

# Vegetarian Diets in Children—Some Thoughts on Restricted Diets and Allergy

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## Abstract

Vegetarianism is a common diet worldwide. For a large proportion of people, meat or fish is not available at all or not regularly as a meal. But also in the industrialised countries, vegetarian nutrition is becoming more and more popular for various reasons. Many vegetarian parents also want a suitable diet for their children. But are restrictive diets beneficial or potentially harmful in certain situations, such as a predisposition to severe atopy? Are vegetarian diets equally suitable for pregnant women, nursing mothers, infants, children, and adolescents? What critical nutrients should parents, children, pediatricians, and nutritionists pay particular attention to? This article is focused on questions like these and discusses scientifically based concepts of nutrition. Main findings are that exposure to a variety of food antigens during early life may play a role in the development of healthy eating habits and that restrictive diets have not been found in studies to prevent allergic disease.

## Keywords

Infants-Children-Adolescents, Nutrition, Vegetarian, Critical Nutrients, Dietary Supplementation, Food Allergy

## 1. Trend towards Vegetarian Diet

Vegetarian diets are common in poor countries where meat (and fish) are scarce and are only regularly available to a few families. For years, there has also been a trend towards vegetarian diets in wealthy countries. This trend is usually based on ethical, ecological and ideological attitudes; often, however, it is also justified in terms of health.

In the latest nutritional survey “EsKi-Mo” II, 2015-2017 in Germany, as part

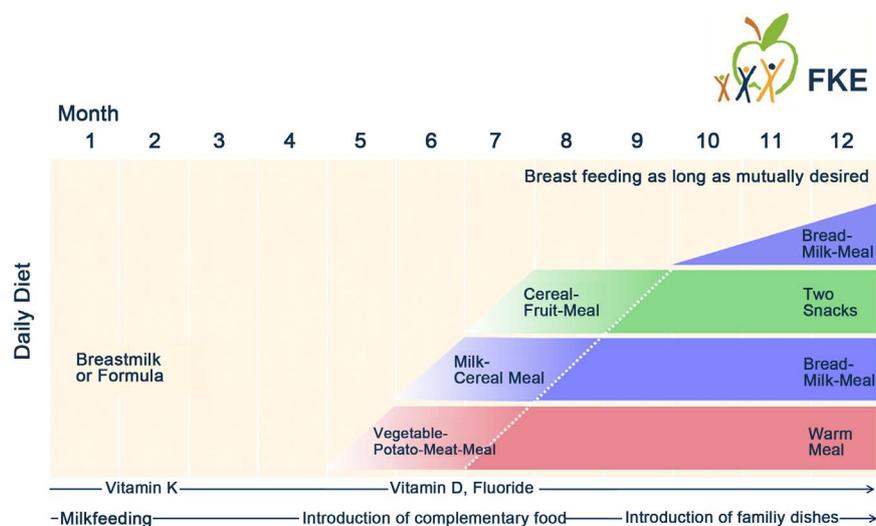
of the Child and adolescent health survey KiGGS, 3.4% of children and adolescents were identified as vegetarians (1.5% of 6 to 11 year olds; 5.1% of 12- to 17-year-olds, [1]). According to the ProVeg Germany for adults the figures are around 10% for vegetarians and about 1% for vegans [2].

Many vegetarian parents want a corresponding diet for their children. From a pediatric-nutritionist’s point of view, these diets need to be monitored very carefully. It is necessary to examine whether the respective diet can adequately and safely achieve all the high and specific nutrient needs of childhood and adolescence due to growth and development.

## 2. Basic Dietary Concepts of the Research Department for Child Nutrition (FKE)

In Germany, the Research Department for Child Nutrition (FKE) has developed scientifically based nutrition concepts for the entire growth-period. Starting with the “Dietary Scheme for the First Year of Life” [3], the concept of the “Optimized Mixed Diet” for children and adolescents (OMD) [4] [5] follows seamlessly. The OMD can also be the basis for the diet in pregnancy and lactation (Figure 1 and Figure 2).

Both concepts, the Dietary Scheme for the First Year of Life and the OMD are based on reference values for nutrient intake. Taking into account existing dietary habits, the nutrient references are translated into practical guidelines for family food choices [6] [7]. They also take into account aspects of the prevention of dietary related diseases such as obesity, cardiovascular diseases and diabetes. This is achieved, for example, by the quality of fat and carbohydrate intake and the preferred use of plant-based foods [6].



**Figure 1.** Dietary scheme for the first year of life. Department of Child Nutrition (FKE). Three main stages can be distinguished with smooth transitions between them: exclusive breastfeeding during the first months, introduction of complementary feeding along with partial breastfeeding during the second half of infancy, and introduction of family diet around the end of the first year of life.



**Figure 2.** “Optimized Mixed Diet” for children and adolescents. Important dietary recommendations can be summarized in three simple rules. Department of Child Nutrition (FKE).

The European Food Safety Authority (EFSA) has identified these modular food-based approaches with calculated nutrient intake as exemplary for child nutrition in Europe [8]. The “Dietary Scheme for the First Year of Life” and the “Optimized Mixed Diet” are scientific reference instruments for child nutrition in Germany [9] [10]. Due to the practical and realistic suggestions, they are the basis for nutrition counselling by pediatricians and nutritionists in the field of child nutrition [6].

### 2.1. Diet in the First Year of Life

In infant nutrition, a meal based on vegetables and potato is introduced for the start of complementary feeding between the 5th to 7th month of life. It is important that iron with high bioavailability is supplied by meat as a further ingredient, since the iron reserves of infants are exhausted at this age (**Table 1**).

### 2.2. Standard for Children and Adolescents: Balanced Mixed Diet

In the diet of children and adolescents, plant-based foods are the basis. Therefore they should be consumed abundantly. Animal-based products are recommended in moderate amounts as carriers of specific nutrients. These are, for example, calcium and iodine in milk (products), iron and zinc in meat, iodine and long-chain, polyunsaturated omega-3 fatty acids in sea fish. The concept of the “Optimized Mixed Diet” combines the preventive potential of a plant-focused diet with the security of a sufficient nutrient supply (**Figure 2**).

The calculated and proven concepts for the nutrition of infants, children and adolescents in Germany guarantee an adequate supply of nutrients with a high degree of certainty. This applies to all pediatric age groups.

## 3. Early Diet in Infants and Children and Development of Food-Allergy

Food allergy affects an estimated 8% of the global population, with evidence of increasing prevalence among children in developed countries [11]. Thus, there is

**Table 1.** Study situation on vegetarian diet in children [53] [54].

Country	Year of study	No. of study groups	Number of study participants	Age of children (years)
Great Britain	1980-1990	3	20 - 50	0 - 11
Netherlands	1980-1990	1	50 - 209	0 - 17
Germany	1991 <sup>1</sup>	1	13	0 - 1
USA	1991 <sup>1</sup>	3	39 - 404	0 - 12
Slovakia	1997 <sup>1</sup>	1 <sup>1</sup>	26 - 32	11 - 15
Belgium	1999 <sup>1</sup>	1	38	6 - 17
Poland	2003-2011	5	2 - 50	2 - 18

<sup>1</sup>Not clearly deducible from the publication.

great interest in any nutritional strategies that may ameliorate or prevent the development of food allergies, especially in atopic infants. Around the turn of the century, international guidelines pushed for delayed introduction of complementary allergenic foods to slow the rise [12]. However, food allergy incidence continued to increase in developed countries [13].

While the exact etiology of food allergies is still unknown, research suggests a complex interaction between the immune system, rising susceptibility due to environmental factors, feeding habits, and genetics. Diet plays a crucial role in both the prevention and management of food allergies. A number of factors, including the maternal diet, the microbiome and early life feeding, have been investigated for the prevention of allergic diseases. As a consequence of currently available data, the traditional avoidance diet during infancy has been, in recent years, completely reconsidered.

As an example, the EAT-trial demonstrated, there is no evidence, that delaying the introduction of foods with high allergenic potential (e.g. peanut, eggs, fish) beyond 4 - 6 months prevents development of atopic disease [14]. Moreover, in the LEAP trial, early introduction of peanuts products was even associated with a significantly lower prevalence of peanut allergy in severely atopic infants [15]. A follow-up study demonstrated that this effect of early peanut consumption was long-lasting, thus comparable to induction of tolerance [16].

## 4. Allergy Prevention

In respect of allergy prevention, the following nutritional aspects should be considered:

### 4.1. Breastfeeding

Studies have shown that perinatal administration of probiotics to mothers during the last weeks of pregnancy and to infants in the first few months of life was associated with a significant reduction in atopic eczema [20].

As widely known, breastfeeding has many benefits for the mother and child

[17]. However recent studies show few evidence for breastfeeding generally being protective against food allergies and allergic disorders [18]. Boyle et al. have published a review in 2016 assessing the impact of hydrolysate formulas on the risk for allergy and autoimmune diseases. Results do not recommend the use of such formulas to prevent allergic diseases in high risk infants [19]. In the following, countries such as Switzerland withdrew recommendations for hydrolysate formulas.

#### **4.2. Probiotics**

Studies have shown that perinatal administration of probiotics to mothers during the last weeks of pregnancy and to infants in the first few months of life was associated with a significant reduction in atopic eczema [20].

#### **4.3. Perinatal Diets and Allergen Induction**

Studies have shown that maternal diet before and during the pregnancy influences the risk of allergy and asthma in children [21]. Higher maternal intake of possible allergens such as peanut, milk, and wheat during early pregnancy are associated with reduced odds of mid-childhood allergy and asthma [22]. Early on exposure to known allergens has been assessed in large prospective studies. Despite difficulties with the compliance of test groups, results show protective effects of early allergen induction in patients with both high and normal risk. These conclusions were published by various studies where high- and normal risk children ingested allergen-mixes [23] and single allergens such as fish [24], peanuts [25], eggs [26] and cow's milk [27].

In already established allergic disorders, therapeutic effects can be achieved by desensitization through allergen-exposure. Patients with confirmed food-allergies are frequently treated with personalized long-term immunotherapies [28]. However oral or subcutaneous injections of allergens often do not lead to long term-desensitization.

#### **4.4. Omega 6/3 Fatty Acid Supply**

An association between food allergies and decreased Vitamin D levels has been shown in several studies. Especially during the first year of life, Vitamin D appears to have a crucial role in the modulation of the immune system. This postulation has been supported by the LINA Study. Low maternal and infant Vitamin D blood levels were associated with increased risk for food allergies [32].

According to various studies, the ratio between Omega 6 and Omega 3 fatty acids seems to have an impact on the development of allergies. The strongest associations were found in children <4 years [29]. High maternal Omega 6 fatty acid blood levels may lead to increased risk for allergic outcomes, especially eczema [24]. Omega 6 fatty acid consumption should be kept to moderate levels in high risk individuals. Increased Omega 6 fatty acid levels are predominantly due to vegetable oil consumption. As such, e.g. butter when compared with margarine (plant-based fatty acids) consumption evidently reduces the risk for aller-

gic diseases [30]. Fish, as rich source in Omega 3-FA can improve the Omega 6: Omega 3 FA-Ratio and as such evidently reduces risk for atopy [24].

A high Omega 6: Omega 3 fatty acid ratio however may not only be due to dietary factors. Genetic defects have shown to be additive to deregulation, according to the KOALA and LISA Studies [31].

#### **4.5. Vitamin D**

An association between food allergies and decreased Vitamin D levels has been shown in several studies. Especially during the first year of life, Vitamin D appears to have a crucial role in the modulation of the immune system. This postulation has been supported by the LINA Study. Low maternal and infant Vitamin D blood levels were associated with increased risk for food allergies [32].

#### **4.6. Fruits and Vegetables**

Studies have shown a significantly lower risk to develop asthma in individuals with high fruit and vegetable consumption, when compared to individuals with low fruit and vegetable consumption. Same results were found in children of mothers with high fruit consumption during pregnancy. Also, high fruit consuming patients with already diagnosed asthma presented with significantly higher FEV1 and less severe exacerbations than when compared with individuals consuming few fruits. [33] Detailed discussion on dietary asthma prevention would surpass the aim of this article. Further information can be found in the referenced review-article [34]. For recent recommendations regarding prevention of food-allergy and atopic diseases we refer to reviews [35] [36].

### **5. Examples for Indicated Restrictive Diets in Patients with Allergic Diseases**

#### **5.1. Empiric Elimination Diets**

Empiric Elimination diets (such as Six-Food-Elimination-Diet; SFED) are used extensively in cases of confirmed, specific allergic reactions. When used in treatment of Eosinophilic Esophagitis, SFED correlates with histologic recession in 74% of children [37].

#### **5.2. Specific Restrictive Diets**

Efficiency of specific restrictive diets, even as first line treatment for food allergies and allergic diseases, is well documented. In some diseases, specific exclusion diets are indicated. Examples of such diseases are: Food Protein-Induced Enterocolitis Syndrome (FPIES), Histamine Intolerance, WDEIA (Wheat dependent Exercise Induced Anaphylaxis), Regular Food-Allergy and metabolic diseases such as Phenylketonuria (PKU).

In already established allergies, or atopic diseases, specific restrictive diets frequently are the gold standard for treatment. Restrictive diets may be suspected to have a preventive effect on food allergies in children. PKU-patients, treated

with phenylalanine-low-diet, were discussed to be at lower risk for allergic sensitization in certain age groups, when compared with healthy individuals on an omnivore diet [38]. For the several other medically indicated, specific restriction diets, no data was found regarding impact on allergy or atopy related diseases. Further investigations should be conducted to assess the impact of restrictive diets on allergy.

## 6. Possible Benefits of a Vegetarian Diet

In nutritional epidemiology, the relationship between plant-based and animal-based foods, as well as the degree of processing of food, is considered a factor influencing the preventive impact of the diet on so-called diseases of civilization. For example, epidemiological studies have shown that high consumption of meat products can increase the risk of single-celled cancers [39]. Furthermore, high proportions of fiber-rich cereal products as well as vegetables and fruit can reduce individual risks of illness, e.g. in cardiovascular diseases [40] or in diabetes mellitus type 2 [41]. Vegetarian diets are often more favorable from these preventive medical points of view than the usual diet in many Western countries [42].

Recent studies propose microbiome-related pathways, by which plant-based diets might modulate the gut microbiome towards a favorable diversity of bacterial species. However, little is known about speculative cognitive effects linked to plant-based diets. Thus, a causal impact of plant-based diets on cognitive functions, mental and neurological health has yet to be demonstrated [43].

### 6.1. Meta-Analyzes on Vegetarian Diets

A recent meta-analysis of various observational studies found that people on a vegetarian diet had a lower risk of cardiovascular disease and cancer compared to people without a vegetarian diet [44]. Furthermore, in children, a preventive effect on obesity is discussed under vegetarian diets [45]. According to a meta-analysis, vegetarian based diets are associated with lower levels of inflammatory mediators such as C-reactive protein, fibrinogen and total leukocyte counts when compared with omnivore individuals [46]. No data however has stated a decreased incidence of allergic disease in individuals on vegetarian diets. No evidence was found to support maternal restrictive diets during pregnancy or lactation [35]. Possible Effects of such restrictive diets require further assessment. Sufficient nutritional supplies should be assessed and monitored.

At second glance, there are some critical points in these studies. Groups of people with vegetarian diets systematically differ from the average population in typical health-related risk factors. For example, they differ in a younger age or a lower body mass index. In addition, the lifestyle of vegetarians is often healthy, e.g. with less alcohol, less smoking and more physical activity. The following criteria apply to typical vegetarians in western countries: mostly female, young, educated and affluent, city dweller, healthy lifestyle [47].

## 6.2. Analysis of Two Prospective Studies

The difficulty of definitively proving separate health-promoting properties of vegetarian diets beyond lifestyle factors is demonstrated, among other things, by the analysis of two prospective studies. These compared mortality between people with vegetarian diets and those with a mixed diet which was also plant-focused and containing small amounts of meat and butcher's products. The analysis found no difference between these two groups [48]. Several other reviews are in line [42] [49] [50].

## 7. Risks of Vegetarian Diets for Children

If a diet differs from the established and safe standards for feeding children, it must be demonstrated—before it can be considered a population-based recommendation—that the diet ensures growth and developmental needs and covers the specific nutritional needs for all age groups. However, if entire groups of food are excluded, as in vegetarian diets, there is a considerable risk that individual nutrients required for the nutrition of children and adolescents are only supplied in critically low or even inadequate amounts [51]. The more restrictive the diet and the younger the children, the greater the risk of inadequate intake of critical nutrients.

Theoretically, critically reduced nutrients can be identified for individual restrictive diets in childhood [52]. Similarly, a supplementary intake of critical nutrients can theoretically compensate for an inadequate supply induced by food exclusion. However, the practical application of this principle is impaired by the fact that the mere indication of a vegetarian diet by the parents does not allow certain conclusions to be drawn about the individual nutrition practices. In addition, the current study situation on vegetarian diets in children in Europe and the USA is unsatisfactory, with only a few studies carried out in the 1980s and most of them in the 1980s-1990s (Table 1). These studies do not allow to draw valid conclusions about current dietary practice and health status in vegetarian-fed children in Germany [53] [54]. New results may be expected from the ongoing VeChi-Diet study.

Little information is available on the effects of a vegetarian diet on the risk of allergies. In one study, it was even observed that vegetarians were more affected by allergies than subjects with other eating habits [55].

Aside from individuals on “voluntary” restrictive diets, attention should also be raised at patients with established allergic diseases. Patients are often managed with exclusion of offending food(s). Especially in children, this could lead to nutrient insufficiencies due to wide range-exclusion. Upon adulthood, patients were found to be more susceptible for possibly harmful extreme-nutrition regimes [56].

## 8. Categories of Vegetarian Diets

The collective term vegetarian diet includes different sub forms. According to the exclusion of food groups, the following forms of vegetarianism can be dis-

tinguished:

Lacto-Ovo vegetarians: abstain from the consumption of meat and fish (killed animals) but accept eggs and milk.

Lacto vegetarians: abstain from the consumption of meat, fish, eggs, but use milk.

Vegans: eat exclusively plant-based foods. In addition to fish and meat, they also abstain from milk, dairy products, and honey.

As a separate group, so called “semi-vegetarians or flexitarians” eat occasionally meat or fish, similar to seven-day Adventists which are, however, often classified as “vegetarians” (Table 2). However, in real life there are mostly barely recognizable transitions between different vegetarian forms of food. A general rule for assessing possible risks is: the more restricted the child's diet, the greater the risk of deficiency, and this is by far the highest in vegan children.

### 8.1. Lacto-Ovo-Vegetarian Food

This form of diet is most practiced among vegetarians. Compared to a standard diet under mixed food, animal protein and further nutrients such as iron, zinc, vitamin B12 (in meat) as well as iodine and long-chain, polyunsaturated omega-3 fatty acids (in fish) are reduced in this diet. When summarized, there is no increased risk of growth and development for children and adolescents [58] [59].

However, for individual groups of subjects who already have an increased risk of nutrient deficiency, such as iron, with the recommended mixed diet, the situation must be considered more carefully. This applies, for example, to female adolescents and infants in the second 6 months of their lives [60].

Moreover, children with allergy may have increased nutritional needs due to comorbidity. Limited consumption of important nutrients, lack of dietary variety and/or reduced bioavailability may enhance the risk for complications. As such, the coexistence of allergy or allergic diseases and restrictive diets may increase risk for malnutrition [61].

**Table 2.** Vegetarian diets and reduced nutrients in children [57].

Diet	Excluded foods	Reduced nutrients
Lacto-ovo-vegetarian	Meat, fish	Meat: animal protein, Fe, Zn (high bioavailability), Vit. B <sub>12</sub> ; Fish: Iodine, n-3-LC-PUFA, Vit. D
Lacto-vegetarian	Meat, fish, and eggs	as above. additionally: animal protein, Vit. D, A
Vegan	Meat, fish, eggs, and milk	as above. additionally: animal protein, Vit. B <sub>12</sub> , Ca, Iodine, Vit. B <sub>2</sub> , A

Fe: Iron, Zn: Zinc, Vit.: Vitamin, n-3-LC-PUFA: long-chain, polyunsaturated omega-3 fatty acids, Ca: calcium, LM: food.

### 8.1.1. Iron Status in Infants

The increasing risk of iron deficiency in infants with low iron intake is well documented by European data [62]. New data show that the iron status in infants in Germany has worsened in recent years, despite counseling on nutrition based on the “Dietary Scheme for the First Year of Life”. Reasons include the decrease in the iron content in formula foods and in the meat content in jar foods. About 30% of the infants had a lack of storage iron at the age of 10 months, but did not show anemia nor clinical signs [63] [64].

Under a lacto-ovo-vegetarian diet, the absence of meat excludes the particularly bioavailable form of  $\text{Fe}^{2+}$  (approx. 20%) from the diet. As a compromise-like replacement, whole grains with (poorly absorbable) trivalent iron (approx. 3%) can be used instead of meat. The recommended combination of  $\text{Fe}^{3+}$  with vitamin C-rich ingredients improves absorption (Table 3). In Germany, however, no data is available on the actual implementation of these recommendations and on iron status in infants on vegetarian diets.

### 8.1.2. Other Potentially “Critical” Nutrients during Growth

There is insufficient data and surveys for the following nutrients [54] [65]: vitamin B12, zinc, iodine, long-chain polyunsaturated omega-3 fatty acids; all of these have a potentially reduced intake under a lacto-ovo-vegetarian diet.

In conclusion: already with lacto-ovo-vegetarian diets, the safe supply of critical nutrients by individual nutritional history should be clarified in situations with an increased risk for critically low intake. In individual cases, it is necessary to obtain additional laboratory data.

## 8.2. Vegan Diet

A vegan diet threatens multiple nutrient deficits and a lack of energy. In addition to the restrictions under the lacto-ovo-vegetarian diet, calcium, iodine, vitamin B2 and vitamin D (milk) are reduced. Vitamin B12 and animal protein with a

**Table 3.** Standard recipe for a home-made meat-containing meal according to the “Dietary scheme for the first year of life and conversion to a vegetarian meal.” Department of child nutrition (FKE).

Ingredients	Standard recipe	Vegetarian recipe
	Vegetable potato meat meal	Vegetable potato and cereal meal
	Amount (g)	
Vegetable	90 - 100	90 - 100
Potatoes	50 - 60	50 - 60
Meat	20 - 30	
Cereals (whole grain)	-	10
Water	-	20
Fruit juice, fruit-puree	15 - 20	30
Rapeseed oil	8 - 10	8 - 10

high biological value (measured by the amino acid pattern) are missing [54] [66].

The diet induced deficits compared to the age-corresponding nutrient requirements either cannot be compensated or can only be partially compensated by the foods permitted in the vegan diet. However, a complete balance of food-induced deficits is essential but requires specific knowledge of the composition of food and the use of nutrient-enriched foods and supplements. With the heterogeneous market supply of foods and preparations, proper advice is extremely difficult even for qualified nutritionists and doctors. Accordingly, studies in Germany showed trends of undersupply of protein and many micronutrients in adult vegans [67]. In children in Eastern Europe under a vegan diet, studies showed lower levels of vitamin D and reduced bone mass compared to children on a mixed diet [68].

### 8.2.1. Vitamin B12

Numerous case reports, some of which are from Germany, reported deficiency of vitamin B12 in breastfed infants of vegan mothers with anemia and additionally, partly irreversible, neurological disorders [69] [70]. Under a vegan diet, however, not only infants, but also children and young people of all age groups must be supplemented with vitamin B12 [71]. A particular medical problem is the insufficient supply of vitamin B12 to breastfed babies of vegan mothers.

### 8.2.2. Indication for Industrially Produced Food

In infant nutrition, industrially produced soy formula for infants is an animal-protein-free diet and must comply with the legislation of the European Union (EU) for infant formulae and follow-on formulae. A soy-formula can be a valuable source of protein and is enriched with other nutrients. In term infants there are only few indications for use of a soy-formula in place of cow milk-based formula. These indications include infants with galactosemia and hereditary lactase deficiency (both of which are rare) and in situations in which a vegetarian diet is preferred. For infants with cow milk protein allergy, extensively hydrolyzed protein formula should be considered as first choice, as 10% to 14% of these infants will also have a soy protein allergy [72].

With a vegan diet, soy-formula can also be used beyond infancy. However, the safety of milk substitute products for children is under discussion. Concerns are based on in vivo and in vitro data that raise the possibility of estrogenic effects of isoflavones contained in soy-formula [73].

## 8.3. Dietary Strategies on a Vegan Diet

A vegan diet increases the risk of an inadequate supply of multiple nutrients in children. This goes hand in hand with an increased risk of developing damage or developmental disorders.

Therefore, elaborate dietary strategies and continuous elaborate substitution must be ensured persistently. The effort to cover the nutritional deficits under

vegan diets is quite comparable with the effort to avoid deficiency symptoms in subjects on medically necessary diets with complex dietary gaps (e.g., complex food allergies, congenital metabolic diseases). As an example, in all patients with phenylketonuria, nutritional, clinical, and biochemical follow-up is necessary, regardless of therapy [74]. Dietary records provide indications of possible critical nutrients and the need for possible further diagnostics and individual dietary counseling. In children on a vegan diet, the course of growth and development is to be recorded regularly. Families on vegan diets need advice and support in which pediatricians and nutritionists cooperate. Good compliance is imperative [75].

## **9. Opinions on Vegetarian Diets in Children**

The positions of renowned institutions on vegetarian nutrition in children are accented differently; probably also as a result of the insufficient study situation [54].

### **9.1. American Dietetic Association and American Academy of Pediatrics**

The American Dietetic Association, like the American Academy of Pediatrics, considers vegetarian diets, including vegan diets, to be suitable for all phases of life only if, for the entire duration of the vegetarian diet, the otherwise inadequate supply is balanced with a high number of nutritional measures [52] [74].

### **9.2. German Society for Nutrition**

The German Society for nutrition (DGE) considers that special care is necessary for pregnant women, breastfeeding women, infants, and toddlers on lacto-ovo-vegetarian nutrition. A purely plant-based, vegan diet is not recommended during pregnancy and lactation as well as during the entire childhood and adolescence [50].

### **9.3. ESPGHAN**

The European Society for Pediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) emphasizes the special risks of a vegan diet for children (insufficient intake of vitamin B12, D, folic acid, iron, Zinc, calcium, n-3 fatty acids, protein) [12].

## **10. Conclusions**

Taken together, the current evidence indicates that maternal avoidance of allergenic solids during pregnancy or breastfeeding and the delayed introduction of such foods in infants' diets after the first year of life are ineffective means of food-allergy prevention. They are no longer recommended by international guidelines. Similarly, there is no evidence that very early exposure, before four months of age, to foods with high allergenicity can prevent food allergies both in stan-

standard risk and high-risk infants. Although recent data suggest considering early introduction of allergenic solids as a potential strategy to tackle the rise in food-allergy prevalence, convincing evidence for such practice is currently available only for peanuts in high-risk infants between 4 and 11 months of life, but not for most other allergenic foods [76] [77]. So far, the recommendations on exclusive breastfeeding over 4 - 6 months, avoiding environmental tobacco smoke and avoidance of overweightness remain unchanged.

In the discussion between supporters of vegetarian diets and pediatricians and nutritionists, ideological arguments and mutual reproaches are not effective. Rather, high-quality studies are needed to evaluate the supply of infants, children, and adolescents with nutrients. These studies should address, on an evidence-based basis, health risks and dietary prevention options for various forms of vegetarian diets, but for standard nutrition concepts as well. New findings on the probably protective effect of an increased diversity of food introduced in the first year of life on allergic diseases are consistent with the hypothesis that exposure to a variety of food antigens during early life might play a role in the development of healthy eating habits. Restrictive diets were not found to be preventive for allergic diseases. Further research is required to understand immunological-allergic trigger pathways and to be able to construct food-recommendations with minimal risk for allergy development in children.

### Author Contributions

Conceptualization, HK, MK.; original draft preparation, HK; review and editing, LL; reviewing and supervision, TL; All authors have read and agreed to the published version of the manuscript.

### Conflicts of Interest

The authors declare no conflict of interest.

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