



Plant-based diets: are they healthy for a child?

With the increasing popularity of plant-based diets, there is much discussion about whether these are healthy and nutritious for young children. A well-planned and balanced vegetarian or vegan diet that includes adequate amounts of essential nutrients can be appropriate for people at all life stages. However, as infancy and childhood are periods of rapid growth and development, extra consideration is required to ensure children are getting sufficient energy and nutrients.

KEY PRACTICE POINTS:

- Vegetarian and vegan diets can be a healthy option in children; they are typically associated with leaner body weight and may be protective against diabetes, heart disease, hypertension and obesity in adulthood
- The greatest concern with a diet excluding animal products is nutrient deficiency; food sources of important nutrients should be recommended first before supplementation. However, supplementation will often be required for some nutrients that are difficult to obtain from diets excluding animal products, e.g. vitamin B12.
- A range of age appropriate and nutrient rich foods should be offered to young children eating a plant-based diet
- Strongly discourage use of home-made infant formulas or alternative “milks” as a replacement for breast milk or commercially prepared infant formulas
- All infants should be regularly exposed to common food allergens including peanuts, tree nuts, cows’ milk, egg, wheat, soy, sesame, fish and shellfish before age 12 months, unless they are already allergic

Vegetarian and vegan diets: an overview

Vegetarianism and veganism are increasingly popular dietary choices. The most recent national data on plant-based eating in New Zealand is from 2018, but it is likely that numbers have since increased. A 2018 online survey of 1,000 participants aged ≥ 18 years in New Zealand found that 10% either completely avoided eating meat, or rarely consumed it; approximately twice the rate reported from the same survey in 2015.¹ In the 2018 New Zealand Attitudes and Values Study, that included responses from > 45,000 participants, it was found that 4.5% of adults exclusively followed a vegetarian diet and 1.1% followed a vegan diet.² The prevalence of plant-based diets in children in New Zealand is not known.

A plant-based diet is generally defined as being:³

- **Lacto-ovo** – the most common type of vegetarian diet, describing someone who excludes meat and seafood but consumes eggs and dairy products
- **Lacto** – a vegetarian diet where someone excludes meat, seafood and eggs but consumes dairy products
- **Vegan** – someone who abstains from eating all animal products, i.e. meat, seafood, dairy and eggs, sometimes honey. Achieving a nutritionally balanced vegan diet can be more challenging, so it is important to identify what foods are being excluded.

There are various other plant-focused diets that include certain kinds of meat or seafood, e.g. pescatarian (fish), pollotarian (chicken).

A well-planned diet that excludes animal products can be healthy and nutritious for an adult, but parents, other caregivers or healthcare professionals may be concerned about the growth and development of a child who is provided with a plant-based diet, particularly in infancy and pre-school years.

Benefits of plant-based diets for children

Data on the benefits of vegetarian and vegan diets in children, particularly young children, are limited.⁴ The available data show that children who follow a properly designed plant-based diet grow and develop normally (Table 1), and typically have a lower intake of cholesterol and fat, a higher intake of fruit and vegetables and are leaner than omnivorous children.⁵ Longer-term data suggest that a nutritionally balanced plant-based diet adopted at an early age may reduce the risk of developing obesity, type 2 diabetes, cardiovascular disease and hypertension in adulthood.^{3,5}

Risks of plant-based diets for children

Most concerns about vegetarian and vegan diets in children are around achieving an adequate intake of energy, protein and micronutrients from plant sources. Nutrients requiring

particular attention include vitamin B12 (which is almost exclusively found in animal products), iron, calcium, zinc, iodine, omega-3 and vitamin D.⁶ Plant-based diets that are restrictive (e.g. macrobiotic diets) or lacking in essential nutrients can result in poor growth, lower bone mineral density, anaemia, and in severe cases, developmental delay, irreversible cognitive damage and death.⁶ Vegetarian and vegan diets may be suitable in children with pre-existing health conditions (e.g. ex-premature infants) or allergies (e.g. to soy or wheat) that make a plant-based diet more challenging to manage, but this should generally be under the guidance of a dietitian and/or clinician and involve regular monitoring.³


Risk of bone fractures likely relates to the quality of the plant-based diet

There is some evidence that people following plant-based diets have lower bone mineral density, however, there is inconsistent evidence about the effect of this on fracture risk. A meta-analysis of five studies found that vegans had an increased fracture risk compared to omnivores, while vegetarians did not.⁷ However, when overall dietary quality was considered (one study only), there were no differences in bone mineral density between groups, suggesting that as long as the diet includes adequate sources of calcium, vitamin D, protein and vitamin B12 then potential adverse effects of a diet excluding animal products on bone health can be avoided.^{7,8}

Restricted diets in infancy may increase the risk of food allergies

To reduce the risk of food allergy in later life, infants should be introduced to, and regularly consume (e.g. twice weekly), common food allergens before age 12 months unless they are already allergic to the food.^{9,10} This includes peanuts and tree nuts (as nut pastes), cows' milk, egg, wheat, soy, sesame, fish and shellfish.^{9,10} In a randomised controlled trial including 640 infants with severe eczema or egg allergy enrolled before the age of 11 months, the rate of peanut allergy at age five years was 1.9% in those who regularly consumed peanuts as part of their diet, compared with 13.7% in infants who completely avoided peanuts.¹¹

Ensure parents and caregivers are aware of the recommendations around the timing of food allergen exposure and the benefits of early exposure. Parents wishing to provide their infant with a vegan or a lacto-vegetarian (excludes eggs) diet should still be encouraged to expose them to animal-derived food allergens in the context of allergy risk reduction to reduce the likelihood of a life-threatening allergic reaction through inadvertent exposure or cross-contamination.

 Further information, including a protocol for introducing peanuts, is available from the Australasian Society of Clinical Immunology and Allergy: www.allergy.org.au/images/

stories/pospapers/ASCIA_HP_guide_introduction_peanut_infants_2017.pdf

National and international position statements on the suitability of plant-based diets for children

New Zealand's Ministry of Health Healthy Eating Guidelines for Babies and Toddlers (2021)¹⁰ and Food and Nutrition Guidelines for Healthy Children and Young People (2012, revised 2015)³ defer to the position of the American Academy of Nutrition and Dietetics, which is that well-planned plant-based diets can meet nutritional needs and are suitable for all life stages, including infants and young children.⁵ The Academy notes the increased protein requirements for young children provided with vegan diets and that vegans require vitamin B12 from fortified foods or supplements.^{4,5}

European organisations are more cautionary in their recommendations. In a 2017 statement on complementary feeding (introducing solid foods to infants) the European Society for Paediatric Gastroenterology, Hepatology and Nutrition emphasised that while vegan diets can theoretically meet infant nutrient requirements, receiving inadequate advice or failing to follow advice has severe consequences and parents choosing to provide a vegan diet for infants should receive regular medical and dietetic monitoring and follow appropriate nutritional advice.¹² Position statements released from individual European countries since largely reflect this stance,⁴ however, in 2019 the French-Speaking Paediatric Hepatology, Gastroenterology and Nutrition Group stated a vegan diet is *"not recommended for infants, children, and adolescents due to the risk of multiple nutritional deficiencies that are inevitable in the absence of supplements"*.⁶

Assessing the health of infants and children following plant-based diets

All infants and young children should have their growth and development assessed periodically. In many instances, this will occur routinely when attending general practice for childhood immunisations, opportunistically when presenting with an illness or during a Well Child/Tamariki Ora visit. Ensure parents/caregivers are asked about the child's diet and document any dietary preferences or exclusions in the clinical notes. Checking with parents or caregivers about their understanding of the nutritional requirements of a vegetarian or vegan diet is important, particularly for nutrients that are harder to obtain from plant-based diets, e.g. iron, zinc, vitamin B12 (Table 2).^{3,17}

Growth assessment of infants and young children (birth to age five years) is based on the New Zealand-World Health Organization (NZ-WHO) Growth Charts (see: www.health.govt.nz/our-work/life-stages/child-health/well-child-tamariki-ora-services/growth-charts); for older children, use the WHO

Reference 2007 (www.who.int/tools/growth-reference-data-for-5to19-years) or the Centers for Disease Control Growth Charts (www.cdc.gov/growthcharts/clinical_charts.htm).³ Growth velocity should be monitored; if there is deviation from growth running parallel to the centile lines, further investigation is required.³ It is also important to document if the weight and height (or length in infants) percentiles differ; weight percentile is likely to be lower than the height (or length) percentile if there are nutritional issues.¹⁸

Reaching developmental milestones within the expected timeframe is a good indicator of a child's health and wellbeing. Nutrient deficiencies can result in developmental delay, therefore, diet should be considered in all infants and young children, particularly in those presenting with neurological abnormalities or faltering growth (previously referred to as failure to thrive).¹⁹

If there are concerns that the child is malnourished or not meeting developmental milestones, discuss with a dietitian and recommend dietary changes or supplementation as appropriate (see: "Infant feeding recommendations"). Arrange follow-up appointments to monitor effectiveness.

 A description of developmental milestones by age is available here: www.cdc.gov/ncbddd/actearly/milestones/index.html

Infant feeding recommendations

Infants who are breastfed by a mother following a plant-based diet

Breast milk should be the only source of nutrition for breastfed infants until around age six months and continued until at least age one year.¹⁰ Infants who have been transitioned to a plant-based diet should ideally continue to be breastfed for at least two years or longer to help bolster their nutritional intake.¹⁰

Mothers who follow a balanced vegetarian or vegan diet can produce breast milk that is nutritionally adequate and similar to that of non-vegetarian/vegan mothers.^{23, 24} Discuss with mothers who follow plant-based diets who are breastfeeding how they are managing to include adequate nutrients in their diet. Food sources of nutrients should be encouraged before considering supplementation (Table 2), unless otherwise indicated, e.g. all breastfeeding women should routinely have iodine supplementation regardless of their diet.¹⁰

Supplementation advice for the mother

Vitamin B12. Vitamin B12 supplementation is recommended for breastfeeding mothers who follow a vegan diet, in addition to consuming vitamin B12-fortified alternatives (e.g. cereals,

Summary of recent studies on vegetarian and vegan diets in children

Table 1 describes three recent studies investigating the effect of plant-based diets on growth and nutrient levels in children. The evidence is limited and based on relatively small studies.

Table 1: Summary of recent international studies on vegetarian and vegan diets in children.^{13, 14, 15}

Reference	Study design	Country	Number and age of participants	Key findings
Growth, body composition, and cardiovascular and nutritional risk of 5- to 10-year-old children consuming vegetarian, vegan or omnivore diets Desmond MA, Sobiecki JG, Jaworski M, <i>et al.</i> ¹³	Cross-sectional	Poland	N = 187 (63 vegetarians, 52 vegans, 72 omnivores) Age 5 – 10 years	In comparison to omnivores: <ul style="list-style-type: none"> ■ Vegetarian children had similar total fat and lean mass, lower bone mineral density that was accounted for by smaller body size. Total cholesterol, HDL, and serum B12 and 25-hydroxyvitamin D [25(OH)D] were lower and glucose, VLDL and triglycerides were higher. ■ Vegan children had lower fat mass but similar lean mass, lower bone mineral content*, vegan children were shorter† and had lower total LDL and HDL, C-reactive protein, iron and serum B12 and 25(OH)D and higher homocysteine and mean corpuscular volume. Vitamin B12 deficiency, iron-deficiency anaemia, low ferritin, and low HDL were more prevalent while high LDL was less prevalent.
Vegan diet in young children remodels metabolism and challenges the statuses of essential nutrients Hovinen T, Korkalo L, Freese R, <i>et al.</i> ¹⁴	Cross-sectional	Finland	N = 40 (10 vegetarians, 6 vegans**, 24 omnivores) Median age 3.5 years	<ul style="list-style-type: none"> ■ No differences in height, BMI or mid-upper arm circumference between the different diet groups; intake of vitamins B12 and A was similar between the groups, and most participants, including all vegan children, took vitamin D supplements ■ Vegetarian children had lower saturated fatty acids and cholesterol and higher folate and iron than omnivorous children ■ Vegan children had lower intake of protein and saturated fatty acids, and higher intake of mono- and polyunsaturated fatty acids, fibre, folate, zinc and iron than omnivorous children; vegan children had very low cholesterol levels, borderline vitamin D level and insufficient vitamin A status (despite adequate estimated intake)
Nutrient intake and status of German children and adolescents consuming vegetarian, vegan or omnivore diets: results of the VeChi youth study Alexy U, Fischer M, Weder S, <i>et al.</i> ¹⁵	Cross-sectional	Germany	N = 401 (149 vegetarians, 115 vegans, 137 omnivores) Age 6 – 18 years old, mean 13 years	<ul style="list-style-type: none"> ■ Total energy intake did not vary between groups ■ Carbohydrate intake was higher in vegetarians and vegans than omnivores ■ Median protein intake was lowest in vegetarians, but all groups exceeded the daily reference value ■ Haemoglobin, vitamins B2 and D3, and HDL and triglycerides did not differ between groups ■ Ferritin concentrations were lower in vegetarians and vegans than omnivores

* May be explained by inadequate supplementation of vitamins D and B12¹⁶

† Height was still in the normal range and the height of the children's parents were not reported¹⁶

** Vegan children had been following a vegan diet since birth and had been breastfed by vegan mothers. Vegan children had been weaned at least one year prior to the study.

plant-based milk alternatives, yeast spreads).^{5, 25} Vitamin B12 can be administered by intramuscular injection (funded) or orally (not funded – available over-the-counter [OTC]*). Injectable treatment provides more rapid improvement and should be considered for those with severe deficiency or neurologic symptoms.²⁶

* Ensure patients check the product they are using – many OTC “B-complex vitamins” do not contain B12

Iron. Iron supplementation is not required for mothers who are breastfeeding unless they are deficient and unable to increase their intake through dietary sources.

Vitamin D. Vitamin D supplementation is not routinely recommended for breastfeeding mothers unless they are deficient or at risk of deficiency and cannot safely increase their sun exposure or achieve adequate intake by consuming vitamin D fortified foods. For further information, see: www.health.govt.nz/your-health/pregnancy-and-kids/first-year/helpful-advice-during-first-year/vitamin-d-and-your-baby

Infants who are formula fed

For infants who are not breastfed or who require a formula top-up after breastfeeding, the Ministry of Health recommends that a commercially prepared cows’ milk-based infant formula should be the only other source of nutrition until around age six months and continue until at least age one year. Although cows’ milk is not part of a vegan diet, it is strongly encouraged that vegan infants who are fully or partly formula fed should receive a cow’s milk-based formula, and ideally continue use until age two years.¹⁰ Commercially prepared cows’ milk-based formulas are fortified with all essential nutrients required to support healthy growth; consumption of at least 500 mL of infant formula daily should provide infants with adequate vitamin D intake if it is not achieved via incidental sun exposure.¹⁰ If use of cows’ milk formula is not acceptable, a commercially prepared soy-based formula can be considered, but is generally only recommended in infants aged over 12

months and should not be given to infants aged under six months;¹⁰ parents should discuss use of a soy-based formula with a medical practitioner or dietitian.


Guidance for introducing solids to infants

Iron stores deplete at around age six months

The natural depletion of iron (and zinc) stores in infants at around age six months alongside increased demands of growth means that another source of nutrition is required in addition to breast milk or formula.¹⁰ The Ministry of Health recommends introducing solid foods (referred to as complementary feeding) at around age six months.¹⁰ Given that iron is not absorbed as effectively from plant-based sources, children following these diets may need to consume larger quantities of iron-containing foods (Table 2).³ Routine iron supplementation is not recommended for otherwise healthy children of normal birth weight and growth.¹⁰

Larger volumes of food are required in plant-based diets to meet energy requirements

Young children require a higher overall intake of nutrient dense foods than adults for growth and energy. Given that children have a smaller stomach capacity, small frequent meals are the best way to meet their energy requirements, rather than infrequent large meals.³ If the diet excludes energy dense animal products, a larger volume of food may be required to meet energy requirements (Table 2); this volume can exceed the point where a child is satisfied, increasing the risk of inadequate energy intake.¹⁰ Including some animal products in the diet, such as eggs and dairy products, and including more refined grains, e.g. white flour and white rice, may help children to meet their energy requirements, without the bulk of a high fibre diet.³

 For further examples of nutrient dense foods that should be offered regularly to infants on a plant-based diet, see: www.health.govt.nz/publication/healthy-eating-guidelines-new-zealand-babies-and-toddlers-0-2-years-old

Alternative “milks”

Alternative “milk beverages”, such as rice, oat or almond milk, or home-made formulas derived from these products are nutritionally inadequate and therefore not recommended as a substitute for breast milk or cows’ milk or soy protein-based formulas in infants.¹⁰ In children aged over one year, full fat cows’ milk or soy milk fortified with vitamin B12 and

calcium are appropriate milk options.^{3, 10} At age two years, low-fat cows’ milk or soy milk are acceptable provided a child’s growth is tracking normally.³ Rice, oat, almond or coconut milk should not be the main milk option for children aged under five years,³ but can be considered as a complementary food from age 12 months onwards.



Table 2. Key nutrition points to guide discussions with the parents or caregivers of children following a plant-based diet.^{3, 5,10, 20}


Nutrient	Source	Notes and recommendations
Iron	Predominantly sourced from meat, poultry or seafood. Potential sources in plant-based diets include iron-fortified cereals and cooked and pureed/mashed broccoli, peas, lentils and chickpeas. Phytic acid, found in nuts, seeds, grains, rice, soybeans and legumes, interferes with iron absorption.	<ul style="list-style-type: none"> ■ Plant sources are not as readily absorbed so the volume of iron-containing foods needed is approximately double that of non-vegetarians ■ Iron deficiency anaemia (or macrocytic anaemia, e.g. due to vitamin B12 deficiency) should be considered in infants or children with signs of anaemia, e.g. pale skin, conjunctiva and fingernails, and tachycardia (indicative of more severe anaemia) ■ Vitamin C rich foods should be offered alongside iron to enhance absorption ■ Children should not be given tea or coffee as the tannins inhibit non-haem iron absorption
Vitamin B12	Found naturally only in animal products, including dairy and eggs. Plant-based milks such as soy, yeast-extracts and cereals can be fortified with vitamin B12.	<ul style="list-style-type: none"> ■ Vitamin B12 deficiency is of particular concern in infants and children with vegan diets because animal products are the most reliable dietary sources. Early symptoms and signs of severe B12 deficiency include faltering growth in young children, fatigue, tingling sensation in the extremities and poor cognition. Some of these symptoms and signs may be difficult to identify in young children. ■ Supplementation should be considered routine for vegan children who are no longer breastfed (see: "Infant feeding recommendations")
Vitamin D	Predominantly sourced from exposure to sunlight. Vitamin D2 (ergocalciferol) and D3 (colecalciferol) can be fortified in foods including alternative milks and margarine.	<ul style="list-style-type: none"> ■ It is difficult to achieve adequate vitamin D levels from diet alone; supplementation is usually not required unless adequate levels cannot be achieved via sun exposure or consumption of vitamin D fortified foods ■ Vitamin D deficiency is often asymptomatic, but can manifest as rickets with clinical features such as swelling of the wrists and ankles, leg deformities, delayed tooth eruption, delayed fontanelle closure or motor development, poor growth and symptoms of hypocalcaemia (tetany, stridor or seizures)²¹
Calcium	Found in dairy products, legumes, some vegetables. Absorption is enhanced by adequate vitamin D and protein intake. Phytic acid and oxalic acid interferes with calcium absorption. Oxalic acid is found in spinach and other leafy greens, beans and brassicas, e.g. cabbage and Brussels sprouts.	<ul style="list-style-type: none"> ■ Calcium-fortified alternatives, e.g. soy milk, may be required for children who do not consume cow's milk
Zinc	Predominantly sourced from meats and seafood. Phytic acid interferes with zinc absorption.	<ul style="list-style-type: none"> ■ Plant sources are not as readily absorbed so the volume of zinc containing foods needed is 1.5 times more than non-vegetarians
Alpha linolenic acid (omega-3)	Long-chain omega-3 fatty acids docosahexaenoic [DHA] and eicosapentaenoic acid [EPA] are naturally found in seafood, eggs and red meat, but can be synthesised from plant-based α -linolenic acid in flaxseed oil, canola oil, chia seeds, walnuts and soybeans	<ul style="list-style-type: none"> ■ Plant-based diets can be higher in linoleic acid (omega-6 fatty acid, found in plant oils, e.g. sunflower oil), which may then compete for the enzyme that converts α-linolenic acid to DHA and EPA; a ratio of no more than 4:1 of linoleic acid to α-linolenic acid is recommended ■ DHA supplementation may be required (see: "Guidance for introducing solids to infants")

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Iodine	<p>Good sources include fish, meat, eggs and milk. Dried seaweeds are the main plant-based source (excluding kelp as the iodine content is too high for children); iodised salt is another source assuming it is consumed within recommended daily limits.</p>	<ul style="list-style-type: none"> ■ Vegan children are at increased risk of iodine deficiency as the best sources are from animals and their products ■ Children eating a plant-based diet should not receive large amounts of iodised salt to compensate; instead, supplementation may be required in cases of deficiency (see: "Guidance for introducing solids to infants")
Protein	<p>Can be obtained from a wide range of foods. Plant-based protein sources include whole foods, such as beans, grains, nuts and seeds and green leafy vegetables.</p>	<ul style="list-style-type: none"> ■ Protein requirements increase as children get older; pre-school children require at least one to two servings of protein per day, school aged children require at least two servings and adolescents require three to four ■ Most children (and adults) in New Zealand have a dietary protein intake that exceeds the recommended minimum;²² assuming a plant-based diet includes a variety of whole foods consumed across the day, protein intake is unlikely to be an issue²³

N.B. Nuts are a choking hazard and should not be given whole until age five years; ground nut pastes can be given (and are encouraged) from age six months.

 Patient information on the nutrient content of different foods is available from the New Zealand Nutrition Foundation: nutritionfoundation.org.nz/

 The recommended daily intake of various nutrients and the nutrient content of foods is available from:

- Nutrient reference values: www.nhmrc.gov.au/sites/default/files/images/nutrient-reference-dietary-intakes.pdf
- New Zealand food composition database: www.foodcomposition.co.nz/downloads/concise-13-edition.pdf

Supplementation advice for children following a plant-based diet


Vitamin B12. Ensuring adequate intake of vitamin B12 is particularly important for people following vegan diets as the main sources, i.e. animal products, are excluded. While incorporating vitamin B12-fortified foods into the child's diet should be encouraged, routine supplementation is recommended if they are no longer breastfed as it is the most reliable way of ensuring adequate intake – investigating serum B12 levels is not necessary.²³ There is limited evidence to guide selection of vitamin B12 for oral supplementation in children (not funded):

- Most studies use cyanocobalamin,²⁷ but this form is less likely to be found in individual vitamin B12 supplements
- Methylcobalamin and adenosylcobalamin are active forms of vitamin B12 that are commonly found in supplements; these do not appear to be more effective than cyanocobalamin.⁵ A chewable tablet or sublingual form is recommended to increase absorption – the B12 binding protein in saliva helps transport vitamin B12 through the digestive tract.^{27,28}


Intramuscular vitamin B12 hydroxocobalamin (fully funded and available on a Practitioner's Supply Order) is indicated for the prevention and treatment of macrocytic anaemia associated

with vitamin B12 deficiency, which is uncommon in children and usually due to an underlying cause, e.g. malabsorption, rather than dietary deficiency alone.²⁹

Iodine, alpha linolenic acid (omega-3) and vitamin D. Iodine and DHA supplementation may be required if adequate intake cannot be achieved through dietary sources (Table 2).³⁰ Vitamin D supplementation is generally not required unless adequate levels cannot be achieved via sun exposure or consumption of vitamin D fortified foods.¹³

 Further information on vegetarian and vegan diets for parents/caregivers is available from:

- HealthEd – Eating for Healthy Vegetarians/Ngā kai tōtika mā te hunga puku-huawhenua: www.healthed.govt.nz/resource/eating-healthy-vegetariansng%C4%81-kait%C5%8Dtika-m%C4%81-te-hunga-puku-huawhenua
- New Zealand Vegetarian Society: www.vegetarian.org.nz
- KidsHealth: www.kidshealth.org.nz/healthy-eating-habits-vegetarian-diet-babies-children
- Health Navigator: www.healthnavigator.org.nz/healthy-living/v/vegetarianism-veganism/

 For general information to support health practitioners "teach" patients about plant-based diets, see: www.doctorsfornutrition.org/professionals

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