

Beta Carotene: Health Benefits & Negatives + High & Low Levels

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Beta carotene is a natural antioxidant that can also be converted into vitamin A in the body. It has multiple beneficial effects — it protects brain, eye, and skin health. It also helps prevent metabolic syndrome and diabetes. However, supplementing with beta carotene can increase the risk of cancer and heart disease in smokers and those who drink alcohol. Keep reading to learn what it means to have high or low beta carotene levels and how to increase or decrease them.

What is Beta Carotene?

Beta-carotene is a plant-derived pigment (carotenoid). It is a source of [vitamin A](#) and an important antioxidant [\[R\]](#).

It is found in many plant products, such as green leafy and yellow-colored vegetables, and orange-colored fruit [\[R\]](#).

Beta-carotene **contributes about 30-35% of the dietary vitamin A intake** in western countries, but in developing countries, it represents the most abundant, and in some instances, the sole source of vitamin A [\[R, R\]](#).

Beta Carotene in Foods

Beta-carotene is found in [\[R, R, R, R\]](#):

- Fruits (apricots, peaches, persimmons, melon, citrus, tomatoes, etc.)
- Green vegetables (spinach, broccoli, parsley, collard greens)
- Orange tuber vegetables (carrots, sweet potatoes)
- Animal tissues and products (salmon, egg yolk, butterfat)

The absorption of beta-carotene from plant sources ranges from 5% to 65% in humans [\[R\]](#). This depends on many different factors, such as the fat and fiber content of the food. Fat has a positive, while fiber has a negative effect on beta-carotene bioavailability [\[R, R, R, R\]](#).

Steaming increases the available of beta-carotene, but prolonged boiling has a negative effect [\[R\]](#).

Beta Carotene Supplements

Beta-carotene can also be obtained from supplements. However, whenever possible, you should aim to acquire your beta-carotene from fruits and vegetables.

When using supplements, bear in mind that they may contain multiple ingredients, and differences are often found between labeled and actual ingredients or their amounts [R].

In addition, excess amounts of beta-carotene can have negative effects on healthy people, especially when they smoke, or consume alcohol.

Beta Carotene: The Good

1) Beta-Carotene is an Antioxidant

Similar to other carotenoids, beta-carotene has antioxidant properties. It **helps protect against reactive oxygen species and prevents oxidative stress** [R, R].

When 12 healthy women were put **on a low carotene diet, they experienced increased oxidative stress** and decreased superoxide dismutase (SOD) antioxidant activity [R].

Similarly, in two studies with a total of 167 lead-exposed workers, beta-carotene supplements [R, R]:

- increased G6PD, catalase, and SOD activity – these are all enzymes that protect our body from oxidative stress
- Increased vitamin E levels
- decreased malondialdehyde (MDA) – a marker of oxidative stress
- decreased homocysteine levels – homocysteine is a metabolic byproduct that has been implicated as a marker of many chronic diseases

However, **beta-carotene decreased glutathione peroxidase (GPx) and glutathione S-transferase (GST) activity**. GPx and GST are important for neutralizing certain free radicals [R, R, R, R].

In a study of over 14k people, higher blood beta-carotene levels were associated with lower CRP and white blood cell levels — both of these are markers of inflammation [R].

Several studies suggest that **beta-carotene is beneficial in patients with cystic fibrosis**, where it decreases oxidative stress and improves the quality of life [R, R, R].

Apart from circulating in the blood, beta-carotene is also a normal component of human colostrum and mature milk, where it contributes to antioxidant defenses in the newborns and infants [R].

2) Beta-Carotene Is Good For The Skin

Many studies have shown that beta-carotene and other carotenoids help protect the skin against [UV](#) rays by exerting antioxidant effects [\[R\]](#), [\[R\]](#).

However, there are also studies that failed to find any beneficial effects [\[R\]](#), [\[R\]](#).

According to a meta-analysis of 7 studies (135 subjects), **beta-carotene supplementation protects against sunburn**. However, the protection **becomes effective only after a minimum of 10 weeks of supplementation**[\[R\]](#).

Another study looked at the effect of 2 different doses (30 and 90 mg/day) of beta-carotene on wrinkles, skin elasticity, collagen content, and UV-induced DNA damage in 30 healthy women. Interestingly, **only the low dose (30 mg/day) improved facial wrinkles and elasticity and counteracted photoaging** [\[R\]](#).

Dietary beta-carotene is more efficient than when it's applied to the skin because it is more stable [\[R\]](#).

3) Beta-Carotene Improves Brain Health

Since oxidative stress contributes to the aging of the brain, antioxidants like beta-carotene can help protect brain function [\[R\]](#).

In a clinical trial of almost 6k people, **those that received long term beta-carotene supplementation performed better on cognitive tasks. They had better memory and cognitive function in general**. This was especially true for the people who took beta-carotene for more than 15 years. However, short-term supplementation was ineffective [\[R\]](#).

In a meta-analysis of 7 studies, dietary intake of beta-carotene was linked to a lower the risk of Alzheimer's [\[R\]](#).

4) Beta-Carotene Protects Eyes Health

In a meta-analysis of 22 articles, **higher blood levels of beta-carotene decreased the risk of developing cataracts**, clouding of the eye lens that impairs vision. A similar association was found for higher beta-carotene dietary intake [\[R\]](#).

In 29 patients with retinitis pigmentosa, an eye disease that can cause loss of vision, a supplement containing beta-carotene improved retinal function [\[R\]](#).

In a clinical trial of 3640 adults, those who took antioxidant supplements (beta-carotene, [vitamin E](#), and [vitamin C](#)) had a reduced risk of vision loss (including age-related macular degeneration) [\[R\]](#).

However, a study in 22k male physicians aged showed no overall benefit or harm of 12 years of beta-carotene supplementation when it comes to cataracts. But beta-carotene did seem to decrease the excess risk for smokers by about one fourth [R].

5) Beta-Carotene Protects Against Metabolic Syndrome

Metabolic syndrome is a cluster of conditions that occur together and increase your risk of diabetes and heart disease. You have metabolic syndrome if you have at least three of the following:

- high blood pressure
- high blood sugar
- excess body fat around the waist
- high cholesterol
- high triglyceride levels

In an observational study of 910 people, **those with high beta-carotene levels had a lower risk of developing metabolic syndrome over the next 10 years.** In addition, they had a lower risk of having high [cholesterol](#) (dyslipidemia) [R].

Beta-carotene may protect against metabolic syndrome by decreasing cholesterol absorption in the gut and increase cholesterol excretion in the feces [R].

A study in rats showed that supplementation with beta-carotene decreased total cholesterol, non-HDL cholesterol, and the liver fat and cholesterol content. These were accompanied by an increase in the loss of fat and cholesterol through feces [R].

6) Beta-Carotene Protects Against Diabetes

In over 37k healthy subjects, **higher dietary intake of beta-carotene was linked with a decreased risk of diabetes** [R].

In 108 obese non-diabetic patients, higher blood levels of beta-carotene were linked to higher blood [adiponectin](#) levels. This means that beta-carotene in the blood increases insulin sensitivity [R].

7) Beta-Carotene May Protect Against High Uric Acid Levels

High uric acid levels can lead to gout and kidney stones [R, R].

In an observational study of over 14k people, **low beta-carotene was linked to [high uric acid levels \(hyperuricemia\)](#)** [R].

8) Beta-Carotene May Protect Against Heart Disease

In over 1000 men followed over 15 years, **people with low blood levels of beta-carotene were over 2 times more likely to die of heart disease** [R].

In mice fed a high-fat diet, a natural source of β -carotene, alga *Dunaliella*, decreased the hardening of the arteries and prevented an increase in blood cholesterol levels [R].

9) Beta-Carotene May Protect Against Cancer

Studies support the role of dietary and circulating beta-carotene when it comes to cancer prevention. But results are controversial when it comes to beta-carotene supplementation.

Circulating and Dietary Beta-Carotene

Higher blood levels of beta-carotene are associated with a decreased risk of cancer, including lung, leukemia, and bone cancer [R, R].

A meta-analysis of 19 studies comprising over 500k people suggests that **higher dietary beta-carotene intake decreases the risk of lung cancer** [R].

Similarly, in another meta-analysis of 5 studies with over 3,7k subjects, **high (versus low) dietary intake of beta-carotene was associated with a 16% lower risk of getting ovarian cancer** [R].

In 540 head and neck cancer patients treated by radiation, **higher dietary and blood beta-carotene levels were associated with fewer adverse effects and a lower rate of cancer recurrence** [R].

A study in 190 healthy individuals showed a U-shaped relationship between beta-carotene intake and genome stability. Both low and high intakes (<4.1 and >6.4 mg/day) increased DNA mutations, which can potentially lead to cancer [R].

Beta-carotene Supplements

Some studies show that **supplementation with beta-carotene is linked to a modestly decreased risk of cancer**, including prostate, neck, and colon cancer [R, R].

Other studies (39k and 29k people) **found no benefit or harm** from beta-carotene supplementation on the incidence of cancer [R, R].

However, a meta-analysis 6 trials, including over 40k participants, found that **beta-carotene supplements increased the risk of bladder cancer** [R].

People who smoke and asbestos-exposed workers should avoid beta-carotene supplements because they increase the risk of getting lung or stomach cancer [R].

10) Beta-carotene May Protect Against Radiation

Beta-carotene supplements effectively decreased cell damage in 709 children exposed to different doses of radiation during and after the Chernobyl accident [R].

In rats, beta-carotene showed significant antimutagenic/radioprotective activity against radioactive iodine, which is used in diagnosing thyroid disorders [R].

11) Beta-carotene May Help Boost the Immune System

Beta-carotene supplements increased [natural killer \(NK\) cell](#) activity in the elderly [R].

12) Beta-Carotene May Promote Longevity

A meta-analysis of 41 observational studies (over 500k people) suggests that **both higher blood levels and a higher dietary intake of beta-carotene are linked with decreased all-cause mortality [R].**

According to another meta-analysis of over 25k people, higher blood levels of beta-carotene were linked to a reduced risk of death from all causes. Similarly, in 150k people, higher intake of dietary beta-carotene was linked to a decreased risk of all-cause mortality [R].

In over 29k men, those with higher serum beta carotene had significantly lower overall, heart disease, stroke, and cancer mortality [R].

However, in a meta-analyses of 53 trials (over 240k participants) **beta-carotene supplementation in a dose above the RDA (9.6 mg/day) slightly increased mortality [R].**

Beta Carotene: The Bad

1) Beta-Carotene Increases Cancer and Heart Disease Risk in Smokers

In two large trials, supplementation with beta-carotene increased the risk of lung cancer. Subjects in these studies were predominantly cigarette smokers, and the adverse effects were concentrated among those who also drank alcohol [R].

The first trial involved 18k participants at high risk for lung cancer because of a history of smoking or asbestos exposure. It was stopped ahead of schedule in 1996, when it became obvious that **people randomly assigned to beta-carotene**

supplements had a 28% increase in the incidence of lung cancer, a 17% increase in incidence of death, and a 26% higher rate of heart disease mortality compared with the participants in the placebo group [R, R].

In the second trial, **beta-carotene increased the risk of getting a heart attack and lung cancer** in 29k male smokers. The risk was not dependant on the tar or nicotine content of cigarettes smoked [R, R].

In a study of 864 subjects with colon cancer who had the cancer removed, beta-carotene markedly decreased the risk of recurrent cancer in those who neither smoked cigarettes nor drank alcohol. There was a modest increase in the risk of recurrence among those who smoked. However, **for those who smoked cigarettes and also drank more than one alcoholic drink per day, beta-carotene doubled the risk of colon cancer recurrence** [R].

Beta-carotene supplements increased the risk of stroke (intracerebral hemorrhage) **by 62%** in a study with over 28k cigarette smokers [R].

Mechanisms

Benzyo[a]pyrene (BaP), present in tobacco smoke, has a well-known carcinogenic track record. It gets activated upon conversion into benzo[a]pyrene diol epoxide (BPDE), which is highly mutagenic. Protection against BPDE is provided by GSTs (glutathione S-transferases). However, **beta-carotene blocks GTS function** [R, R].

In addition, carotenoid breakdown results in some very reactive products that increase oxidative stress. These are normally neutralized by other antioxidants, such as vitamins C and E, but smoking decreases their levels [R, R].

2) Beta-carotene Increases Cancer and Heart Disease Risk When Used With Alcohol

Alcohol (etanol) interferes with the conversion of beta-carotene into vitamin A [R].

In smokers who also consume alcohol, beta-carotene supplementation promotes lung cancer and, possibly, heart disease [R].

3) Excess Beta-Carotene Supplementation Increases Mortality

A meta-analyses of 53 trials with over 240k participants suggests that beta-carotene supplementation in a dose above 9.6 mg/day may slightly increase mortality [R].

Normal Range

Beta-carotene levels can be measured by a simple blood test. Women will usually have slightly higher levels than men [R].

Normal levels for men are 4-51 ug/dL (micrograms per deciliter) and for women 6-77 ug/dL. Levels may vary slightly between laboratories.

Low Beta Carotene Levels

Causes of Low Beta Carotene Levels

1) Malnourishment

Beta-carotene levels are a good indicator of your fruit and vegetable intake, and your overall dietary habits [R].

Beta-carotene levels are low in inadequately nourished children and in those with low vegetable and fruit consumption [R].

A review of 7 articles including around 4503 European adolescents, showed that beta-carotene deficiency was quite prevalent, affecting 14-19% [R].

2) Obesity

Overweight and obese people have lower beta-carotene levels than people with a healthy weight [R, R].

In a study with 92 healthy overweight subjects receiving beta-carotene supplements, those with higher BMI had lower circulating beta-carotene levels [R+].

3) Smoking

Smoking decreases beta-carotene levels [R, R].

4) Alcohol Consumption

Drinking alcohol also decreases beta-carotene levels [R].

5) Cholestatic Liver Disease

Cholestatic liver disease can cause problems with the absorption of nutrients in the gut. In an observational study of 53 children with cholestatic liver disease, more than 80% had low beta-carotene levels [R].

6) Hyperthyroidism

In various studies, patients with hyperthyroidism, or overactive thyroid, had decreased beta-carotene levels [R, R].

7) HIV

Beta-carotene deficiency is common in all stages of HIV/AIDS. This disease can cause diarrhea and prevents the small intestine from absorbing fats, which leads to decreased beta carotene levels in the blood [R, R].

However, clinical trials have not shown any beneficial effects of beta-carotene supplementation. Low beta-carotene levels tend to reflect a more active HIV-1 infection rather than a deficiency amenable to intervention [R, R].

8) Birth Control Pills

In an observational study of 150 women, the ones that took birth control pills (oral contraceptives) had lower beta-carotene levels than the ones that didn't [R].

How to Increase Beta Carotene Levels

Increase the amount of beta-carotene-rich foods in your diet. Good sources, include [R, R, R, R]:

- Fruits (apricots, peaches, persimmons, melon, watermelon, citrus, tomatoes)
- Green vegetables (spinach, broccoli, parsley, collard greens)
- Orange tuber vegetables (carrots, sweet potatoes)
- Animal tissues and products (salmon, egg yolk, butterfat)

Fiber can interfere with beta-carotene absorption. That is why **fruit and vegetable juices are a better source than whole fruits/vegetables** [R].

But **what's even better is adding fats to your beta-carotene rich meals.**

Dietary fats increase the bioavailability of carotenoids from meals. For example, **avocado increases both beta-carotene absorption** by 2.4 to 6.6-fold **and also improves the conversion to vitamin A** by 4.6 – 12.6 – fold [R].

Similarly, **mayonnaise increases the absorption of beta-carotene.** A mayonnaise-containing meal is a better source of beta-carotene than fruit/vegetable juice [R, R].

Processed vegetables, such as carrots and spinach, are a better source of beta-carotene than their raw counterparts [R].

Consuming greater amounts of plant sterols, that reduce cholesterol absorption, **reduces beta-carotene bioavailability** [R]. Plant sterols are found in wheat germ, vegetable oils (corn, sesame, canola and olive oil), peanuts, almonds, and fortified foods.

Lose weight if overweight [R]. People who are obese/overweight have lower beta-carotene levels.

Quit smoking [R, R]. Smoking decreases beta-carotene levels.

Reduce your alcohol consumption [R].

Sometimes, and especially in developing countries, parasites can interfere with the absorption of nutrients in the gut. Studies show that in children, **deworming (anthelmintic) therapy helps increase beta-carotene levels** [R].

These supplements can help increase beta-carotene levels:

- Beta-carotene [R]
- Coriander (cilantro) [R]
- Basil [R]

Avoid lutein supplements, they decrease the absorption of beta-carotene [R, R].

High Beta Carotene Levels

Causes of High Beta Carotene Levels

1) Dietary Intake

Excessive dietary intake of beta-carotene rich foods will cause your beta-carotene levels to rise, as well as potentially cause vitamin A toxicity [R]. This, however, is extremely rare and happens with highly specific diets.

Beta-carotene conversion to vitamin A decreases as the dietary dose increases, protecting us in most cases from vitamin A toxicity [R].

2) Hypothyroidism

Patients with hypothyroidism (underactive thyroid) have significantly higher beta-carotene levels [R, R].

Symptoms of Excess Beta Carotene Consumption

Excess consumption of beta-carotene-rich foods can cause vitamin toxicity. Symptoms include [R, R, R]:

- [Headache](#)
- Nausea
- Vomiting
- Fatigue
- Dizziness
- [Weight loss](#)
- Hair loss
- Dry skin
- Diarrhea
- Muscle [pain](#)

How to Decrease Beta Carotene Levels

Decrease the amount of beta-carotene-rich foods in your diet. Avoid fruit and vegetable juices in favor of whole fruits and vegetables [\[R\]](#).

You can consume greater amounts of plant sterols that reduce cholesterol absorption and **reduce beta-carotene bioavailability** [\[R\]](#). Plant sterols are found in wheat germ, vegetable oils (corn, sesame, canola and olive oil), peanuts, almonds, and fortified foods.

Lutein supplements can help as they decrease the absorption of beta-carotene [\[R, R\]](#).

Genetics

BCO1

The BCO1 (beta-carotene oxygenase 1) gene produces the enzyme **responsible for converting beta-carotene into vitamin A** (retinoid), thereby supporting vision, reproduction, and immune function [\[R\]](#). 5 SNPs in this gene were linked to blood beta-carotene levels and the efficiency of beta-carotene conversion into vitamin A.

SNP	High enzyme activity/Lower blood beta-carotene levels	Low enzyme activity/Higher blood beta-carotene levels	Reference
rs7501331	CC	T (32% lower enzyme activity, 1.6 times higher beta-carotene levels)	R
rs7501331 & rs12934922	CC & AA	T in both SNPs (69% lower enzyme activity, 2.4 times higher beta-carotene levels)	R

rs6564851	TT	GG (48% lower enzyme activity); lower macular pigment optical density*	R , R , R , R
rs11645428	AA	GG (51% reduced activity); lower macular pigment optical density*	R , R
rs6420424	GG	AA (59% reduced activity); lower macular pigment optical density*	R , R

* The higher the macular pigment density, the better the visual performance. People with higher density have a lower risk for certain eye disease [R](#), [R](#).

A missense mutation in this enzyme, T170M, leads to elevated beta-carotene levels and mild vitamin A deficiency [R](#).

BCO2

If carotenoids accumulate in mitochondria, they interfere with mitochondrial function and cause oxidative stress. In fact, this may explain the adverse health effects of excess beta-carotene reported in clinical studies [R](#), [R](#).

BCO2 (beta-carotene oxygenase 2) is a key enzyme that prevents oxidative stress by breaking down beta-carotene in the mitochondria [R](#). BCO2 breaks down beta-carotene in a different fashion from BCO1, without producing vitamin A.

The following SNPs in the BCO2 gene are related to increased inflammation, through the production of inflammatory cytokines (IL-18):

- [rs2115763](#) – the minor variant T is linked to higher IL-18 levels [R](#)
- [rs2250417](#) – the minor variant C increases IL-18 levels [R](#), [R](#)