

# Take your Vitamins

## Vitamins, Minerals & Immunity



Everyone has heard that you should take more vitamin C if you have a cold, but why is that? Vitamins are important for maintaining good health, but how do they help you out when you are suffering from a cold? Vitamin C is certainly the most widely recognized vitamin for supporting the immune system; however, many other vitamins play a critically important role in keeping your immune system running at an optimal level.

Vitamins can act on your immune system in a variety of ways. Many vitamins act as antioxidants, and can help to improve and protect immune function as a result of their antioxidant actions. Vitamins which support the immune system primarily through their role as antioxidants include vitamins C and E as well as some of the B vitamins. Other vitamins play a much more specific role in immunity, targeting very specific aspects of the immune response. These vitamins include vitamin A and vitamin D, which are unique from other vitamins in that they have hormone-like properties, which are highly related to their role in immune system functioning. Minerals are also essential for proper immune function, and can act as

antioxidants or play fundamental roles in regulating cell function. While all vitamins and minerals are essential for good health, including immune system support, some of them play a stronger role than others.

### Vitamin C – The Immunity Superstar

Vitamin C is probably the most widely known vitamin for supporting the immune system and for combating colds and the flu. This reputation is not without reason! In the body, white blood cells contain up to 80 times more vitamin C than the plasma. These important immune cells actively store this vitamin and deliver it to infection sites. At these sites the antioxidant actions of vitamin C come into play, eliminating free radical stress and oxidizing toxins.<sup>1</sup> A wide variety of studies have attested to the benefits of vitamin C for supporting the immune system.

The recommended dietary intake (RDI) of vitamin C is 45 mg per day, however this represents the amount required to avoid an all-out deficiency in the vitamin, leading to scurvy. The renowned researcher Linus Pauling has suggested that higher doses of 240-4000 mg of vitamin C per day are required in order to reduce cold and flu severity and duration.<sup>2</sup> This was based on a study performed by Pauling involving 272 students at a ski camp in Switzerland. Although Pauling's results have come under scrutiny, growing evidence still supports a beneficial role for vitamin C in immune system support.<sup>3</sup>



Overall; the results of numerous studies show that increased vitamin C intake can reduce the duration and severity of cold symptoms. For example, in one study involving over 800 individuals, a daily supplement of 4000 mg of vitamin C was associated with a 21% decrease in disability associated with illness, as defined as days confined to their house. This was also associated with reduced duration of symptoms, fewer days of work missed and fewer

Table 1. Key Functions of Vitamins. Daily doses are for adults and are those recommended by Health Canada.<sup>26</sup> Minimum doses represent requirements to avoid a state of outright deficiency. Higher doses provide more therapeutic benefits.

Vitamin	Daily Dose	Function	Natural Sources
Vitamin A	Minimum: 65 mcg Maximum: 3000 mcg	Promotes skeletal growth, normal tooth structure, healthy immune function, healthy mucous membranes, healthy skin, eyes and hair; essential for night vision.	Fish liver oils, liver, carrots, green and yellow vegetables, dairy products
Vitamin C	Minimum: 6 mg Maximum: 2000 mg	Essential for the formation of collagen; prevents oxidation of other vitamins; aids in metabolism of amino acids and calcium; stops internal bleeding; strengthens blood vessels maintains hard bones and teeth; prevents infections, colds, fatigue and stress; reduces allergies; heals wounds and burns.	Citrus fruits, berries, green and leafy vegetables, tomatoes, cauliflower, potatoes, sweet potatoes
Vitamin E	Minimum: 1 mg Maximum: 179 mg	Protects body from destructive oxidation; strengthens capillary walls; prevents loss of other vitamins; aids blood flow to heart; lowers blood cholesterol and fatty acids; vital to cell health and immune function.	Soybeans, vegetable oils, broccoli, Brussels sprouts, leafy greens, enriched flour, whole wheat, wheat germ, whole grain cereals, eggs
Vitamin D	Minimum: 30 IU Maximum: 1000 IU	Promotes bone and tooth development and normal growth; aids utilization of phosphorus and calcium; maintains nervous system and heart action; prevents rickets; modulates the immune system.	Exposure to UVB light, not present in significant amounts in food.
Vitamin B1 (Thiamin)	Minimum: 0.07 mg Maximum: 100 mg	Helps convert sugar and starches into energy; promotes digestion, strong heart muscle, child growth; prevents fatigue and fat deposits in arteries	Liver, lean meat, whole wheat, brewer's yeast, wheat germ, fish, eggs, roasted peanuts, poultry, sesame seeds, nuts
Vitamin B2 (Riboflavin)	Minimum: 0.07 mg Maximum: 100 mg	Aids in releasing energy to body cells; enables utilization of fats, proteins and sugars	Dairy products, liver, kidney, yeast, leafy greens, fish, eggs
Vitamin B3 (Niacin)	Minimum: 1 mg Maximum: 500 mg	Aids normal functioning of tissues, particularly skin, gastrointestinal tract and nervous system; used with other vitamins in converting carbohydrates to energy	Liver, lean meat, whole wheat, brewer's yeast, wheat germ, fish, eggs, roasted peanuts, poultry, sesame seeds, nuts
Vitamin B5 (Pantothenic Acid)	Minimum: 0.4 mg Maximum: 500 mg	Needed for many chemical processes in the body; Helps modulate stress response; energy production and metabolism; antioxidant; fights infections and accelerates wound healing	Liver, lean meat, whole grain cereals and legumes
Vitamin B6	Minimum: 0.1 mg Maximum: 100 mg	Aids metabolism of protein carbohydrates and fats; controls cholesterol level; builds hemoglobin; Improves energy production	Wheat bran, wheat germ, organ meats, beef, avocados, bananas, milk, eggs
Vitamin B12	Minimum: 0.14 mcg Maximum: 1 mg	Promotes utilization of protein, fats and carbohydrates; essential for formation of red blood cells; builds nucleic acid; prevents pernicious anemia; helps nervous system	Liver, beef, pork, eggs, dairy products, shellfish
Folic Acid	Minimum: 30 mcg Maximum: 1 mg	Crucial for proper brain function and plays an important role in mental and emotional health, especially important during pregnancy	Green, leafy vegetables, orange juice, organ meats, sprouts
Vitamin K	Minimum: 6 mcg Maximum: 120 mcg	Essential for normal blood clotting, supports skeletal health	Green leafy vegetables like swiss chard, spinach and kale

doctor visits.<sup>3</sup> A more recent study from 2002 including 167 individuals found that supplementation with 1000mg of vitamin C daily for 60 days resulted in a significant decrease in number of colds as well as the duration of symptoms when infected.<sup>4</sup>

While there is substantial support for vitamin C's ability to reduce symptom duration, the evidence regarding its ability to prevent infection in the first place is mixed. Generally, it seems that vitamin C is most likely to provide protection against infection under harsh circumstances.<sup>3</sup> For example, several studies have shown that vitamin C supplementation can help to reduce cold incidence in individuals under heavy physical stress, like athletes and military troops.<sup>5</sup> In these higher risk groups, supplementation can help to reduce infection incidence by up to 50%.<sup>5</sup>

### **Vitamin E – Another Antioxidant Vitamin**

Vitamin E is another well-known antioxidant vitamin which has also been shown to have positive effects on the immune system. Like vitamin C, this vitamin is highly concentrated in the white blood cells, helping to protect them from oxidative damage, thereby supporting immune function.<sup>6</sup> Immune system benefits from vitamin E supplementation seem to be particularly pronounced in elderly individuals. As we age T-cell function naturally begins to decline, however, research on both mice and humans has shown that supplementation with vitamin E can help to restore T-cell function.<sup>7</sup> In one study, supplementation with 200 mg of vitamin E in elderly individuals for 235 days significantly improved various indices of immune function. The results of this trial suggested that vitamin E can help to improve T-cell-mediated immunity in healthy elderly individuals.<sup>8</sup> Vitamin E supplementation has also been shown to have similar effects in younger individuals, helping to modulate cell-mediated immunity and reduce oxidative stress.<sup>6</sup>

Other research has suggested that these improvements do translate into tangible results. For example, a study examining the effects of vitamin E supplementation (200IU per day) for one year in an elderly population showed that supplementation had a protective effect, reducing the chance of acquiring an upper respiratory tract infection.

To date, most studies of vitamin E and immune function have focused on only the alpha-tocopherol fraction of vitamin E. However, preliminary studies are suggesting that the tocotrienol fraction of vitamin E may also have a profound effect on immune function. Tocotrienol supplementation in old mice was found to

significantly reduce the age-related decline in white blood cell proliferation that was seen in the control mice.<sup>10</sup> In humans, women who supplemented with 400 mg of palm-sourced tocotrienols for one month prior to receiving a tetanus vaccination showed an improved immune response, including increased antibody and interferon levels.<sup>11</sup>



### **Vitamin D – Immune System Modulator**

More and more research is starting to show the importance of vitamin D for supporting a healthy immune system. This vitamin is synthesized in the skin in response to UVB radiation, and is difficult to obtain from dietary sources.<sup>12</sup> Many individuals, especially those living at northern latitudes, are deficient in this very important vitamin.

In terms of its effects on the immune system, the active metabolite of vitamin D, 1,25(OH)2D3, is a very important immune modulator. Vitamin D acts to inhibit the formation of dendritic cells, which are important for activating the rest of the immune system, and are specialized in antigen presentation. This means that they will engulf invaders and then display markers of the invader, or antigens, which in turn activate other cells of the immune system, such as helper T-cells. By inhibiting dendritic cells, vitamin D reduces the activation of T-cells, and the T-cell mediated immune response.<sup>13,14</sup> In addition to the regulation of T-cells, vitamin D also has an effect on the actions of B-cells. It seems to act on them in two primary ways; first, it stimulates increased production of interleukin (IL)-10, which inhibits antigen presentation by dendritic cells and prevents T-cell activation, and second, it inhibits the production of IgE antibodies, the primary antibody associated with the allergic response.<sup>15</sup> Overall, the immunomodulatory actions of vitamin D play a very important role in preventing the activation of an inappropriate immune response, and is very important for maintaining self-tolerance and preventing auto-immunity.

Beyond its role in immune system modulation, vitamin D is also critically involved in the body's innate immune response. Specifically, vitamin D has been shown to activate important antibacterial proteins, called defensin and cathelicidin.<sup>13</sup> Researchers have related these actions to numerous beneficial effects, including a reduction in the risk of skin infection in individuals with atopic dermatitis<sup>16</sup>, a reduced risk of placental infections during pregnancy<sup>17</sup>, and even a reduction in the occurrence of the common cold.<sup>18</sup>

For example, an examination of the results of the Third National Health and Nutrition Examination Survey found that serum vitamin D levels were inversely associated with the incidence of upper respiratory tract infections.<sup>18</sup> The study examined vitamin D levels and recent URTI in over 18,000 individuals, and found that recent infections were reported in 24% of individuals with the lowest serum levels (<10ng/mL) as compared to only 17% of individuals with the highest serum levels (>30ng/mL).<sup>18</sup>

Scientists have also speculated that vitamin D may be important for helping to reduce the severity of influenza infections. During an influenza infection macrophages release a large amount of pro-inflammatory cytokines, and in many cases the severity of infection is associated with the virus's ability to stimulate cytokine release.<sup>19</sup> For example, highly dangerous flu epidemics such as the 1918 Spanish flu have been associated with high levels of cytokine release, or a cytokine "storm". This innate cytokine immune response can be overwhelming, and levels of such cytokines are significantly higher in those with a fatal outcome.<sup>19</sup> This response also explains how some flu strains are highly virulent even in young, healthy individuals. Research suggests that vitamin D may play a role in regulating the response of monocytes, preventing them from releasing too many pro-inflammatory cytokines.<sup>19</sup> Furthermore, the antimicrobial proteins that are activated by vitamin D have also been shown to help inactivate the influenza virus directly.<sup>19</sup>

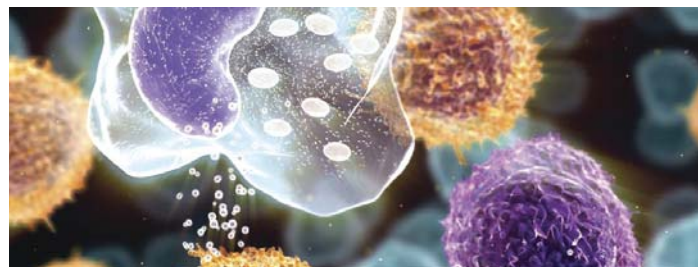


Figure 1. Cytokines released by macrophages in response to influenza infection

These hypotheses have been supported by a recent clinical trial examining whether vitamin D supplementation could help to reduce influenza A incidence in school children.<sup>20</sup> The study occurred over 4 months and involved 334 Japanese school children. The authors found that supplementation with 1200IU of vitamin D3 daily had a protective effect, significantly reducing the incidence of influenza A infection over the study period. Only 10% of children receiving vitamin D suffered from flu infection, as compared to 18% in the placebo group.<sup>20</sup>

### Key Minerals to help keep you Healthy

A large number of minerals also play an important role in maintaining and supporting the immune system. For example zinc, copper, iron and selenium are some of the important mineral players involved in immunity. Individuals with zinc deficiency are more susceptible to infection.<sup>21</sup> Zinc plays an essential role in RNA and DNA replication, and is therefore essential for normal immune cell development and proliferation. Zinc deficiency also results in damage to epidermal cells, preventing the skin from acting as an effective barrier to infection.<sup>21</sup> The importance of zinc for proper immune function was shown in one study which found that zinc supplementation can reduce the incidence of acute lower respiratory infections by 45%.<sup>22</sup> However, supplementation with zinc can lead to copper deficiency, which can also depress the immune system, so it is important to balance supplementation of these two minerals.

Another essential element for proper immune function is selenium. Selenium has been shown to have an enormous number of effects on the immune system, and has been implicated in both helping to prevent infection as well as showing potential for helping to prevent certain cancers.<sup>23</sup> Selenium is a powerful antioxidant, and exerts many of its beneficial effects by preventing oxidative stress and damage in the body. Selenium has also been shown to help boost immunity by improving T-cell response and enhancing neutrophil function.<sup>23,24</sup> Selenium deficiency has been found to be associated with the progression of a number of viral infections including HIV, and in AIDS patients selenium levels have been correlated to survival times.<sup>23</sup> In terms of cold and flu infection, new research in mice has shown that selenium deficiency may actually be a driving force contributing to the evolution of more virulent influenza strains!<sup>23,25</sup> Studies have shown that when selenium deficient mice are infected with the influenza virus, the strain emerges from the mice with far more mutations, which can drive the evolution of more virulent strains of the flu.<sup>25</sup>

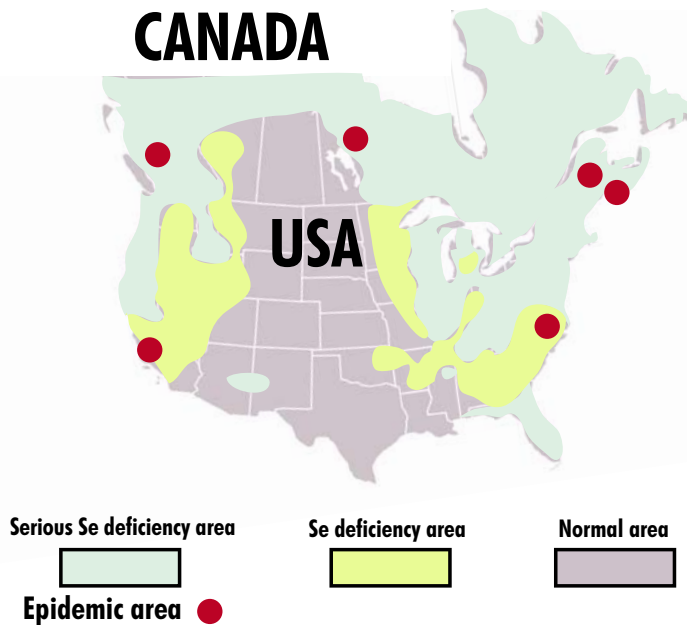


Figure 2. The relationship between selenium levels and the 2005 avian flu epidemic in North America

## Conclusion

It is obvious that an adequate intake of vitamins and minerals is important for keeping your immune system functioning and, therefore, for keeping you healthy. A deficiency in any vitamin or mineral, not just those mentioned above, can result in impaired immune function and other serious health complications. A healthy diet can go a long way towards keeping vitamin and mineral levels up; however, many of us do not eat well all of the time. Furthermore, some nutrients, like vitamin D, cannot be obtained in high enough amounts even from the healthiest of diets. In these cases supplementation is a great solution for getting the nutrients that you need. A good multi-vitamin or individual vitamin or mineral supplements can be used to complement your diet and support your immune system. Not every cold or flu can be prevented, but with vitamins and minerals on your side, your body will be better equipped to face the challenge.

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