

Vegetarian Nutrition

a dietetic practice group of the Academy of Nutrition and Dietetics

Experts in Plant-Based Nutrition

RDN Resources for Consumers:

Vitamin B12 in Vegetarian Diets

Function

Vitamin B12 (B12) facilitates conversion of homocysteine to methionine, is important for energy synthesis, and plays a role in the production of blood cells.

Digestion and Absorption

In foods, B12 is bound to protein, therefore, it needs to be split off in order to be absorbed. The process of digestion and absorption requires adequate synthesis of hydrochloric acid, enzymes, a substance called the intrinsic factor (IF), and healthy small intestines. B12 from supplements does not need to be digested and its absorption occurs in the same time as other nutrients are being absorbed.

Recommended intake

The 1998 Institute of Medicine's (IOM) Recommended Dietary Allowance (RDA) calls for intake of 2.4 µg/day by non-pregnant adults, 2.6 µg/day and 2.8 µg/day, for pregnant and lactating women, respectively.[5] However, newer research studies have shown that these recommendations have been underestimated and that adequate intake may be considerably higher. The European Food Safety Authority's recommendations, issued in 2014, call for intake of 4.0, 4.5 and 5.0 µg/day by non-pregnant, non-lactating adults, pregnant women, and lactating mothers, respectively. Elderly vegetarians, especially vegans, may need still higher doses due to age-related factors that lead to higher risk of B12 malabsorption.

B12 Status of Vegetarians and Vegans

B12 deficiency among vegetarians, especially vegans, is high, ranges from 12% to as much as 94%, and often exceeds 50% of studied participants. B12 deficiency among vegans is usually higher compared to that of vegetarians.

Causes of deficiency

The most common cause of B12 deficiency among vegetarians and vegans is inadequate B12 intake. B12 deficiency in vegetarians has been reported regardless of factors, such as demographic characteristics, place of residency, age, or type of vegetarian diet. Older vegetarians, especially vegans, may also develop a deficiency due to age-related physiological changes that impact B12 absorption.

Symptoms of deficiency

Symptoms of B12 deficiency among vegetarians, especially vegans, have been reported in both adults and children, including infants. Symptoms caused by and complications associated with inadequate B12 status are listed in table 1 and 2. Hematological problems, such as megaloblastic anemia along with peripheral neuropathy symptoms, such as tingling and feeling pins and needles, most of the time develop when serum B12 drops below traditional deficiency cutoffs (see Table 3). However, associations between brain atrophy or cardiovascular complications have been reported among those with considerably higher serum B12 concentrations, often two to two and a half times higher than RDA. Inadequate B12 and/or elevated homocysteine concentration (e.g. >10µmol/L) have also been associated with diabetic complications, organic mental disorder, and bone fractures.

Cases of B12 deficiency among infants and toddlers are of most concern. Infants and toddlers who developed B12 deficiency were often diagnosed with profound developmental delays and neurological damage. In most severe cases, infants and children developed such symptoms as inability to sit on their own, anorexia, and severe deficient in weight, height and head circumference.

Food Sources and Bioavailability of B12

Some food items believed to be made exclusively of plant ingredients (e.g. cereal, breads, pies and even cookies) may contain very small amounts of B12 due to either contamination during processing, adding of small amounts of ingredients derived from products of animal origin such as milk solids, or nutrient fortification. However, the amount of B12, in the majority of these foods, except foods fortified with this vitamin, is negligible. Eggs contain more B12 than milk and dairy products. Cooking destroys B12, the longer food is cooked the less active B12 is available.

Supplements and fortified foods

B12 in a supplement form, mostly as cyanocobalamin, is widely available in pharmacies, grocery stores, and health food outlets. Other forms of B12, such as methylcobalamin and hydroxocobalamin, can also be found. Several cereal products, fortified with B12, constitute a significant source of B12, often containing above 3 µg of B12 per 3.5 oz. serving. Additionally, some brands of nutritional yeast are fortified with vitamin B12. It is important to read labels as not all cereals, meat analogues, soymilks, and nutritional yeast are fortified with B12, and the amount of fortification can change. Using B12 supplement, especially as cyanocobalamin is the most reliable way to ensure adequate B12 status is maintained.

Unreliable "sources" of B12

Although some bacteria in the small intestine produce B12, this synthesis does not appear to be adequate for maintenance of sufficient B12 status in humans. Findings regarding B12 content of algae, such as spirulina, nori, and kombu, are inconsistent. Algae may or may not contain the active B12; they often contain the biologically inactive B12 analogues, which are useless for humans. Fermented soy products, such as tempeh and other plant foods, do not contain biologically active forms of B12. Using probiotics is not a reliable method of preventing B12 deficiency. "Living" vitamin supplements, made from plants, do not contain biologically active B12.

Misconceptions about B12

All forms of B12 available as supplements are appropriate for a long-term use. Cyanocobalamin does contain cyanide; however, the amount is several times smaller than what is typically ingested with food. Thus, the use of cyanocobalamin is not associated with cyanide toxicity. All vegetarians, not just vegans, should pay attention to ingesting adequate B12, preferably as supplements. Human body may or may not store enough B12 for years. It is thus critical to ensure reliable sources of B12 are ingested on regular basis.

Recommendations for Vegetarians

In order to prevent deficiency, vegetarians should ingest a reliable B12 source, such as fortified foods or supplements. As B12 deficiency and insufficiency is common among individuals who regularly ingest eggs and dairy products, lacto-ovo-vegetarians should ensure additional sources of B12, preferably supplements, are used.

All vegetarians, regardless of type, should periodically be screened for B12 deficiency.

All vegetarians, especially vegans, pregnant women, and the elderly, should be using B12 supplements regularly.

Consult with your physician and/or Registered Dietitian regarding supplemental dose and if you suspect you may be deficient.

Table 1. Selected symptoms of B12 deficiency in pediatric population.

Category	Symptoms
Anthropometric	Developmental delays/fall in growth curves Weight G10th percentile Height G 10th percentile Head circumference G 10th percentile Unable to sit alone Unable to walk Involuntary movements Hyperpigmentation Abnormal fine and gross motor functions
Hematological	Elevate MMA Elevated Hcy Low or normal B12 Pancytopenia (low count of all blood cell types) Low or subnormal RBC, WBC, platelets
Other	Anorexia Failure to thrive Lethargic Lack of responses to stimuli/ interaction with people Hypotonic
	Muscular weakness Involuntary movements Slow/abnormal EEG Delays in speech development

Abbreviations: MMA, methylmalonic acid; Hcy, homocysteine; RBC, red blood cells; WBC, white blood cells; EEG, electroencephalogram.

Table 2. Selected symptoms of b12 deficiency in adults.

Category	Symptoms
Neurological	Deterioration of the myelin, cognitive decline (e.g. memory loss), speech impairment (slurring), difficulty walking, inability to feel the ground, tingling, difficulty concentrating, numbness in both legs, mood alteration/swings, muscle cramps, paralysis, electric shock sensations, jerking movements of abdominal muscles, anxiety, depression, clumsiness, visual impairment
Psychiatric	Disorientation, hyperactivity, decreased need for sleep, reckless and agitated behavior, social withdrawal, decreased interest, apathy, difficulty with falling asleep and concentrating, suspiciousness, hearing voices, hallucinations
Oral	Glossitis, pain and burning sensation in tongue, gradually progressive hoarseness, difficulty eating, red stains on inside of cheeks and tongue, oral epithelial dysplasia
Dermatological	Hyperpigmentation (blackish discoloration of the skin on knuckles, darkening of hands, feet, and tongue), skin lesions on feet, neck, and upper and lower limbs
Hematological	Pancytopenia (low count of all blood cell types), macrocytic anemia, hyperhomocysteinemia
Other/rare	Anorexia, exercise intolerance, urinary incontinence, persistent watery diarrhea, normal blood pressure in supine position and rapid blood pressure drop in standing up position

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