Vitamin E: the latest science 2016

Executive summary

Vitamin E is an essential micronutrient for protecting cells from oxidative stress and supporting human health. Studies have shown that it can contribute substantially to overall wellbeing if the desired status of 30 nmol/L is achieved and there is emerging evidence that, in certain conditions, higher doses of vitamin E can provide significant health benefits. However, recent data indicates that consumption of vitamin E is in decline and even healthy populations do not receive sufficient intake. It is estimated that more than 90% of Americans do not meet the recommended daily allowance, and recent negative media coverage has taken attention away from the fundamental role vitamin E plays in supporting the human body.

Despite this, more than 31,550 studies on vitamin E have been published from 1964 to date, examining the vital role of this micronutrient in human health. There is growing interest in vitamin E research with regards to antioxidant activities, heart health, diabetes, non-alcoholic fatty liver, macular eye degeneration, cognitive function, and more.

As with all emerging fields of science, more research is needed to explore the full potential of vitamin E. DSM is actively involved in supporting research projects that investigate the health effects of vitamin E. This white paper highlights the latest science behind the different roles of vitamin E in human health. It examines new data on global vitamin E status, as it addresses important questions in terms of usage levels and concerns that may not always be scientifically substantiated. This paper is not a comprehensive list of health benefits and contains scientific and technical information on emerging science pertaining to vitamin E.
Why does our body need vitamin E?

Vitamin E is vital for human health. It is a key element in cell membranes to protect against the damaging effects caused by oxidation and it plays an important role in supporting brain, eye, cardiovascular, maternal and infant health, as well as protecting the skin. The European Commission has authorized an Article 13.1 health claim stating that ‘vitamin E contributes to the protection of cell constituents from oxidative damage’.

Vitamin E cannot be produced by the body itself, therefore it must be obtained from the diet. Due to changes in modern eating habits, combined with a growing consumption of processed foods, it can be difficult to achieve the required amount of vitamin E through diet alone. Supplementation may be required to maintain adequate vitamin E concentrations in blood and tissues. Fortified foods or multivitamins can play an important role in closing the gap between inadequate intake via the diet and recommended levels. Globally, the impact of low vitamin E status should be a serious public health concern. More attention and research is needed on the role of vitamin E in the human body, as well as on vitamin E intake and status.

**The latest National Nutrition Study for Germany** found that around 40% of the population does not get enough vitamin E compared to recommendations via the diet. Dietary surveys for other countries, such as the UK and the Netherlands, report similar findings: in the US, 90% of the population does not consume the recommended dietary intake of vitamin E. Recent papers have also reported a widespread vitamin E deficiency in women in Asian countries, such as Bangladesh and Tibet.

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Vitamin E in a nutshell

**Functions:** Vitamin E is the major fat-soluble antioxidant of the body. It has non-antioxidant functions in cell signaling, gene expression and in the regulation of other cell functions.

**Form:** Vitamin E is a generic term for eight fat-soluble compounds found in nature, of which “α-tocopherol” has the highest biological activity and is the most abundant in the human body. Therefore, only α-tocopherol counts for vitamin E activity in dietary intake recommendations.

**Sources:** The most important sources of vitamin E are vegetable oils, nuts, wholegrains and wheatgerm. There is also a limited supply in seeds and green leafy vegetables. However, its content in these foods can degenerate over time due to oxidation in incorrect storage conditions, such as exposure to sunlight and the type of container used.

**Deficiency:** Symptoms of vitamin E deficiency include muscle weakness, loss of muscle mass, problems with vision, other neurological disorders and higher risk of miscarriage.

**Fortification and supplementation:** The most common fortified foods are cereals. Vitamin E is also widely available in soft gelatin capsules or as chewable or effervescent tablets, as well as being found in most multivitamin supplements.
Essentiality and biological function

The main biological function of vitamin E as a powerful antioxidant is prevention of propagation of free-radical reactions. The damaging effects caused by oxidation can impact cellular structures and metabolic processes, affecting long-term health, including increasing the risk of heart disease, cancer and inflammatory conditions. In addition, vitamin E plays a critical role in cell signaling, gene expression and regulation of other cell functions.

Apart from maintaining the integrity of cell membranes in the human body, vitamin E protects low density lipoprotein (LDL) from oxidation. There are studies to suggest that immunity in the elderly can be compromised by low vitamin E intake and that supplementation with vitamin E significantly lowers the risk of upper respiratory tract infections, such as the common cold. It also supports red blood cells and contributes to healthy blood flow by helping to regulate the opening of blood vessels.

Potential benefits of higher intakes in specific applications

Emerging science reveals a potential role for vitamin E in specific circumstances at intakes above the recommended daily allowance in the U.S. and European Union. In the following sections, results from a number of studies are summarized that suggest additional health benefits of vitamin E in:

- cardiovascular health;
- delaying cognitive decline;
- people with diabetes with a certain genotype;
- age-related macular degeneration (AMD);
- non-alcoholic fatty liver; and
- the negative health impact of air pollution.

The effect of vitamin E in cognitive health

The role of vitamin E supplementation in neurodegenerative conditions and cognitive decline is under intensive investigation. In a recent major study, vitamin E supplementation was found to slow functional decline among individuals with mild and moderate Alzheimer’s Disease (AD). As part of the trial, 613 patients with mild to moderate AD were studied over a two year timeframe in the longest and largest study of its kind to date. Participants took 2,000 IU of vitamin E or a placebo. The vitamin E group showed a 19% lower rate of decline in daily living skills compared to the placebo group. The participants that took vitamin E also remained far more independent, relying less on caregivers for standard daily living activities and this made a significant improvement on quality of life. Importantly, vitamin E was safe and well tolerated in this relatively high dose application.

Watch DSM’s webinar on the latest findings on vitamin E and its potential role in maintaining cognitive function [here](#).

Vitamin E is associated with benefits in non-alcoholic fatty liver

Fat accumulation in the liver may progress to non-alcoholic fatty liver (NAFL) and is a serious issue in overweight and obese people worldwide. Results of several clinical studies suggest that the use of vitamin E is associated with a number of health benefits in people with NAFL. In addition, it has been demonstrated that vitamin E administered at a daily dose of 800 IU significantly improves liver histology in non-diabetic adults with NAFL.

Watch DSM’s webinar on the latest research on the role of vitamin E supplementation in helping maintain normal liver structure and function [here](#).
The suggested role of vitamin E in bone health and muscle strength

Studies have also demonstrated that vitamin E is required in skeletal muscle myocyte plasma membrane repair. Research examining animals during downhill running showed those deficient in vitamin E required more plasma regeneration for continuous muscle functioning. This demonstrates the essential role of vitamin E for muscle strength and a requisite component in the plasma membrane repair mechanism.11

Benefits of vitamin E on health issues connected to air pollution

Air pollution is a significant global environmental issue that has been associated with a number of serious health issues, such as increased risk of CVD, diabetes and cancer via oxidative stress and inflammatory mechanisms. Studies have shown that micronutrients, such as vitamin E and PUFA can play an important role helping maintain cell structure and function against pollutants and reduce their negative effects on health.12, 13

People with obesity require a higher vitamin E intake

Metabolic syndrome is a condition with a high prevalence around the globe and encompasses numerous health risks, such as obesity, high blood pressure and NAFL. An estimated 34% of US adults have metabolic syndrome, putting them additionally at higher risk of heart disease, stroke and damaged blood vessels.14 A recent study examined vitamin E absorption in adults with metabolic syndrome and demonstrated that they absorbed up to 29.5% of the vitamin E dose (15 mg), those with metabolic syndrome processed only 26.1%. Not only did people with metabolic syndrome have limited absorption of vitamin E, but its distribution to the tissues from the bloodstream was slowed. These findings suggest that adults with metabolic syndrome may need more vitamin E to maintain adequate status. Importantly, because vitamin E helps maintain liver function among the overweight and obese, inadequate vitamin E status may lead to greater secondary consequences in those with metabolic syndrome.

This information is solely for scientific informational purposes only and not intended for marketing and/or sales claims purposes.
Emerging benefits of vitamin E in cardiovascular health

There are clinical studies suggesting that diabetic patients with the Hp 2-2 genotype may benefit from increased vitamin E intake which appears to lower the risk of heart disease. In Western countries, around 40% of the population have the Hp 2-2 genotype and in South East Asia, the figure is as high as 90% of all individuals. Vitamin E has also been shown to help maintain arterial flexibility, a risk factor of CVD. Emerging data suggest that a daily intake of 400mg of vitamin E significantly reduces the risk of a composite cardiovascular endpoint consisting of cardiovascular death, myocardial infarction or stroke.

A meta-analysis conducted by the Human Nutrition Research Centre at Newcastle, UK examined the effect of antioxidant vitamin supplementation on arterial stiffness in adults and concluded that there was a significant reduction in arterial stiffness with vitamin E and also with vitamin E combined with other antioxidant vitamins. Vitamin E was effective at all doses investigated. There were greater improvements observed with participants having lower levels of vitamin E in their blood at the beginning of the studies.

Antioxidant vitamin supplementation reduces arterial stiffness – a marker for increased CVD risk

- Arterial stiffness is a hallmark of aging and closely associated with many pathological conditions (atherosclerosis, a.o.)
- Artificial stiffness is regarded as a marker for increased CVD risk
- Oxidative stress and inflammation contribute to onset and progression

Antioxidants – including vitamin E at all doses investigated – produce a significant reduction in arterial stiffness

Many studies have shown that vitamin E and other antioxidant nutrients produce significant reductions in artery stiffness associated with aging. Arterial stiffness is an important risk factor in cardiovascular disease. Several studies are listed in the table above and, as indicated by the position of the ‘dot’, they show reduced arterial stiffness in the study. Figure courtesy of Professor Manfred Eggersdorfer.

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I-V Overall (% squared = 8.7%, p = 0.336)
D + L Overall
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Vitamin E protects PUFAs from oxidative damage

Vitamin E plays an important role in protecting polyunsaturated fatty acids (PUFAs) from oxidative damage. The requirement for vitamin E is related to the amount of PUFAs consumed in the diet and the EC Scientific Committee on Foods (SCF) has suggested a consumption ratio of 0.4 mg α-tocopherol equivalents (a-TE) per gram of PUFA.²¹

A recent paper reviewed the published evidence on the function and requirements of α-tocopherol in relation to the amount of PUFAs in the human diet.²² It argues that vitamin E requirements increase with a rise in PUFA consumption and with the degree of unsaturation of the PUFA in the diet. High intake of PUFAs accompanied by a very low intake of vitamin E may lead to symptoms of vitamin E deficiency. Using 0.5 mg α-tocopherol/g of PUFA, the estimated requirement for vitamin E varies from 12 to 20 mg/day for a typical range of dietary PUFA intake. The most beneficial PUFA is generally thought to be DHA and it has approved EU health claims for the maintenance of heart, brain and eye health.

In summary, the higher the level of PUFA intake, the more vitamin E is required.

Expert quote

Peter Weber, Corporate Scientist at DSM, says: “Vitamin E intakes of Korean adults are generally adequate compared with the Korean Daily Reference Intakes (DRIs). However, the α-tocopherol intake was lower than those of other countries. Further research is needed to determine whether the current vitamin E unit in South Korea is appropriate. The study is another example that we cannot take adequate vitamin intake for granted even in apparently healthy or affluent populations. This highlights the importance of good, balanced nutrition, which may be complemented by a supplement if required.”
Despite the many benefits of vitamin E, a new study shows that status remains low in many countries. 

- **2/3** of U.S. adults have plasma vitamin E concentrations below the RDA. 
- **87%** of 20-30 year old... 
- and **68%** of 31-50 year old Americans have suboptimal (≤30 µmol/L) vitamin E concentrations. 

Research into Japanese adults reported a daily vitamin E intake of **6.6–7.1mg**. 

- **89.6%** of Japanese adults have vitamin E levels below **20 µmol/L**, at which point there might be an increased risk of cardiovascular disease (CVD). 

A study examining vitamin E intake of 20-59 year old adults in South Korea concluded: 

- **23%** were vitamin E deficient. 
- **67%** had suboptimal range of vitamin E plasma level.
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Proven safety of vitamin E

Vitamin E is safe in the range of recommended daily usage and also at higher doses compared to the RDA, as has been demonstrated in numerous studies. Large, long-term studies have been conducted to evaluate the role of vitamin E in eye health with 400 mg/day, fatty liver with 800 mg/day and in cognitive function with a daily dose of 2,000 IU without any reported safety concerns. Several recent meta-analyses studying the relation of vitamin E intake and risk for mortality indicate that it is safe up to 5,000 IU per day and person.

Expert quote

Dr. Manfred Eggersdorfer, Senior Vice President, Nutrition Science & Advocacy at DSM and Professor for Healthy Ageing at Groningen University says: “The targeted approach in nutrition to address risk factors in cardiovascular and cognitive health, as well as metabolic syndrome and others is over Looked and underestimated. There is encouraging data that micronutrients, such as vitamin E, can beneficially impact the onset and course of these conditions and other health risks associated with them.”

References:


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