VitaminE-HealthProfessional

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Vitamin E  
Fact Sheet for Health Professionals  
  
This is a fact sheet intended for health professionals. For a general overview, see our consumer fact sheet.  
  
Introduction  
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 -) 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 the following:  
  
Recommended Dietary Allowance (RDA): Average daily level of intake sufficient to meet the nutrient requirements of nearly all (97% 98%) healthy individuals; often used to plan nutritionally adequate diets for individuals  
Adequate Intake (AI): Intake at this level is assumed to ensure nutritional adequacy; established when evidence is insufficient to develop an RDA  
Estimated Average Requirement (EAR): Average daily level of intake estimated to meet the requirements of 50% of healthy individuals; usually used to assess the nutrient intakes of groups of people and to plan nutritionally adequate diets for them; can also be used to assess the nutrient intakes of individuals  
Tolerable Upper Intake Level (UL): Maximum daily intake unlikely to cause adverse health effects  
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.  
  
Naturally sourced vitamin E is called RRR-alpha-tocopherol (commonly labeled as d-alpha-tocopherol); the synthetically produced form is all rac-alpha-tocopherol (commonly labeled as dl-alpha-tocopherol).  
  
RDAs for vitamin E are provided in milligrams (mg) and are listed in Table 1. One mg vitamin E (alpha-tocopherol) is equivalent to 1 mg RRR-alpha-tocopherol or 2 mg all rac-alpha-tocopherol. 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.  
  
Table 1: Recommended Dietary Allowances (RDAs) for Vitamin E (Alpha-Tocopherol) [6]  
Age Males Females Pregnancy Lactation  
0 6 months\* 4 mg 4 mg  
7 12 months\* 5 mg 5 mg  
1 3 years 6 mg 6 mg  
4 8 years 7 mg 7 mg  
9 13 years 11 mg 11 mg  
14+ years 15 mg 15 mg 15 mg 19 mg  
\*Adequate Intake (AI)  
  
International Units and Milligrams  
Vitamin E is listed on the new Nutrition Facts and Supplement Facts labels in mg [7]. The U.S. Food and Drug Administration (FDA) required manufacturers to use these new labels starting in January 2020, but companies with annual sales of less than $10 million were allowed to use the old labels that list vitamin E in International Units (IUs) until January 2021 [8]. 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 the natural form is equivalent to 0.67 mg of alpha-tocopherol.  
 1 IU of the synthetic form is equivalent to 0.45 mg of alpha-tocopherol.  
For example, 15 mg of natural alpha-tocopherol would equal 22.4 IU (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).  
  
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) [9]. 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: Vitamin E (Alpha-Tocopherol) Content of Selected Foods [9]  
Food Milligrams (mg)  
per serving Percent DV\*  
Wheat germ oil, 1 tablespoon 20.3 135  
Sunflower seeds, dry roasted, 1 ounce 7.4 49  
Almonds, dry roasted, 1 ounce 6.8 45  
Sunflower oil, 1 tablespoon 5.6 37  
Safflower oil, 1 tablespoon 4.6 31  
Hazelnuts, dry roasted, 1 ounce 4.3 29  
Peanut butter, 2 tablespoons 2.9 19  
Peanuts, dry roasted, 1 ounce 2.2 15  
Corn oil, 1 tablespoon 1.9 13  
Spinach, boiled, cup 1.9 13  
Broccoli, chopped, boiled, cup 1.2 8  
Soybean oil, 1 tablespoon 1.1 7  
Kiwifruit, 1 medium 1.1 7  
Mango, sliced, cup 0.7 5  
Tomato, raw, 1 medium 0.7 5  
Spinach, raw, 1 cup 0.6 4  
\*DV = Daily Value. FDA developed DVs to help consumers compare the nutrient contents of foods and dietary supplements within the context of a total diet. The DV for vitamin E is 15 mg for adults and children age 4 years and older [7]. One mg vitamin E = 1 mg RRR-alpha-tocopherol = 2 mg all rac-alpha-tocopherol. FDA does not require food labels to list vitamin E content unless vitamin E has been added to the food. 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) FoodData Centralexternal link disclaimer website 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 arranged by nutrient content and by food name.  
  
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 (all rac-alpha-tocopherol; commonly labeled as DL or dl) is therefore only half as active as the same amount (by weight in mg) of the natural form (RRR-alpha-tocopherol; commonly labeled as D or d).  
  
Most vitamin-E-only supplements provide 67 mg (100 IU of natural vitamin E) of the nutrient. These amounts are substantially higher than the RDAs.  
  
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 National Health and Nutrition Examination Survey (NHANES) [10], NHANES III (1988 1994) [10], and the Continuing Survey of Food Intakes by Individuals (1994 1996) [11] 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 [6,10]. The 1999 2000 NHANES found that 11.3% of adults took vitamin E supplements containing at least 400 IU [12].  
  
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 [13].  
  
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 [6,14]. 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 [15]. 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 [16].  
  
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 [17].  
  
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 [18]. 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 [19].  
  
However, randomized clinical trials cast doubt on the efficacy of vitamin E supplements to prevent CHD [20]. 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 [21], found that participants taking 400 IU/day of natural vitamin E (268 mg) experienced no fewer cardiovascular events or hospitalizations for heart failure or chest pain than participants taking a placebo. In the HOPE-TOO follow-up study, almost 4,000 of the original participants continued to take vitamin E or placebo for an additional 2.5 years [22]. 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 [23]. 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 (form not specified) and 500 mg vitamin C twice a day or placebo for >4 years [24]. 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 (402 mg) on alternate days or placebo and who were followed for an average of 10 years [25]. 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 (180 mg) every other day, 500 mg vitamin C daily, both vitamins, or placebo [26]. During a mean follow-up 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 morality. 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 [27]. 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 [9]. 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 [28]. 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 of natural vitamin E (268 mg) or a placebo [22]. In the Women s Health Study, in which healthy women 45 years of age received either 600 IU of natural vitamin E (402 mg) every other day or a placebo for 10 years, the supplement did not reduce the risk of developing any form of cancer [25].  
  
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 [29]. However, among current smokers and men who had quit, vitamin E intakes of more than 400 IU/day (form not specified) 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 111 IU of synthetic vitamin E (50 mg, as dl-alpha-tocopheryl acetate) for 5 8 years had 32% fewer prostate cancers compared to subjects who did not take the supplements [30]. 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 400 IU of synthetic vitamin E (180 mg, 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 [31]. 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% increased risk of prostate cancer compared to men only taking placebos, a statistically significant difference [32]. 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 website provides additional information on the SELECT trialexternal link disclaimer.  
  
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 [33]. The overall relative risk for the highest quintile of intake (>35.7 IU/day, form not specified) compared to the lowest quintile (<5.7 IU/day, form not specified) 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 [34]. 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 [35].  
  
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 [36]; 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 of synthetic vitamin E [180 mg]) 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., 20 mg/day [30 IU]) have an approximately 20% lower risk of developing AMD than people with low intakes (e.g., <10 mg/day [<15 IU]) [37,38]. However, two randomized controlled trials in which participants took supplements of vitamin E (500 IU/day [335 mg] d-alpha-tocopherol in one study [39] and 111 IU/day (50 mg) dl-alpha-tocopheryl acetate combined with 20 mg/day beta-carotene in the other [40]) 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, found that participants at high risk of developing advanced AMD (i.e., those with intermediate AMD or those with advanced AMD in one eye) reduced their risk of developing advanced AMD by 25% by taking a daily supplement containing vitamin E (400 IU [180 mg] dl-alpha-tocopheryl acetate), beta-carotene (15 mg), vitamin C (500 mg), zinc (80 mg), and copper (2 mg) compared to participants taking a placebo over 5 years [41]. A follow-up AREDS2 study confirmed the value of this and similar supplement formulations in reducing the progression of AMD over a median follow-up period of 5 years [42].  
  
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 [43]. In another study, long-term use of vitamin E supplements was associated with slower progression of age-related lens opacification [44]. However, in the AREDS trial, the use of a vitamin E-containing (as dl-alpha-tocopheryl acetate) formulation had no apparent effect on the development or progression of cataracts over an average of 6.3 years [45]. The AREDS2 study, which also tested formulations containing 400 IU (180 mg) vitamin E, confirmed these findings [46].  
  
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 formulations of vitamin E, other antioxidants, zinc, and copper used in AREDS hold promise for slowing the progression of AMD in people at high risk of developing advanced 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 [47]. 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 [47]. 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 age 65 102 years [48]. However, a clinical trial in primarily healthy older women who were randomly assigned to receive 600 IU (402 mg) d-alpha-tocopherol every other day or a placebo for 4 years found that the supplements provided no apparent cognitive benefits [49]. Another trial in which 769 men and women with mild cognitive impairment were randomly assigned to receive 2,000 IU/day vitamin E (form 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 [50]  
  
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 [51]. More research is needed to identify the role of vitamin E, if any, in the management of cognitive impairment [52].  
  
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 [53] and the other trial involved a large group of male physicians in the United States who consumed 400 IU (180 mg) of synthetic vitamin E every other day for 8 years [26]. 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 up to 3,200 mg/day of alpha-tocopherol for only 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 200 mg  
4 8 years 300 mg 300 mg  
9 13 years 600 mg 600 mg  
14 18 years 800 mg 800 mg 800 mg 800 mg  
19+ years 1,000 mg 1,000 mg 1,000 mg 1,000 mg  
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 (form not specified), although the risk began to increase at 150 IU [54]. 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 [form not specified]) or combined with up to four other antioxidants, significantly increased mortality risk [55].  
  
The implications of these analyses for the potential adverse effects of high-dose vitamin E supplements are unclear [56-59]. 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 [60].  
  
However, results from the recently published, large SELECT trial show that vitamin E supplements (400 IU/day [180 mg] as dl-alpha-tocopheryl acetate) may harm adult men in the general population by increasing their risk of prostate cancer [32]. 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 health care 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 [61].  
  
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 [62,63].  
  
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 [64,65]. Although a systematic review of randomized controlled trials has called this concern into question [66], 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 2020 2025 Dietary Guidelines for Americans notes that Because foods provide an array of nutrients and other components that have benefits for health, nutritional needs should be met primarily through foods. In some cases, fortified foods and dietary supplements are useful when it is not possible otherwise to meet needs for one or more nutrients (e.g., during specific life stages such as pregnancy).   
  
For more information about building a healthy dietary pattern, refer to the Dietary Guidelines for Americansexternal link disclaimer and the USDA s MyPlate.external link disclaimer  
  
The Dietary Guidelines for Americans describes a healthy dietary pattern as one that  
  
Includes a variety of vegetables; fruits; grains (at least half whole grains); fat-free and low-fat milk, yogurt, and cheese; and oils.  
 Vitamin E is found in green leafy vegetables, whole grains, fortified cereals, and vegetable oils.  
Includes a variety of protein foods such as lean meats; poultry; eggs; seafood; beans, peas, and lentils; nuts and seeds; and soy products.  
 Nuts are good sources of vitamin E.  
Limits foods and beverages higher in added sugars, saturated fat, and sodium.  
Limits alcoholic beverages.  
Stays within your daily calorie needs.  
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