REVIEW article

Lifestyle and nutritional deficiencies associated with vegetarian diets

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ABSTRACT

Vegetarian and vegan diets are becoming increasingly popular as people become more aware of the benefits they offer to human health and the environment. Even though vegetarian diets have been associated with a decreased risk of death and chronic illnesses, followers of these diets might not acquire adequate nutrients, which could limit the benefits to their health. The main nutrients to be concerned about are iron, calcium, vitamin B12, vitamin D, iodine, and selenium. Anyone following a vegetarian or vegan diet needs to take vitamin B12 supplements. To avoid vitamin B12 deficiency, adults should take 50 µg - 100 µg of cyanocobalamin orally once a day or twice a week at 2000 µg. Iodine supplements are recommended for pregnant and lactating women, as well as vegetarians and vegans who are unable to consume sea vegetables or iodine-fortified foods. Adults should take 150 µg of iodine supplements every day. Understanding the entire spectrum of effects of a vegetarian diet - not just the nutritional ones-is essential. In addition to providing more reliable data, studies in this area may assist in eliminating all factors that could deter people from adopting a vegetarian diet or negatively impact the quality of life of those who already do so.

Introduction

Around 3200 BC, ancient Egyptian communities began to embrace vegetarian diets based on the idea that avoiding meat would facilitate rebirth. Vegetarianism first appeared during this time. The sanctity of cows and the Hindu belief in nonviolence were also connected to this tradition in India, another important vegetarian hotspot [1, 2]. When Darwin's theory of evolution challenged the Church belief that animals had no souls and that their only purpose on Earth was to serve humans, vegetarianism started to gain support again in the late 18th and early 19th centuries [3, 4]. The frequency of vegetarianism varies around the globe. Asia is the continent where this practice is most prevalent, with 19.0% of the population following suit. The outcomes of the Asian continent are influenced by India, the nation with the largest frequency in the world (40.0% of the population) [5]. In Central and South America, the incidence is 8.0%, whereas it is over 16.0% in Africa and the Middle East. The lowest rates of vegetarianism can be seen in North America, where roughly 6.0% identify as vegetarians, and Europe, where 5.0% follow this diet. Different diets are included in vegetarianism, which is categorized according to how restrictive they are. Although cutting meat from one's diet is the common definition of vegetarianism, the term can also refer to other less stringent eating habits. These include, for instance, pescatarians, who abstain from all meat save fish and seafood, flexitarians, who occasionally or even weekly consume meat, and organolacto-vegetarians, who abstain from all meat but eat dairy and eggs. Conversely, a rigorous vegetarian diet forgoes any food derived from animals. A strict vegetarian diet and the avoidance of other consumer goods derived from animal products or that depend on animal exploitation, such as clothing and cosmetics, are two aspects of the more expansive idea of veganism [6, 7].

One can choose a vegetarian diet for several reasons. The ethical arguments, which build on the idea that killing animals for human use is immoral, are the main ones. Vegetarianism's potential and health advantages are powerful motivators. The decision to adopt a vegetarian diet is heavily influenced by faiths that support vegetarianism and worries about the environmental effects of meat production [8-12]. Vegetarian diets are linked to improvements in classic cardiovascular disease risk markers such as blood pressure, plasma lipids, and weight status when compared to omnivore diets [13, 14]. Quality of life (QoL) is a subjective concept that encompasses physical, psychological, social, environmental, and spiritual dimensions, according to the World Health Organization (WHO). Based on 12 surveys, a systematic review study evaluated the nutritional quality of vegetarian meals and discovered that vegetarians had greater levels of nutritional quality than omnivores [15]. As long as they are well-planned, vegetarian diets are suitable for all life phases, according to the Academy of Nutrition and Dietetics [16]. Nonetheless, some steps must be taken to reduce the possibility of dietary deficits.

Cobalamin (vitamin B12), is a water-soluble micronutrient that is produced by microbes [17, 18]. In addition to being necessary for the methylation processes involved in DNA and cell metabolism, vitamin B12 is also necessary for the development of neural tissue and blood cells [19]. Peripheral neuropathy and megaloblastic anemia are just two of the severe multi-system clinical symptoms that can result from a vitamin B12 shortage. Unusual weariness, tingling in the fingers or toes, impaired digestion, and poor cognition are the main signs of a B12 shortage. Even though subclinical vitamin B12 insufficiency can cause stroke, dementia, and poor bone health over time, people with low vitamin B12 consumption may appear healthy at first.

Plant-based foods are virtually devoid of vitamin B12 due to sanitization processes that destroy microbes that create the vitamin [20]. However, because livestock require vitamin B12 to stay healthy and are exposed to it from a variety of sources throughout their lives, including faces, feed tainted with microbes that synthesize B12, feed that contains foods derived from animals, and B12 supplements, the vitamin builds up in animal products like meat, dairy, and eggs [21]. It is crucial to keep in mind that processed beef and red meat are not always reliable sources of B12. Thus, those following plant-based diets that exclude animal products must have a consistent source of vitamin B12 in their diets, such as B12 supplements and foods that have been fortified with B12. A person may be deficient in vitamin B12 even if their blood concentration is normal, therefore it's important to keep in mind that serum vitamin B12 is not a good predictor of vitamin B12 deficiency. The actual prevalence of vitamin B12 insufficiency in vegetarians is most likely higher than what this study suggests.

In the human body, vitamin D plays a major role in maintaining proper levels of calcium and phosphorus in the blood. Numerous metabolic functions, including bone metabolism and transcription regulation, are supported [22]. Vitamin D's known biological significance has grown significantly during the last few decades. More than 36 different cell types are susceptible to physiological processes triggered by vitamin D metabolites [23]. Vitamin D may therefore affect multiple systems and perform a variety of roles in preserving health. Vitamin D deficiency and insufficiency have been linked to several adverse health consequences, including rickets, osteomalacia, some types of cancer, cardiovascular disease, type 2 diabetes mellitus, autoimmune diseases, neurological problems, poor pregnancy outcomes, and mortality. Furthermore, a variety of accessibility barriers prevent some populations from receiving adequate amounts of sunlight. Many factors, including skin pigmentation, sunscreen use, season, latitude, altitude, and air pollution, affect a person's ability to produce enough vitamin D from sunshine. An estimated 20.0% of vitamin D is acquired through diet, with the remaining 80.0% coming from exposure to sunlight [24].

According to a small amount of data, vegetarians are more likely than omnivores to be deficient in vitamin D and to consume insufficient amounts of the vitamin in their diet. Based on studies with 4703 individuals, Bakaloudi et al. [25] conducted a systematic evaluation of vegans' nutritional intake and found that vegan diets were associated with lower vitamin D intakes than reference intake values or lower intakes than omnivore

and other vegetarian diets. Ho-Pham et al. [26] discovered in a cross-sectional analysis of 210 postmenopausal Asian women (105 omnivores and 105 vegans) that omnivores had considerably greater plasma 25-hydroxyvitamin D concentrations than vegans. This conclusion is consistent with the findings of the previous study. The prevalence of vitamin D insufficiency was 73.0% in vegans and 46.0% in omnivores, while the prevalence of vitamin D deficiency was 27.0% in vegans and 6.5% in omnivores, based on plasma 25-hydroxyvitamin D concentrations <30 ng/mL and <20 ng/mL, respectively, as the cut-off values [27]. Higher percentages of vitamin D insufficiency and deficiency observed in vegetarians as opposed to meat eaters may help to explain why vegetarian and vegan diets are commonly associated with poor bone health. A 2019 meta-analysis encompassing 20 trials and 37,134 participants found that vegetarians and vegans have lower bone mineral density at the femoral neck and lumbar spine compared to omnivores [28].

Iodine is one essential micronutrient needed for thyroid hormone synthesis. Triiodothyronine (T3) and thyroxine (T4) are created when two connected tyrosine molecules are joined by three (T3) or four (T4) iodine atoms [29]. Thyroid hormones have important effects on metabolism, growth, and brain development [30]. A group of detrimental health consequences associated with iodine shortage are collectively referred to as iodine deficiency disorders. These include mental disability, goitre and its aftereffects, hypothyroidism, and endemic cretinism [31]. About 110 μg of iodine may be found in 250 mL of cow's milk, which is a substantial amount of the 150 μg/d of iodine that the Institute of Medicine recommends adults consume each day. Just 6.4% of the 47 plant-based milk substitute products that were available in the UK had been fortified, even though the iodine contents in fortified plant-based milk substitutes are similar to those in cow's milk [32]. In 2021, a systematic review involving 1890 participants revealed that vegans' iodine consumption was significantly lower than nonvegans' and often lower than the recommended daily allowance of 150 μg [25]. A comprehensive analysis of research evaluating the iodine status and intake of persons adhering to vegan and vegetarian diets was released in 2020 [33]. Data from 127,094 people were considered. In 83.0% of the trials, the study found that omnivores consumed the most iodine, whereas vegans often consumed the least. Furthermore, the vegan diet group had the lowest median urine iodine levels and failed to achieve optimal status. The median urine iodine levels of vegetarians were lower than those of omnivores but higher than those of vegans. The simplest ways for vegans to receive the iodine they require are through sea vegetables, iodised salt, iodine supplements, and plant-based milk substitutes enriched with iodine. Sea vegetable eaters should be aware that excessive iodine consumption might result in hyperthyroidism [34]. If iodised salt and fortified plant-based milk alternatives are not accessible, or frequent use of sea vegetables is not practical, an iodine supplement should be administered. Health groups such as the American Academy of Pediatrics and the American Thyroid Association recommend that women who are pregnant, breastfeeding, or considering pregnancy take a daily supplement that contains 150 μg of iodine, regardless of their diet. The most common mineral in the human body is calcium, which makes up 2.0% of the average adult's body weight [35]. Body fluids and soft tissues contain 1.0% of the total calcium, with the remaining being retained in bones and teeth [36]. To reach maximal bone mass and promote bone growth, calcium is necessary along with potassium [37]. Low bone mineral density from inadequate calcium consumption can raise the risk of osteoporosis later in life. Vegans may run the danger of not getting enough calcium in their diets. A total of 6376 people were included in the research that examined calcium intake and dietary choices according to Bakaloudi et al. [25]. Vegans ingested less calcium than non-vegans, according to the collective findings of all three studies. Moreover, the WHO RNI for calcium was not met by 76.0% of vegan diet followers. A meta-analysis conducted in 2022 that included 166,877 participants found that vegans had substantially lower calcium intakes than vegetarians and omnivores combined [38]. Vegans should concentrate on eating foods that are high in calcium and bioavailability. Because plant-based diets contain substances like oxalic acid and phytotic acid that prevent absorption, the bioavailability of calcium varies greatly. Despite having a high calcium content, many green leafy vegetables, such as spinach and Chinese spinach, can also have a high oxalic acid content, which reduces the calcium bioavailability to about 5.0%. Vegans with low calcium status should try

to solve the problem by eating more foods high in calcium, such as calcium-fortified plant-based meals, before thinking about taking supplements. This is because supplements have been connected to a higher risk of heart attacks [39].

In a cross-sectional study, the effect of a vegetarian diet on runners' QoL was assessed. 281 people, 158 of whom were vegetarians and 123 of whom were omnivores, were selected as a convenience sample from German-speaking countries, namely Germany, Switzerland, and Austria. The study participants' quality of life was assessed using the WHOQOL-BREF, a digitally administered instrument. The results showed that all individuals, regardless of diet type, had high QoL levels and that there was no difference in QoL values between groups. Thus, it was concluded that runners enjoy good QoL and that vegetarianism was as favourable as omnivory for this population segment [40]. In Brazil, a specific questionnaire to evaluate the QoL of vegetarians was developed and validated, since other studies used only general questionnaires or others that were not specific to vegetarians [41]. According to the responses, vegetarians have an acceptable QoL (average ratings range from 70 to 80 on a 100-point scale). Out of all the different types of vegetarians, vegans received the highest ratings. In a clinical trial, the effects of a vegetarian diet and a standard type 2 diabetes treatment diet on patients' eating patterns and quality of life were assessed. QoL was assessed using the Weight-Related Symptom Measure questionnaire (WRSM) and the Obesity and Weight-Loss QoL questionnaire (OWQOL). Type 2 diabetic individuals may benefit from such a dietary pattern not only for their physical health but also for their mental well-being, as both diets enhanced mood and quality of life, but the effect was stronger in the vegetarian diet group [42]. Barnard, Scialli, Bertron, Hurlock, and Edmonds conducted a study to assess American women's acceptability of a low-fat vegan diet. 35 nonmenopausal women were divided into two groups for the study using a crossover design: one group adhered to the diet for two menstrual cycles, while the other group underwent no diet at all. Although the participants said that it required more effort to follow the low-fat vegan diet, it was widely accepted and had great adherence. They also reported reducing weight, which can improve QoL, along with improved digestion, vigour, and sleep [43]. It should be mentioned that four aspects of QoL can be improved by adopting a vegetarian diet. Decreased prevalence of noncommunicable diseases and better health outcomes have a positive effect on the physical domain. Good deeds generate positive emotions, and a sense of community or stronger ties to the vegetarian community benefit the social and psychological realms, respectively. Lastly, the environmental domain benefits from vegetarian diets because they have a lesser environmental impact. A non-balanced vegetarian diet can result in nutritional deficits that would be harmful to health and impact the physical realm, even though overall health would be improved. Since vegetarians are still a minority, stigmatization, and rejection from non-vegetarians could negatively affect vegetarians in society. A vegetarian diet may have unknown psychological and mental impacts, yet some research suggests that there may be a higher risk of depression. Numerous elements from other QoL categories may also have an impact on the decision to adopt a vegetarian diet. Improving one's health is a primary motivation for attempting a vegetarian diet. A desire to reduce one's impact on the environment as well as psychological considerations like morality, religion, and spirituality can drive someone to choose a vegetarian diet. A person may also decide to become a vegetarian as a result of feeling like they fit in with a social group. Finally, persons who live in places with limited access to plant-based food sources may find it difficult to make the changeover to a vegetarian diet because changing one's eating habits is somewhat influenced by contextual factors like food availability and cost.

Conclusion: Numerous nutritional inadequacies associated with vegetarian and vegan diets may restrict their typical benefits in reducing non-communicable diseases. Thus, to ensure that these diets are nutritionally adequate, meticulous preparation is required. While vitamin and mineral-fortified foods are a useful tool, not everyone can access them, thus vegetarians and vegans should develop a suitable supplement regimen. We need to monitor the nutritional features of these diets, particularly as innovative dairy and meat alternatives become more popular. It's important to understand not only the nutritional effects of a vegetarian diet but also its whole range of implications.

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