements provided no apparent cognitive benefits [45]. Another trial in which 769 men and women with mild cognitive impairment were randomly assigned to receive 2,000 IU/day vitamin E (type not specified), a cholinesterase inhibitor (donepezil), or placebo found no significant differences in the progression rate of Alzheimer's disease between the vitamin E and placebo groups [46]

In summary, most research results do not support the use of vitamin E supplements by healthy or mildly impaired individuals to maintain cognitive

performance or slow its decline with normal aging [47]. More research is needed to identify the role of vitamin E, if any, in the management of cognitive impairment [48].

Health Risks from Excessive Vitamin E

Research has not found any adverse effects from consuming vitamin E in food [6]. However, high doses of alpha-tocopherol supplements can cause hemorrhage and interrupt blood coagulation in animals, and *in vitro* data suggest that high doses inhibit platelet aggregation. Two clinical trials have found an increased risk of hemorrhagic stroke in participants taking alpha-tocopherol; one trial included Finnish male smokers who consumed 50 mg/day for an average of 6 years [49] and the other trial involved a large group of male physicians in the United States who consumed 400 IU every other day for 8 years [24]. Because the majority of physicians in the latter study were also taking aspirin, this finding could indicate that vitamin E has a tendency to cause bleeding.

The FNB has established ULs for vitamin E based on the potential for hemorrhagic effects (see Table 3). The ULs apply to all forms of supplemental alpha-tocopherol, including the eight stereoisomers present in synthetic vitamin E. Doses of up to 1,000 mg/day (1,500 IU/day of the natural form or 1,100 IU/day of the synthetic form) in adults appear to be safe, although the data are limited and based on small groups of people taking at least 2,000 IU for a few weeks or months. Long-term intakes above the UL increase the risk of adverse health effects [6]. Vitamin E ULs for infants have not been established.

Table 3: Tolerable Upper Intake Levels (ULs) for Vitamin E [6]

Age	Male	Female	Pregnancy	Lactation
1–3 years	200 mg (300 IU)	200 mg (300 IU)		
4–8 years	300 mg (450 IU)	300 mg (450 IU)		
9–13 years	600 mg (900 IU)	600 mg (900 IU)		
14–18 years	800 mg (1,200 IU)	800 mg (1,200 IU)	800 mg (1,200 IU)	800 mg (1,200 IU)
19+ years	1,000 mg (1,500 IU)	1,000 mg (1,500 IU)	1,000 mg (1,500 IU)	1,000 mg (1,500 IU)

Two meta-analyses of randomized trials have also raised questions about the safety of large doses of vitamin E, including doses lower than the UL. These meta-analyses linked supplementation to small but statistically significant increases in all-cause mortality. One analysis found an increased risk of death at doses of 400 IU/day, although the risk began to increase at 150 IU [50]. In the other analysis of studies of antioxidant supplements for disease prevention, the highest quality trials revealed that vitamin E, administered singly (dose range 10 IU–5,000 IU/day; mean 569 IU) or combined with up to four other antioxidants, significantly increased mortality risk [51]. The implications of these analyses for the potential adverse effects of high-dose vitamin E supplements are unclear [52-55]. Participants in the studies included in these analyses were typically middle-aged or older and had chronic diseases or related risk factors. These participants often consumed other supplements in addition to vitamin E. Some of the studies analyzed took place in developing countries in which nutritional deficiencies are common. A review of the subset of studies in which vitamin E supplements were given to healthy individuals for the primary prevention of chronic disease found no convincing evidence that the supplements increased mortality [56]. However, results from the recently published, large SELECT trial show that vitamin E supplements (400 IU/day) may harm adult men in the general population by increasing their risk of prostate cancer [30]. Follow-up studies are assessing whether the cancer risk was associated with baseline blood levels of vitamin E and selenium prior to supplementation as well as whether changes in one or more genes might increase a man's risk of developing prostate cancer while taking vitamin E.

Interactions with Medications

Vitamin E supplements have the potential to interact with several types of medications. A few examples are provided below. People taking these and other medications on a regular basis should discuss their vitamin E intakes with their healthcare providers.

Anticoagulant and antiplatelet medications

Vitamin E can inhibit platelet aggregation and antagonize vitamin K-dependent clotting factors. As a result, taking large doses with anticoagulant or antiplatelet medications, such as warfarin (Coumadin®), can increase the risk of bleeding, especially in conjunction with low vitamin K intake. The amounts of supplemental vitamin E needed to produce clinically significant effects are unknown but probably exceed 400 IU/day [57].

Simvastatin and niacin

Some people take vitamin E supplements with other antioxidants, such as vitamin C, selenium, and beta-carotene. This collection of antioxidant ingredients blunted the rise in high-density lipoprotein (HDL) cholesterol levels, especially levels of HDL2, the most cardioprotective HDL component, among people treated with a combination of simvastatin (brand name Zocor®) and niacin [58,59].

Chemotherapy and radiotherapy

Oncologists generally advise against the use of antioxidant supplements during cancer chemotherapy or radiotherapy because they might reduce the effectiveness of these therapies by inhibiting cellular oxidative damage in cancerous cells [60,61]. Although a systematic review of randomized controlled trials has called this concern into question [62], further research is needed to evaluate the potential risks and benefits of concurrent antioxidant supplementation with conventional therapies for cancer.

Vitamin E and Healthful Diets

The federal government's 2010 Dietary Guidelines for Americans notes that "nutrients should come primarily from foods. Foods in nutrient-dense, mostly intact forms contain not only the essential vitamins and minerals that are often contained in nutrient supplements, but also dietary fiber and other naturally occurring substances that may have positive health effects.

...Dietary supplements...may be advantageous in specific situations to increase intake of a specific vitamin or mineral."

For more information about building a healthful diet, refer to the [Dietary Guidelines for Americans](#) and the U.S. Department of Agriculture's food guidance system, [MyPlate](#).

The *Dietary Guidelines for Americans* describes a healthy diet as one that:

- Emphasizes a variety of fruits, vegetables, whole grains, and fat-free or low-fat milk and milk products.

Vitamin E is found in green leafy vegetables, whole grains, and fortified cereals.

- Includes lean meats, poultry, fish, beans, eggs, and nuts.

Nuts are good sources of vitamin E.

- Is low in saturated fats, *trans* fats, cholesterol, salt (sodium), and added sugars.

Vitamin E is commonly found in vegetable oils.

- Stays within your daily calorie needs.

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