

# The Whitehall-Robins Report

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## Potential micronutrient inadequacies in vegetarian diets

Candice A. Rideout, PhD

Assistant Professor, Department of Family and Nutritional Sciences, University of Prince Edward Island  
Adjunct Professor, Department of Human Nutritional Sciences, University of Manitoba

Approximately 2.3% of American adults<sup>1</sup> and 4% of Canadian adults<sup>2</sup> indicate they are vegetarian. Vegetarian diets have been associated with notable health benefits, including reduced risk for obesity, type 2 diabetes, cardiovascular disease, and various cancers<sup>3-5</sup>. Although it is recognized that well-planned vegetarian diets are consistent with good health<sup>6</sup>, it is important to be aware of micronutrients that may be inadequate if nutritious choices are not made. This report will briefly review different types of vegetarian diets and highlight micronutrients warranting special attention.

### Types of vegetarianism

People who self-identify as vegetarian may be characterized by a number of different dietary patterns. Generally speaking, a vegetarian diet is one that excludes meat, poultry, and seafood. Lacto-ovo vegetarians include both eggs and dairy products, whereas lacto vegetarians consume dairy products (but exclude eggs) and ovo vegetarians consume eggs (but exclude dairy products). People following a vegan diet typically consume grains, legumes, fruits, vegetables, nuts, and seeds, but avoid all foods of animal origin, including meat, poultry, seafood, eggs, dairy products, and possibly honey.

Vegetarian diets are broadly defined on the basis of foods they exclude, thus the actual composition of vegetarian diets varies substantially. Many self-identified vegetarians may, in fact, consume some animal tissue foods periodically. For example, in the British Columbia Nutrition Survey, 5.8% of adult respondents identified as vegetarian – however, of those, 75% consumed seafood occasionally, 58% consumed poultry occasionally, and 22% consumed red meat occasionally<sup>7</sup>.

In affluent Western societies, vegetarian diets are typically consumed by health-conscious people<sup>8</sup> and usually conform to dietary recommendations more closely than do average omnivorous diets<sup>9</sup>. They tend to be quite high in beneficial dietary components (including fibre, folate, vitamins C and E, and phytochemicals) and low in less desirable dietary components (such as saturated fat and cholesterol)<sup>9</sup>. However, the more restrictive the vegetarian diet, the greater the likelihood of nutritional inadequacy.

### Micronutrients and vegetarianism

Several micronutrients may be lacking in a vegetarian diet that is not well planned. The following deserve special consideration to ensure adequate intakes are achieved.

**Iron:** As a component of hemoglobin, iron is critical to the transport of oxygen throughout the body. Insufficient iron intake is common and prolonged inadequate intakes can lead to lethargy, reduced work capacity, and other signs of iron deficiency<sup>10,11</sup>. Dietary iron is present as either heme or nonheme iron. Heme iron is the most readily absorbed, but it occurs only as a component of myoglobin or hemoglobin in animal tissue foods. While vegetarian and vegan diets tend to be relatively high in dietary iron<sup>12</sup>, that iron is exclusively the less bioavailable nonheme form. Not surprisingly, vegetarians and vegans tend to have lower serum ferritin (the storage form of iron) than omnivores<sup>13,14</sup>. However, their hemoglobin levels tend to be similar to those of omnivores<sup>13,14</sup>, reflecting no difference in functional capacity.

Notably, the extent to which nonheme iron is absorbed is greatly affected by both an individual's iron status (absorption is higher in people with low iron stores) and the presence of other nutrients and dietary compo-

nents<sup>10</sup>. For example, absorption is inhibited by phytate (present in grains and legumes), calcium, fibre, and polyphenols (including tannins present in black tea, coffee, and some wines)<sup>10,15</sup>. Conversely, absorption is substantially increased in the presence of vitamin C<sup>10,16</sup>. Overall, the bioavailability of iron in a vegetarian diet is approximately 10% (compared to 18% from a typical omnivorous diet)<sup>10</sup>. As a result, the Recommended Dietary Allowance (RDA) for iron for vegetarians is 1.8 times higher than that for people consuming a mixed diet<sup>10</sup>. Men and postmenopausal women consuming well-planned, varied vegetarian or vegan diets will typically be able to meet this higher RDA quite easily. However, the higher intake required for women aged 19–50 years (to accommodate the loss of iron that accompanies blood loss in the monthly menstrual cycle) requires greater vigilance and application of strategies to maximize absorption of nonheme iron.

**Zinc:** Zinc plays roles in protein structure and the regulation of gene expression. Although overt deficiency is rare, vegetarians may be at risk for suboptimal zinc intake because it, like iron, is less bioavailable in vegetarian diets<sup>17</sup>. In a mixed omnivorous diet, zinc is largely provided by animal foods, especially beef. Vegetarian diets tend to be slightly lower in total zinc than omnivorous diets<sup>12</sup> and plant foods that are high in zinc (including whole grains, legumes, nuts, and seeds) also tend to be high in phytate, which inhibits its absorption<sup>17,18</sup>. A study of women consuming a lacto-ovo vegetarian or omnivorous diet for eight weeks indicated that 26% of the zinc present in the high-phytate vegetarian diet was absorbed, versus 33% of that present in the lower-phytate omnivorous diet (a 21% reduction in the efficiency of absorption from the vegetarian diet)<sup>19</sup>. The higher phytate content characteristic of vegetarian diets appears primarily responsible for differences in zinc bioavailability: a comparison of controlled vegetarian and meat-based diets (each designed to contain similarly high amounts of phytate) revealed comparable fractional absorptions of zinc<sup>20</sup>.

The lower zinc content of vegetarian diets and its reduced bioavailability put vegetarians at higher risk for deficiency, but provided a variety of whole grains and legumes are consumed, vegetarians can meet their zinc requirement and maintain zinc balance<sup>19</sup>. Although it has been estimated that vegetarians may need to consume up to 50% more than the RDA for zinc to accommodate its lower bioavailability from plant foods, at this time there are insufficient data to support a modification of the RDA for zinc for people consuming vegetarian diets<sup>10</sup>.

**Vitamin B<sub>12</sub>:** Vitamin B<sub>12</sub> is required for normal DNA synthesis, homocysteine metabolism, and myelination of nervous tissue. It is synthesized by bacteria and dietary sources include foods of animal origin, fortified plant foods, or supplements<sup>6</sup>. Neurological disturbances ranging from tingling in the extremities to cognitive changes and dementia occur with clinically observable vitamin B<sub>12</sub> deficiency<sup>21</sup>. Vegetarians, especially vegans,

have often been shown to consume less vitamin B<sub>12</sub> than omnivores<sup>12,22</sup>, although overt deficiency (reflected in clinical symptoms or low serum vitamin B<sub>12</sub>) has been relatively rare<sup>22</sup>. However, more recently, vitamin B<sub>12</sub> status has been investigated using metabolic markers and it has been reported that vegetarians (especially vegans) are more likely to be deficient in vitamin B<sub>12</sub> and have elevated total plasma homocysteine, a risk factor for cardiovascular disease<sup>23,24</sup>.

Vegans in particular must consume fortified foods and/or supplements containing vitamin B<sub>12</sub> on a regular basis to ensure adequate reliable vitamin B<sub>12</sub> intake. It is also important to note that up to 30% of older adults (regardless of dietary pattern) may produce insufficient gastric acid, reducing their ability to absorb naturally-occurring vitamin B<sub>12</sub> from the diet<sup>21</sup>. Therefore, all adults over the age of 50 years should aim to consume the RDA from foods that have been fortified with vitamin B<sub>12</sub> or consume a supplement containing vitamin B<sub>12</sub><sup>21</sup>.

**Calcium:** Calcium is essential for bone health, nerve transmission and muscular contraction. Over time, inadequate calcium intake increases risk for bone loss and osteoporosis<sup>25</sup>. Vegetarians who consume dairy products tend to have calcium intakes that are roughly equal to, or even greater than, those of people consuming an omnivorous diet, although vegans typically consume significantly less<sup>6,12</sup>. Vegans are not the only group at risk for low calcium intake, however. Among adult Canadians, only young men aged 19–30 years have a mean calcium intake (from food and supplements combined) that meets recommended levels<sup>26</sup>. Women over the age of 50 years appear to be furthest from achieving the Adequate Intake (AI) for calcium, with consumption from food averaging only approximately 60% of what is recommended, and intakes still falling short of the AI when supplemental calcium is also considered<sup>26</sup>.

Whether dairy consumption is required for a healthy vegetarian diet has been debated<sup>27,28</sup>. Cow's milk has been cited as the most economical source of nutrients critical to bone health, especially calcium<sup>28</sup>. Further, a large prospective study indicated that while the rate of bone fracture among vegetarians was no different from that among people consuming an omnivorous diet, vegans had a 30% higher risk of fracture<sup>29</sup>. This was attributed to their lower consumption of calcium: calculated average daily calcium intakes were 1011 mg in meat eaters, 1033 mg in vegetarians, and 592 mg in vegans<sup>29</sup>. The difference in fracture risk was eliminated when participants with very low calcium intakes (<525 mg/day) were excluded from the analysis<sup>29</sup>.

Although there are many calcium-rich plant foods<sup>6</sup>, consuming the recommended amount of calcium from whole plant foods alone would be challenging for most people<sup>30</sup>. However, in recent years, the availability of plant food products fortified with calcium has increased, which would facilitate meeting the calcium requirement for strict vegetarians who do not consume dairy products. Notably, calcium-fortified soy beverage is

now widely available in Canada, and is recognized as interchangeable with cow's milk in meeting the recommendations of Canada's most recent food guide<sup>31</sup>.

**Vitamin D:** The role of vitamin D in calcium absorption and bone health has long been recognized and its association with risk for various types of cancer, autoimmune diseases and other health conditions has received increasing attention<sup>32</sup>. Humans produce vitamin D with adequate skin exposure to UVB radiation from sunlight. However, sunlight exposure is insufficient to meet vitamin D needs throughout the year in northern latitudes and many Canadians experience vitamin D insufficiency<sup>33</sup>.

There are few dietary sources of vitamin D. Fatty fish (such as salmon) is a good source for people who consume seafood, but the majority of dietary vitamin D is derived from fortified cow's milk<sup>25</sup>. Low intakes of vitamin D among vegetarians and vegans have been reported<sup>34,35</sup> and in the absence of sufficient sun exposure, vegans with low vitamin D intake may have low circulating vitamin D<sup>35</sup>. However, it appears that vegetarian status is less important than other factors (including sun exposure, skin pigmentation, and use of supplements) in determining serum 25-hydroxyvitamin D concentration<sup>34</sup>. Further, as was the case with calcium, the increasing availability of foods fortified with vitamin D (including soy beverage and, more recently, orange juice) will make it easier for vegans to regularly consume the recommended amount of vitamin D.

Regardless of dietary pattern, vitamin D intake is below recommended levels in Canadians over the age of 50 years<sup>36</sup> and Eating Well with Canada's Food Guide advises that all adults over 50 years of age consume 10 µg (400 IU) of supplemental vitamin D daily<sup>31</sup>.

## CONCLUSION

Well-planned vegetarian and vegan diets promote good health and conform to current dietary guidance. The consumption of a variety of nutrient-dense plant foods (with dairy products and eggs, if desired) and the appropriate inclusion of fortified foods will enable vegetarians and vegans to meet their needs for iron, zinc, vitamin B<sub>12</sub>, calcium, and vitamin D. If dietary intake of key micronutrients is insufficient, supplements (such as a daily multivitamin/mineral supplement) may be warranted to ensure recommended intakes are achieved.

**Table 1. Micronutrients of potential concern in vegetarian diets, amounts required, and possible food sources.**

Micronutrient	Amount required	Selected vegetarian food sources <sup>1</sup>
Iron	Women 19–50 years: RDA* = 32 mg/day <sup>2</sup> Women ≥ 51 years: RDA = 14 mg/day <sup>2</sup> Men ≥ 19 years: RDA = 14 mg/day <sup>2</sup>	Tofu, legumes, nuts and seeds, dried fruit, fortified vegetarian meat substitutes, fortified cereals (e.g., cream of wheat)
Zinc	Women ≥ 19 years: RDA = 8 mg/day <sup>3</sup> Men ≥ 19 years: RDA = 11 mg/day <sup>3</sup>	Dairy products, legumes, nuts and seeds, whole grains, fortified soy beverage, vegetarian meat substitutes
Vitamin B <sub>12</sub>	Women ≥ 19 years: RDA = 2.4 µg/day <sup>4</sup> Men ≥ 19 years: RDA = 2.4 µg/day <sup>4</sup>	Cow's milk, eggs, fortified soy beverage, vegetarian meat substitutes, nutritional yeast (Red Star Vegetarian Support Formula only)
Calcium	Women and men 19–50 years: AI** = 1000 mg/day Women and men ≥ 51 years: AI = 1200 mg/day	Dairy products, tofu (set with calcium), legumes, green vegetables, almonds, sesame seeds, fortified soy beverage, fortified orange juice
Vitamin D	Women and men 19–50 years: AI = 5 µg (200 IU)/day Women and men 51–70 years: AI = 10 µg (400 IU)/day <sup>5</sup> Women and men ≥ 71 years: AI = 15 µg (600 IU)/day <sup>5</sup>	Cow's milk, eggs, fortified soy beverage, fortified orange juice

Notes:

\*RDA (Recommended Dietary Allowance)

\*\*AI (Adequate Intake)

1. Most vegetarian food sources from taken from references #6.
2. These values are 1.8 times higher than the RDA for iron for people consuming an omnivorous diet.
3. Vegetarians may need to consume up to 50% more than the RDA in order to meet their zinc requirement.
4. All adults over the age of 50 years should consume most of this amount from fortified foods or supplements.
5. All adults over the age of 50 years should consume a daily supplement of vitamin D (10 µg/400 IU).

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Correction: The May 2009 Whitehall-Robins Report and Supplement should have read Volume 18, Number 2