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# Vegan Diet in Young Children

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**Abstract**

The prevalence of restrictive diets, mainly vegetarian and vegan, is markedly on the increase in Europe and other Western countries. In young children and adolescents, not only weight and height but also neurocognitive and psychomotor development are all strongly influenced by the source, quantity, and quality of their nutrition. In studies done mainly in adult populations, a plant-based diet showed benefits in the reduced risk of chronic diseases such as obesity, type 2 diabetes, cardiovascular diseases, and some types of cancer. However, there is no clear evidence that a vegan diet started in early childhood confers a lasting health benefit. On the other hand, a vegan diet can be potentially critical for young children with risks of inadequate supply in terms of protein quality and energy as well as long-chain fatty acids, iron, zinc, vitamin D, iodine, calcium, and particularly vitamin B12. Deficiencies in these nutrients can lead to severe and sometimes irreversible developmental disorders. If such a diet is chosen for ethical, ecological, or health reasons, a well-planned, diversified diet with additional supplementation of vitamin B12, vitamin D, iodine, and potentially other micronutrients is crucial to ensure a healthy and nutritious intake during childhood.



In addition to regions where vegetarian and vegan diets have a long cultural- and religious-based tradition, these diets have recently become more and more prevalent in Europe and other Western countries. It is estimated that the prevalence of vegan adolescents and adults in Western Europe countries ranges from around 0.2 to 3% [1]. Reliable population-based numbers on vegan-fed infants and young chil-

**Table 1.** Definitions of vegetarian and vegan diets, adapted from [1]

| Type of diet (selection, preparation) | Summary of definitions collected from numerous sources, abridged |
|---|---|
| Flexitarian (semi-vegetarian)/ meat reductionism/ reducetarian | Occasional inclusion (less than once per week) of flesh foodstuff (meat, poultry, and fish) and permits eating all other animal products (e.g., eggs, milk, honey) |
| General vegetarian diets | Whenever not specified, a vegetarian diet is often an ovo-lacto-vegetarian diet |
| Pescetarian (pesco-vegetarian) | Includes seafood/fish, but not flesh of other animals (meat, poultry), and permits eating all other animal products (e.g., eggs, milk, honey). This diet is sometimes included in the semi-vegetarian group |
| Pollo-vegetarian | Poultry is the only animal flesh consumed, as well as dairy and egg products. This diet is sometimes included in the semi-vegetarian group |
| Ovo-lacto-vegetarian | Excludes all types of flesh foodstuffs (meat, poultry, fish), but permits eating all other animal products (e.g., eggs, milk, honey) |
| Lacto-vegetarian | Excludes flesh foodstuffs and eggs but allows dairy products, honey |
| Ovo-vegetarian | Excludes consumption of all animal products with the exception of eggs |
| Vegan | Diet which excludes all animal products (both as ingredients and processing aids, the latter being an important aspect); an exception is human mother's breast milk, given voluntarily; veganism can also imply excluding all items of animal origin (e.g., made from wool, silk, leather materials)<br>Other subcategories of a vegan diet are:<br>– *Vitarian (raw vegan):* Permits consumption of organic, raw, and fresh foods only; excludes coffee and tea<br>– *Fruitarian:* Excludes flesh foodstuffs, animal products, and vegetables, cereals → permitted are only fruit, nuts, seeds, which can be gathered without damaging the plant<br>– *Sproutarian:* Eating foods in the form of sprouted plant seedlings, such as grains, vegetables, fruits |

dren are not available. Furthermore, little is known about the duration of a vegan diet in this population group. A recent survey in Switzerland found that a majority of vegans (76%) had followed a vegan diet for <5 years [2] and only 2% for >11 years. In this survey, vegans are usually young adults, mostly of a higher socioeconomic status and with an urban lifestyle. Interestingly, men and women were equally distributed. Various other studies have found predominantly moral, ethical, and ecological motivations, whereas health reasons are less frequently mentioned [2, 3].

A vegetarian diet is generally defined as a plant-based diet omitting meat and fish, whereas in a vegan diet no foods of animal origin, including milk, milk products, eggs, and honey are included. Definitions of subcategories of vegetarian and vegan diets in the scientific literature are summarized in Table 1.



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In young children and adolescents, not only weight and height but also neurocognitive and psychomotor development are strongly influenced by the form and quality of their nutrition. Dietary influences on the intestinal microbiota may also influence epigenetic phenomena, allergic predisposition, and emotional and cognitive aspects of a person [4, 5]. Furthermore, the type of diet in infancy influences eating behavior later in life [6].

There is hardly any evidence that a vegan diet started early in childhood brings lasting health benefits [1, 7, 8]. Whereas studies on short-term outcome, such as coverage of macro- and micronutrients are relatively easily performed, studies on long-term health benefits are much more difficult to carry out. There are many confounders influencing long-term outcomes and incidence of chronic disease, vegans being in general more health-conscious, smoke less, are leaner, and physically more active [1]. Moreover, a vegan diet is a negative definition – it describes what is excluded from the diet – but what is actually eaten can be very heterogeneous, much depending on the options of the cultural and economical environment.

In a systematic review with meta-analysis of observational studies of adult cohorts, a plant-based diet was beneficial in terms of a reduction in chronic noncommunicable diseases such as obesity, type 2 diabetes, cardiovascular diseases, and some types of cancer [9]. The question remains whether this effect is due to the fact that animal products are avoided or whether this is to be attributed to a higher plant food intake. Another systematic review showed a dose-dependent risk reduction for coronary heart disease, stroke, total cancer, and all-cause mortality in correlation with daily fruit and vegetable consumption [10].

The only systematic review of studies on dietary intake and nutritional or health status of vegetarian and vegan infants, children, and adolescents was published in 2017 by Schürmann et al. [7]. They reviewed 24 publications from Western countries, among which there were only 2 studies of children on a vegan diet [11, 12]. The British collective of 39 children who were supplemented with vitamin B12 and vitamin D had on average a lower caloric intake (up to 300 kcal/day), whereas vitamin B12 and iron intakes exceeded the reference values [11]. In the larger US study with 404 young children who continued to receive supplementation after weaning, the children's physical development was within the reference range. The smaller height at 0–3 years of, on average, 2 cm, compared to the reference population, approached the 50th percentile at 10 years [12]. Neither study analyzed biomarkers. This systematic review by Schürmann et al. [7] revealed large study heterogeneity, generally small sample size often without control group, a trend toward upper social classes as a potential bias, and a peak of data stemming from the 1980s to the 1990s, which may limit the relevance of the findings to the present. The authors concluded that the existing



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data would not allow drawing any firm conclusions on the health benefits or risks of a vegetarian or vegan diet on the nutritional or health status of children in industrialized countries.

## Nutrient Coverage of a Vegan Diet

In the following, we will briefly discuss the special nutritional aspects of a vegan diet. Plant-based nutrition is characterized by a rich coverage of β-carotene, vitamin C, folate, and magnesium as well as fiber and phytochemicals [13]. The latter are considered as protective modulators in the pathogenesis of inflammatory and carcinogenic processes [14]. On the other hand, a diet that completely dispenses with foods of animal origin is potentially critical in terms of energy, protein quality, long-chain fatty acids, iron, zinc, vitamin D, iodine, calcium, and especially vitamin B12 [1].

Awareness of these potentially critical nutrients allows parents who plan a vegan diet for themselves and their children to make informed decisions in their choice of foods and supplements.

Plant-based proteins have a less diversified amino acid composition than those from animals, so it is important to be aware of specific sources of different plant proteins and to increase intake in order to avoid a lack of essential amino acids. This is especially important as children require an approximately 30% higher intake for up to 2 years, 20–30% up to 6 years, and 15–20% for older children [15]. Vegan food sources generally have a higher fiber content and can thus lead to a deficit in the energy intake, particularly in infants and toddlers due to premature satiety and fullness. In this regard, attention needs to be paid to an adequate energy density of the food, good examples being pureed tofu or avocado, legumes, or cooked dried fruit. In the case of the vegan-fed infant, breast milk is generally recommended for at least the first 6 months of life, as with any newborn. If breastfeeding is not possible, a soy-based infant formula may be used. A systematic review published in 2014 concluded that soy-based infant formula is safe in terms of growth, metabolic, endocrinological, reproductive, and neurological functions [16]. However, compared to a cow's milk-based formula, soy-based milks have a higher concentration of phytates, aluminum, and phytoestrogens (isoflavones).

Essential polyunsaturated fatty acids such as omega-3 fatty acids, alpha-linolenic acid, eicosapentaenoic acid, and docosahexaenoic acid are vital for normal neurological development (e.g., synaptogenesis, retinal development). Since docosahexaenoic acid and eicosapentaenoic acid occur mainly in animal products, vegan children need to be sufficiently supplied with their alpha-linolenic



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acid precursor [17]. The inclusion of flaxseed, walnut, or rapeseed oil can prevent a shortage of omega-3 fatty acids.

In addition to its role in hemoglobin synthesis, iron is important for myelination of nerve sheaths and for neurotransmitter synthesis. Iron requirements in early childhood and adolescence are increased in comparison to adults. The bioavailability of heme iron (Fe2+), which is typically found in meat, is better than that of nonheme iron (Fe3+), the absorption of the latter being, depending on the food consumed at the same time, only between 2 and 20%. Therefore, care must be taken that inhibitors of iron absorption such as phytates from legumes, oxalic acids from rhubarb or spinach, and calcium compounds from milk are not taken simultaneously with important ferrous food sources. Conversely, it is known that ascorbic acid is a potent enhancer of nonheme iron absorption [18]. Zinc is also inhibited in its absorption by phytic acid. As an essential trace element and cofactor for many enzymes, clinical symptoms of zinc deficiency are diverse – in addition to impaired wound healing, nail brittleness, hair loss, or susceptibility to infection, possible consequences of a severe zinc deficiency are chronic diarrhea and impaired growth [19]. In the absence of food of animal origin, attention should be paid to sources of food rich in zinc such as cereals, fermented soy products, and nuts. For clinical zinc deficiency, additional supplementation is required (5 mg Zn/day for children 6–36 months, 10 mg Zn/day for older children) [20].

Although vitamin D is found in several foods of animal origin such as dairy products or fatty fish, the requirements of this vitamin are mainly covered by the endogenous production by UV-B irradiated skin. Use of fortified products or supplementation with 400–600 IU/day is recommended for all infants and toddlers [21]. The lack of milk and dairy products in the diet also reduces the supply of calcium, especially when the infant is weaned from breast milk or the (calcium-supplemented) soy-based infant formula. In the growing child, a sufficient calcium intake is important for the achievement of an optimal bone density (peak bone mass) and is a unique opportunity to reduce the risk of fractures and osteoporosis later in life. Green vegetables low in oxalate, such as broccoli, Chinese cabbage, collards, and kale, are good sources of calcium. Calcium-fortified drinks, cereals, and calcium-rich mineral water complete the food options [22].

As with other micronutrients, the content of iodine in breast milk depends on the nutritional status of the mother. In many countries, the use of iodine-supplemented salt is one of the most important factors to prevent previously endemic hypothyroidism. Particular attention should be paid to a sufficient supply of iodine to the baby, especially with self-prepared complementary foods [22].



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Vitamin B12 (cobalamin) in a biologically active form is not available from non-animal sources and a vegan diet must therefore be regularly supplemented. Vitamin B12 is critical for the body to carry out many essential functions such as erythropoiesis, in myelin synthesis, axon homeostasis, and even mitochondrial energy metabolism. Deficiency, which may also occur in the breastfed child of a vitamin B12-deficient mother, may lead to severe, sometimes irreversible neuropsychological damage and developmental delay [23, 24]. Laboratory assessment of vitamin B12 status plays a central role in the support of a vegan-fed child. Combining measurement of the vitamin substrate (holo-transcobalamin II having a higher sensitivity compared to cobalamin) together with measurement of methylmalonic acid in urine (as a sensitive metabolite of cobalamin metabolism) yields the best sensitivity and also excludes a functional cobalamin deficiency. The daily dose of cobalamin, which must be given orally as a supplement in infancy and childhood, is not yet established – suggestions recommend daily doses of 5 ug for infants and toddlers [25]. Some available commercial products use routes of administration such as nasal spray or toothpaste supplemented with vitamin B12 that are still under-studied for adequate absorption in childhood.

## Recommendations and Conclusion

There are significant differences between the recommendations of the various nutrition and health associations worldwide, which in turn are probably due to the paucity and heterogeneity of available studies. North American nutrition and health organizations consider a well-balanced and well-planned vegan diet to be adequate to ensure healthy development at each stage of life including early childhood [26, 27]. However, European professional societies, such as the Swiss Federal Commission for Nutrition, the German Society for Nutrition and the European Society for Pediatric Gastroenterology, Hepatology and Nutrition, do not recommend a vegan diet during childhood [1, 28, 29]. If a vegan diet is chosen for ethical, ecological, or health reasons, a well-planned, diversified, adequate diet with additional supplementation of vitamin B12, vitamin D, iodine, and potentially other micronutrients is crucial to ensure a healthy and nutritious intake during childhood. The younger the child, the more we need to be critically aware of the potential dangers of a restrictive diet to the growing individual and, therefore, primarily advocate a diet that does not need to be supplemented [1]. At any age, a vegan diet requires profound nutritional knowledge from the parents and regular laboratory testing of the child. Qualified nutritional counseling and continuous pediatric medical support are indicated when a child is fed a vegan diet. Supporting tools, such as the recently developed food ex-



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**Table 2.** Practical points to accompany children fed a vegan diet, adapted from [18]

| | |
|---|---|
| In general<br>– Vegan diet accompanied by qualified dietician and pediatrician<br>– Explore motivation, discuss sources of information<br>– Collect a nutritional history, analyze a 3-day food diary, and regularly check critical nutrients (laboratory controls)<br>– Discuss supplements | |
| Infants<br>*Breastfed:* if the mother is on a vegan/vegetarian diet, an nutritional evaluation is recommended (with analyses of critical micronutrients and potentially supplement them)<br>*Formula-fed:* adapted soy-infant formula<br>*Complementary food*<br>– BM or infant formula until 12 months<br>– Pulses (puréed)/tofu is possible from 6 months onwards<br>– Calorie dense solid food with oil supplemented (ALA-rich such as linseed, walnut, or rapeseed)<br>– Consider iron supplement (mainly in BM-fed infants after 6 months)<br>– Vitamins K and D prophylaxis as all infants<br>– Supplement vitamin B12 (after starting with complementary food) | Toddlers and children<br>– Monitor energy intake (percentiles)<br>– Limit raw food in toddlers (lower digestibility and caloric density)<br>– Check calcium intake (e.g., Ca-rich mineral water)<br>– Evaluate iodine supply (salt)<br>– Discuss vitamin B12 Supplement<br>– Check iron and vitamin D levels, possibly supplement<br>– Cave danger of aspiration (e.g., grinding nuts) |

BM, breast milk; ALA, alpha-linolenic acid.

change systems for meal planning in vegan children, could be helpful in covering macro- and micronutritional needs [30]. A summary of aspects that need to be considered in the different age-groups is summarized in Table 2.

## Disclosure Statement

The author has no conflicts of interest to declare.

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