

Vitamin B12 and Plant-Predominant Diets

Abstract: *Vitamin B12 deficiencies are common in individuals consuming plant-predominant diets, including those who consume dairy and/or eggs. Deficiencies can lead to megaloblastic anemia and peripheral neuropathy, among other multi-system manifestations. The prevalence, assessment and prevention of vitamin B12 deficiency in patients following plant-predominant diets will be discussed.*



Keywords: vitamin B12; plant-based diet; vegan; vegetarian

While plant-based diets are rich in nutrients such as fiber, vitamin C, folate, and magnesium, nutrient deficiencies including that of vitamin D, iron, omega-3 polyunsaturated fatty acids, and vitamin B12 can occur.¹ Vitamin B12 is unique in that it is only synthesized by microorganisms and thus essentially devoid in foods of plant origin, except through contamination with soil, exposure to foods containing vitamin B12, or if the plant-based food is fortified.² Vitamin B12 is essential for neurologic function, red blood cell production, and DNA synthesis.³ Deficiencies can lead to megaloblastic anemia and peripheral neuropathy, among other, multi-system manifestations.⁴ Usually, hematologic manifestations and anemia precede neurologic signs; however, because

a plant-predominant diet is rich in folate, early hematological symptoms may be masked, making monitoring and prevention of deficiency of utmost importance.⁵

Although vitamin B12 deficiency was once thought to be extremely rare except in very strict vegan/vegetarian diets, it is now known that deficiency is more common, even in those vegetarians consuming eggs and dairy.² Another common misconception is the idea that vitamin B12 deficiency takes many years to

suspected vitamin B12 deficiency starts with a serum vitamin B12 level.^{4,7,8} Serum vitamin B12 thresholds diagnostic for deficiency vary widely, and it has been found that deficiency conditions may be present at concentrations above commonly used cutoffs (156 pg/mL).⁹⁻¹¹ Extremely low levels (< 70 pg/mL) usually reflect deficiency accompanied by clinical manifestations, but there is a large range of uncertainty (100–300 pg/mL) in which further testing with

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develop, whereas we now know that it can occur within the first 2 years of initiating a plant-predominant diet.⁶ The prevalence, assessment, and prevention strategies of vitamin B12 deficiency in patients following plant-predominant diets will be discussed.

Assessment

The recommended laboratory evaluation for patients with

serum or urine methylmalonic acid or holotranscobalamin II may be useful.⁸ Due to the lack of reference method or gold standard for assessing vitamin B12 deficiency, it may be prudent to treat all patients with mild deficiency while evaluating for and treating other diagnoses.⁸ Likewise, because of the prevalence of vitamin B12 deficiency in patients following

a plant-predominant diet, a supplement should be recommended for most patients.

Prevalence

One of the first studies to link vitamin B12 deficiency to plant-based dietary patterns was published in 1955 by Wokes et al.¹² The study systematically compared a group of British, Dutch, and US vegans with omnivores from the same countries. The study found that many of the vegans had significantly lower vitamin B12 concentrations than their meat-eating counterparts. A second study, published a year later by Dhopeswarkar et al.,¹³ observed a similar trend in lactovegetarians vs nonvegetarians in India.

While the prevalence of vitamin B12 deficiency in the United States/United Kingdom general population is approximately 6% in patients less than 60 years of age and 20% in patients older than 60, the prevalence in patients consuming plant-predominant diets is higher.^{2,3,14} In a systematic review of literature based on serum concentrations of vitamin B12 among vegetarians, a deficiency was present ranging from 0 to 86.5% in adults and elderly, up to 45% in infants, from 0 to 33.3% in children and adolescents, and from 17 to 39% among pregnant women.¹⁴ As discussed previously, this research was based on the use of serum vitamin B12 levels which likely underestimates the true rate of deficiency, due to the inaccuracy of this assessment method.¹⁵ Likewise, this study was conducted in vegetarians and included patients who consume dairy, eggs, or both.

A second review reported vitamin B12 deficiency rates from studies that identified deficiency using methylmalonic acid, holotranscobalamin II, or both.² In this study, a deficiency was documented in 11–90% of adults and

elderly, 62% of pregnant women, 25–86% of children, and 21–41% of adolescents. Of interest, the prevalence of deficiency among children in the United States was estimated to be 55% in general, but a sub-analysis revealed that prevalence was 67% in children who followed a vegetarian diet their entire life vs 25% among other vegetarian children.¹⁶ The authors hypothesized this finding was likely due to low maternal B12 stores that resulted in low stored B12 in offspring. Although a wide range of reported B12 deficiency was found in adults and children, there was heterogeneity in the definition of deficiency used in many of the studies. For example, the lowest rates of deficiency (11%) were reported in a study that used criterion for deficiency that was 2 to 3 times higher than what was used in the other included studies. The study also found that B12 deficiency was more likely in vegans than vegetarians.

Prevention

While it may be possible for patients consuming plant-predominant diets to obtain adequate amounts of vitamin B12 through intake of eggs, dairy, and fortified products, as evidenced by the studies described above, most patients do not. The vitamin B12 content of eggs and milk is quite low, and appreciable loss in content or bioavailability is demonstrated when milk is processed and eggs are cooked.¹ Nutritional yeast is a product commonly fortified with vitamin B12 and often recommended for use in patients consuming plant-predominant diets to reduce the risk of deficiency. Approximately 2 tablespoons of nutritional yeast contain the amount equal to the US RDA (2.4 mcg/day) for adults.¹⁷ While the product can add B12 to the diet, it must be consumed consistently to prevent

deficiency and supplements have been shown to be more effective in correcting an existing vitamin B12 deficiency than use of nutritional yeast.¹⁸ Furthermore, nutritional yeast is not endorsed as an adequate practical source of B12 by the American Dietetic Association.¹⁹

Cyanocobalamin is the most economical and commonly encountered vitamin B12 supplement in the United States. Oral doses range from 100 to 5000mcg. The absorption of vitamin B12 depends on the dose and frequency of administration.²⁰ In general, the higher the dose, the lower the absorption rate.²¹ Various oral and intramuscular formulations are available, and high-dose oral supplementation has been found to be as effective as parenteral administration.²² There is no universal dosing recommendation for cyanocobalamin for health maintenance in patients consuming a predominantly plant-based diet. Recommendations for adults range from 250 mcg by mouth daily to 500–1000 mcg by mouth several times per week.^{19,23} Despite the common misconception that a vitamin B12 deficiency takes decades to develop, it is known that vitamin B12 deficiency can occur as early as 2 years after initiating a plant-predominant diet.^{18,24,25} Therefore, supplementation with cyanocobalamin should be initiated, ideally, with the onset of the plant-based diet.

Conclusions

Vitamin B12 deficiency in patients consuming plant-predominant diets is high, even among those vegetarians who consume dairy, eggs or both. The risk for deficiency is higher in vegan patients and in those who have consumed plant-based diets from birth. Because of the increased risk of deficiency, most patients consuming plant-based diets should be encouraged to use

a vitamin B12 supplement. Oral cyanocobalamin at doses of at least 250 mcg daily should be recommended. If laboratory measures are used to assess or monitor B12 status, it is important to note that serum vitamin B12 thresholds diagnostic for deficiency vary widely, and it may be prudent to supplement patients with mild deficiency (< 300 pg/mL) or employ more specific tests (methylmalonic acid and holotranscobalamin II). While nutritional yeast can be helpful in obtaining vitamin B12 in the plant-predominant diet, a supplement is preferred for patients with existing deficiency. Lastly, because deficiencies can present within the first 2 years of initiating a plant-based diet, patients should be encouraged to begin supplementation at the onset of the diet.

Declaration of Conflicting Interests

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