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Plant-Based Diets in Clinical Practice: Nutrient Adequacy, Monitoring and the Supplements That Are Not Optional

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Abstract

Risk on a plant-based diet tracks supplementation rather than duration. In a clinical nutrition centre cohort of 151 vegans and 85 non-vegans, those not using cobalamin supplements were at higher risk of low plasma cobalamin, with an odds ratio of 4.41 (95% CI 1.2 to 16.16), while no significant difference in cobalamin status related to duration of the diet was observed and regularly supplementing vegans had levels similar to non-vegans. Attention is unevenly distributed across nutrients: among 213 vegan respondents to a survey, all who supplemented took vitamin B12 and 73 per cent took vitamin D, but only 12 per cent took iodine and 7 per cent zinc. Analysis of a published one-week vegan meal plan found it supplying 1 per cent of the daily value for iodine, 5 per cent for vitamin D and 82 per cent for vitamin B12.

Keywords: *Plant-based diet; Vegan; Vitamin B12; Iodine; Nutritional monitoring*

Introduction

Plant-based diets are associated with lower risk of several diet-related chronic diseases and are increasingly adopted for health, ethical and environmental reasons [1,2]. They also carry risk of micronutrient deficiency where inadequately planned, and that risk is described as reliably reducible by supplementation given sufficient awareness [3].

The nutrients repeatedly identified as of concern are vitamin B12, vitamin D, omega-3 fatty acids, calcium, iron, iodine, zinc and protein [4,5]. Systematic review of 141 studies found intakes and status of vitamin B12, vitamin D, iron, zinc, iodine and calcium lower in plant-based diets, with vegans having the lowest intakes of vitamin B12, calcium and iodine and lower bone mineral density [6].

This review examines what actually determines deficiency risk, which nutrients receive attention and which do not, and what monitoring is performed.

Objective

This review sets out to establish four things from the published literature. First, whether deficiency risk on these diets is a function of the diet itself or of supplementation practice. Second, which nutrients are supplemented and which are neglected. Third, what an unsupplemented plant-based diet supplies when analysed directly. And fourth, what monitoring takes place and where professional guidance diverges.

Literature Review

What determines cobalamin status: A cross-sectional analysis of medical data from a clinical nutrition centre compared 151 adult vegans aged 18 to 67, of whom 72 were female, with 85 healthy non-vegans. Vegans had significantly lower cobalamin, haemoglobin and ferritin, with higher folate and mean cell volume. Vegans not using cobalamin supplements were at higher risk of low plasma cobalamin than regularly supplementing vegans, with an odds ratio of 4.41 (95% CI 1.2 to 16.16), and of low holotranscobalamin at 19.18 (95% CI 1.02 to 359.42) (Figure 2) [7].

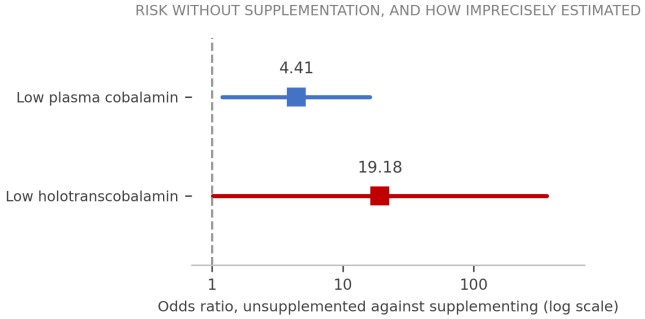

Figure 2: Risk without supplementation, and how imprecisely estimated [7]

Duration did not predict it: In the same cohort, no significant differences in cobalamin status related to duration of the vegan diet were observed, and regularly supplementing vegans had cobalamin and holotranscobalamin levels similar to non-vegans (Figure 3). The authors concluded that cobalamin deficiency risk depends on supplementation status and not on the duration of an exclusive vegan diet, and that cobalamin monitoring and counselling on supplement use should be integrated into routine clinical care [7].

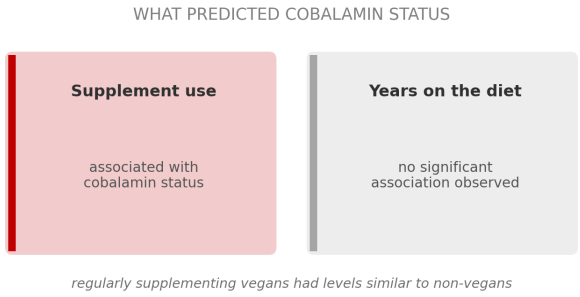

Figure 3: What predicted cobalamin status in the cohort [7]

Iron behaved differently: Despite lower ferritin and haemoglobin in the vegan group, there was no indication of higher risk of iron deficiency among vegans [7]. A lower biomarker value and a clinically meaningful deficiency are therefore not the same finding, and the distinction matters for what is acted upon (Table 1).

Table 1: Unsupplemented against regularly supplementing vegans [7]

Comparison	Odds ratio	Interval
Low plasma cobalamin	4.41	1.2 to 16.16
Low holotranscobalamin	19.18	1.02 to 359.42
By duration of diet	No significant difference	—

Which nutrients receive attention: A survey distributed at a congress on plant-based nutrition returned 475 questionnaires from healthcare professionals, including 213 strict vegan participants, of whom 2 per cent took no supplements at all. All supplementing vegans reported taking vitamin B12. Vitamin D was taken by 73 per cent, omega-3 fatty acids by 22 per cent, iron by 13 per cent, iodine by 12 per cent, calcium by 11 per cent, zinc by 7 per cent, magnesium by 5 per cent and selenium by 4 per cent (Figure 1) [3].

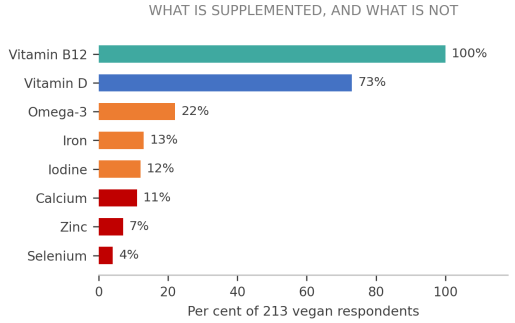

Figure 1: What is supplemented and what is not, among 213 vegan respondents [3]

What monitoring took place: In the same survey, nearly 50 per cent had vitamin B12 tested at least once a year, nearly one quarter every two years, and another quarter rarely or never (Figure 5) [3]. Participants following a vegan diet were better informed about institutional recommendations than those following vegetarian or omnivorous diets [3].

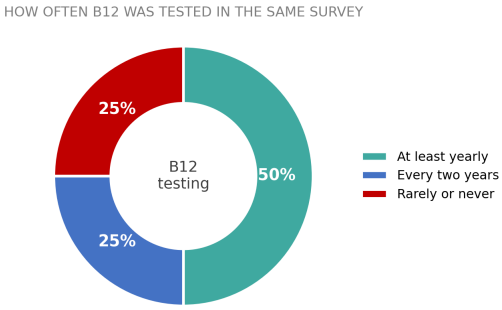

Figure 5: How often vitamin B12 was tested in the same survey [3]

What an unsupplemented plan supplies: Analysis of a one-week meal plan composed of published vegan recipes found it did not meet at least 90 per cent of the daily value for biotin at 56 per cent, calcium 58, choline 30, iodine 1, niacin 75, selenium 68, vitamin B12 82, vitamin D 5, vitamin E 7 and zinc 64 (Figure 4) [8]. Unfortified plant-based diets are described as devoid of vitamin B12 and as supplying low intakes of iodine, zinc, selenium and calcium [9].

Table 2: Attention given against shortfall observed, by nutrient [3,8]

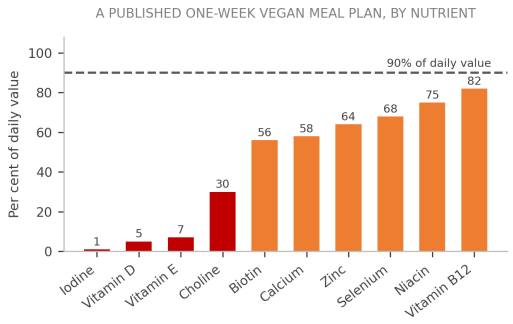

Figure 4: A published one-week vegan meal plan, by nutrient [8]

Children specifically: A systematic review reports that both vegetarian and vegan children develop signs of vitamin B12 deficiency where the diet is not supplemented, that supplementation rectifies this, and that on average around 30 per cent of studied vegetarian and vegan children were not supplemented with vitamin B12. Both groups had lower ferritin, though other iron metabolism markers were similar or slightly lower than in comparison groups, and both had lower 25-hydroxyvitamin D if unsupplemented [10].

Where guidance diverges: One national society does not recommend vegan diets for children or during pregnancy and lactation while recommending reliable vitamin B12 supplementation. Another has stated that a plant-based diet is acceptable at all stages of life, emphasising health-promoting effects and recommending reliable sources of vitamin B12 such as fortified foods or supplements, with vitamin B12 intake determined in vegan-fed infants and children (Figure 6) [3,11] (Table 2).

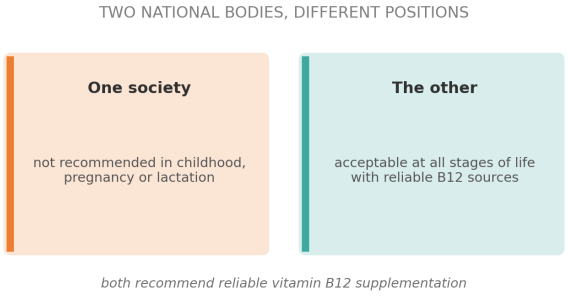

Figure 6: Two national bodies, different positions [3,11]

Nutrient	Supplemented by	Supplied by the analysed plan
Vitamin B12	All who supplemented	82% of daily value
Vitamin D	73%	5%
Iodine	12%	1%
Zinc	7%	64%
Calcium	11%	58%

How prevalent B12 deficiency is: Prevalence among vegetarians has been reviewed directly [12], and status assessed using holotranscobalamin and methylmalonic acid alongside serum B12 in vegetarian populations [13]. Serum concentrations have been compared across omnivores, vegetarians and vegans in a large male cohort [14], and status, assessment and supplementation reviewed together [15]. Professional position statements set out the dietary pattern as acceptable when planned [4], and intake adequacy has been assessed by systematic review [5].

The nutrients that receive less attention: Iodine intake across dietary patterns has been examined by systematic review [16], and iodine deficiency in vegetarians and vegans reported directly [17]. Zinc intake and status across the lifecycle have been reviewed for vegetarian diets [18], and the effect of vegetarian diets on iron status assessed by systematic review and meta-analysis [19]. Docosahexaenoic acid status in vegetarians has been described separately [20]. These are the nutrients for which dietary shortfall and supplementation attention diverge most sharply [3,8].

Bone and fracture: Prospective cohort data report fracture risk in vegetarian and vegan participants [21], and systematic review with meta-analysis has examined bone mineral density and fracture risk together [22]. Those findings sit alongside the lower calcium and vitamin D intakes described above and are the outcome through which they would be expected to manifest [6,21,22].

Children and practical guidance: Practical tools for healthcare providers covering vegan nutrition in mothers and children have been published [23], as have guidelines for the safe and effective use of plant-based diets [24]. Metabolic effects in young children have been studied directly [25], alongside energy and macronutrient intake and anthropometry in comparison groups [26], growth and cardiovascular risk in school-age children [27], and a systematic review of vegetarian diets in children [28]. The health outcomes literature more broadly reports benefit across several endpoints [29,30], with the distinction between healthful and less healthful plant-based patterns bearing on how those results should be read [31,32,33,34] (Table 3).

Table 3: What is and is not established about nutrient risk on these diets

Question	What the evidence supports
Does the diet cause deficiency?	The unsupplemented diet does [7]
Does duration matter?	No significant association found [7]
Does supplementing correct it?	Levels similar to non-vegans [7]
Is attention well targeted?	No; iodine least supplemented [3,8]
Is monitoring routine?	A quarter tested rarely or never [3]

Method

Search strategy: PubMed and the archives of the major clinical nutrition, dietetics and paediatric journals were searched for studies of nutrient adequacy on plant-based diets. Search terms combined vegan and plant-based diet with vitamin B12, iodine, nutrient adequacy, supplementation and monitoring. Reference lists of the healthcare professional survey [3] and the clinical nutrition centre analysis [7] were screened by hand for primary sources.

Eligibility: Studies were included if they reported biochemical status, supplement use or nutrient intake in defined plant-based populations, or analysed the composition of plant-based dietary patterns. Position statements are cited for their content and identified as such. Where a sample is selected in a way that would raise apparent adherence, that is stated.

Data extraction and handling: Population, diet definition, the biomarker or intake measure used and the reported figure were extracted as published. How the sample was recruited is stated alongside every supplementation figure, because the principal survey drew on healthcare professionals attending a congress on plant-based nutrition and its figures should be read as a favourable case rather than as typical practice. This review reports published findings and does not constitute dietary, supplementation or monitoring guidance for any individual, which are matters for the treating clinician and dietitian. No pooling or re-analysis was performed. Figures 1 to 6 and Tables 1 to 3 reproduce published values only. This is a narrative synthesis of published literature and was not registered as a systematic review.

Concluding Remarks

The most useful finding reframes the clinical question. Cobalamin status depended on whether people supplemented, not on how long they had followed the diet, and regularly supplementing vegans had levels similar to non-vegans [7]. The relevant category is therefore not the diet but the unsupplemented diet, and long-standing vegans who supplement are not accumulating a deficit.

That makes vitamin B12 genuinely non-optional in the sense the title intends, and the evidence for it is unusually clean: the deficiency occurs without the supplement, resolves with it, and is not explained by anything else about the diet [7,10]. Both of the professional bodies whose positions differ on other points agree on this one [3,11].

The odds ratios should be quoted with their intervals rather than alone. The estimate for low holotranscobalamin is 19.18 with an interval running from 1.02 to 359.42 [7]. The direction is clear and the magnitude is essentially unestimated, which is what an interval of that width means in a cohort of this size.

The distribution of attention across nutrients is the finding with most practical consequence. Among vegan respondents, vitamin B12 supplementation was universal and iodine reached 12 per cent, zinc 7 per cent [3]. Set that against the meal plan analysis, where iodine supplied 1 per cent of the daily value and zinc 64 per cent [8]. The nutrient with the largest dietary shortfall received almost the least attention, and it is not the one the public conversation is about.

Iron illustrates the opposite error. Vegans had significantly lower ferritin and haemoglobin, and the investigators nonetheless found no indication of higher iron deficiency risk [7]. Treating a lower mean biomarker as equivalent to deficiency would generate investigation and supplementation without evidence of benefit, and the same caution applies to the lower bone mineral density reported elsewhere [6,7].

On monitoring, the survey figures deserve their caveat stated plainly. A quarter of respondents tested vitamin B12 rarely or never, and these were healthcare professionals who had chosen to attend a congress on plant-based nutrition [3]. That is close to a best case, and monitoring in an unselected population is unlikely to be better. The authors' recommendation to integrate cobalamin monitoring into routine care follows directly [7].

Three limitations belong with these conclusions. The principal supplementation figures come from a self-selected sample of congress attendees and are not representative of people following these diets generally [3]. The clinical centre cohort is cross-sectional with 151 vegans, so associations are measured at a single point and several intervals are very wide [7]. And the meal plan analysis examines one published one-week plan from one organisation, which demonstrates what such a plan can omit but not what people following plant-based diets typically eat [8].

There is a service implication that follows without further evidence. If cobalamin status is determined by supplementation rather than by the diet, then the useful clinical action at the point a patient reports following a plant-based diet is to establish what they take rather than to record the dietary label [7,15]. Those are different questions and only the second is routinely asked.

Iodine deserves separate emphasis because it is the clearest mismatch in this literature. Intake across dietary patterns has been reviewed and deficiency in vegetarians and vegans reported directly [16,17], the analysed meal plan supplied 1 per cent of the daily value [8], and 12 per cent of a well-informed vegan sample supplemented it [3]. Whether that shortfall translates into thyroid consequences in practice is not established by the studies reviewed here, which is itself the gap worth naming.

Finally, the health benefits should not be lost in a review about deficiency. Umbrella and systematic reviews report favourable outcomes across several endpoints [29,30,32], and the distinction between healthful and less healthful plant-based patterns matters more for those outcomes than the presence or

absence of animal products alone [31]. The argument here is that specific supplements are not optional, not that the dietary pattern is unsound [4,24].

Acknowledgements

The authors thank the investigators who separated supplement use from duration of diet in their analysis, since that distinction determines whether the clinical concern attaches to the diet or to a correctable omission within it.

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Conflict of Interest

The authors declare no competing interests.

Ethics Statement

This article reviews previously published studies only. No new patient data were collected and no participants were recruited, so ethical approval was not required.

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