Infants and children consuming atypical diets: Vegetarianism and macrobiotics

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Alternative diets have been recognized for centuries. In this 1813 pamphlet, *A Vindication of Natural Diet*, the poet Shelley wrote, "There is no disease, bodily or mental, which adoption of vegetable diet and pure water has not infallibly mitigated, wherever the experiment has been fairly tried" (1).

In the rapidly expanding multicultural population of North America, vegetarianism is a popular dietary practice. It may be based on religious or cultural beliefs, or on economic, health or ethical concerns. A 2002 survey (2) found that approximately 4% of Canadian adults consumed a vegetarian diet that excluded meat, poultry and fish. Furthermore, 20% to 25% of adults in the United States reported eating four or more meatless meals weekly, or that they 'usually or sometimes maintain a vegetarian diet', suggesting an increasing interest in vegetarianism (2). Because parents are the principal providers of what their infants eat, vegetarian parents often wean their children onto the family's vegetarian diet. It is important to note that atypical diets are more likely to cause problems of malnutrition in children than in adults due to their greater nutrient requirements relative to body weight. Thus, without the appropriate care for these children, health issues may arise that could concern health care professionals.

Vegetarianism is a very broad category consisting of diets with varying degree of animal product consumption. This distinction is important because the more strictly vegetarianism is followed, the more difficult it becomes to guarantee an adequate diet for growing infants and children. For example, lacto-ovo-vegetarians include eggs, milk and dairy products along with a plant food selection; however, they refrain from animal flesh. On the other hand, a lacto-vegetarian diet consists of plant foods such as grains, legumes, nuts, fruits and vegetables, complemented with milk and milk products, with avoidance of eggs and animal flesh. Pure or total vegetarians (or 'vegans') reject all foods of animal origin, including milk and eggs. Finally, another atypical diet that is far more restrictive than pure vegetarianism is the macrobiotic diet. The original macrobiotic dietary regimen comprised of 10 diets, ranging from the lowest level, which includes 10% cereal, 30% vegetables,

10% soups, 30% animal products, 15% salads and fruits, and 5% desserts, to the highest level, which is composed of 100% cereals (3). The revised macrobiotic diet may contain whole-grain cereals (mainly unpolished rice), vegetables and pulses, with small additions of seaweeds, fermented foods, nuts, seeds and seasonal fruit (4).

POTENTIAL BENEFITS

There have been few studies looking at the long-term health outcomes of vegetarian or macrobiotic diets in children. Adult vegetarians have lower intakes of fat, a lower body mass index and lower mean serum cholesterol levels than nonvegetarian individuals (2). Thus, these findings suggest an indirect effect on reducing the prevalence of coronary artery disease, with a potential decreased risk of mortality in the future (2). In addition, a large study of adults conducted in 1984 showed that Seventh-day Adventists, proponents of a vegetarian culture, have lower age-specific mortality rates than the nonvegetarian population (5).

POTENTIAL CONCERNS

The American Dietetic Association (2) and the American Academy of Pediatrics (6) state that a well-planned vegan diet can, in fact, support adequate nutrition in the growing child. However, as health care professionals, we should become concerned when foods within strict vegetarian diets or macrobiotic diets are not appropriately chosen and/or lack adequate supplementation.

Protein intake

Total protein in vegetable-based foods is lower than in animal sources; plant protein is less digestible than animal protein; and many vegetable proteins are deficient in one or more essential amino acids (5). Nevertheless, human physiological requirements for a well-balanced source of amino acids can be met if a variety of plant proteins are consumed, and additionally, if caloric needs are met (7).

However, diets such as the macrobiotic diet are more restrictive during infancy and are of greater concern. One study (8) of Dutch infants on a macrobiotic diet, ranging in

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age from six to eight months, found that 59% of infants had a protein intake of less than 80% of the Dutch recommended daily intake.

Energy intake

As a vegetarian diet becomes more restrictive, the energy intake requirements become more difficult to attain. The vegetarian diet is a bulky one that can restrict energy intake in children. Furthermore, energy intake in infants receiving macrobiotic diets compared with vegetarian diets is considerably lower than the recommended requirements (9). A major potential concern relates to the expanding knowledge of the critical window of early environmental influences on subsequent child development and health (10). Because the energy density of macrobiotic diets is lowest in infants during the weaning period of 10 to 12 months of age, this diet could adversely affect their future growth and development (11).

The growth of a child is a sensitive indicator of the potential negative effects of vegetarian, vegan and macrobiotic diets. Children younger than two years of age who were fed vegetarian or vegan diets exhibited significant lower mean weight and length velocities (12) and were overall lighter in weight and smaller in stature than reference populations (13). The Farm Study (14) analyzed 404 children from a vegetarian community in which parents were well educated about the diet and children were supplemented with the appropriate minerals and vitamins. While these vegetarian children were within the 25th and 75th percentiles for United States growth standards, height for age and weight for age were below the median when compared with reference populations for most ages. Values were statistically significant for children younger than five years of age. Thus, with the appropriate supplementation and parent education, children on vegetarian or vegan diets can attain adequate growth, but it may be somewhat less than reference populations.

In children following macrobiotic diets, weight and length were more depressed when compared with vegetarian children (15). A marked decline from the median for reference weight, and height and arm circumference, was observed between six months and two years of age, following which a partial catch-up for weight and arm circumference was reached, given no change in diet. However, no catch-up growth in height occurred in macrobiotic children, which may indicate the existence of chronic nutritional deficiencies that do not allow for adequate catch-up growth (4).

Vitamin D

Because vitamin D is most commonly found in fortified milk products, egg yolk or oily fish, it is the most likely vitamin to be deficient in vegetarian and macrobiotic diets, but not in lacto-ovo-vegetarian diets. Exposure to sunlight may be an unreliable source of vitamin D, especially in northern areas and dark-skinned infants; thus, supplementation is important to avoid an increased risk of osteoporosis or rickets (16).

Vitamin B₁₂

Plant foods are not a high-quality source of vitamin B₁₂. Thus, it is not surprising that studies have shown low serum concentrations of vitamin B₁₂ in children on vegan and macrobiotic diets without supplementation (4). Vitamin B₁₂ deficiency is not a benign condition; it may lead to megaloblastic anemia and neurological disorders. Mild vitamin B₁₂ deficiency in infancy, with or without hematological signs of deficiency, may be associated with impaired cognitive performance in adolescence, specifically, fluid intelligence (which involves reasoning, the capacity to solve complex problems, abstract thinking ability and the ability to learn), spatial ability and short-term memory (17). Moreover, lack of cobalamin may lead to long-term neurological disorders in infants and toddlers fed vegetarian diets (18). In addition, recent data indicate that the adverse effects of cobalamin deficiency in the macrobiotic community may not be restricted to just early childhood, but may also cause symptoms related to impaired cobalamin status later in life. Even a change to a lacto-ovo-vegetarian or omnivorous diet at six years of age is not sufficient to restore normal cobalamin status in previously strict macrobiotic adolescents (19). Thus, it is obvious that vitamin B₁₂ supplementation for children consuming vegan and macrobiotic diets is essential to ensure normal growth and development.

Iron

Iron intakes in vegan preschoolers have been shown to be above the current recommended daily allowance (20); however, nonheme iron from plants is less bioavailable than heme iron from animal sources. Consequently, iron deficiency anemia has been shown in many studies to occur in vegetarian children and in a greater proportion of macrobiotic children (4). Iron deficiency is also not a benign condition, because anemic infants may have significantly lower Mental and Psychomotor Developmental Index scores compared with control infants (4). Thus, iron is another nutrient that should be monitored in children who follow atypical diets.

Calcium

Calcium intake for vegan and macrobiotic children may be below current recommendations (2), and their diets may contain substances found in plant foods that may impair calcium absorption (2). Low calcium may result in rickets (4) and reduced bone mineral content or osteoporosis (21), with important implications for future fracture risk. Therefore, foods rich in calcium, or calcium itself, should be supplemented to assure adequate intake.

IS THERE A REAL CAUSE FOR CONCERN?

As noted above, a well-planned and carefully followed vegetarian diet can satisfy the nutrient requirements for infants and children, and thus cause no real concern. However, the deleterious effects that these atypical diets can have on infants and children, such as scurvy, rickets and kwashiorkor,

are well documented (22). Further, Dagnelie and van Staveren (4) found that infants weaned onto macrobiotic diets were significantly slower in gross motor development, especially locomotion, and to a lesser degree in speech and language development. Moreover, major skin and muscle wasting occurred in 30% of macrobiotic infants.

The more restrictive diets, such as the vegan and macrobiotic diets, have attracted some negative attention in the media due to the serious health concerns they may cause. In some cases, parents have rejected treatment for the documented nutritional deficiencies, and legal intervention was necessary to protect the health and safety of the child. In 2002, a vegan couple from New Zealand was accused of child abuse after 'failing to provide the necessities of life' for their six-month-old child. Their son died of medical complications due to vitamin B₁₂ deficiency after the parents left the hospital against medical advice to treat their son with herbal remedies (23). In addition, seven infants exclusively breastfed by vegan mothers developed nutritional vitamin B₁₂ deficiency. Most of these children presented with hypotonia, lengths and weights below the third percentile, and psychomotor retardation that improved with the appropriate nutritional supplementation (24).

As recently as 2005, despite the significant available literature on the potential risks of alternate diets, strict vegan parents were taken to court and charged with neglect after one of their children died of malnutrition (25). Their other four children were all found to be below the lowest appropriate percentile for height and weight for their age. These parents avoided taking their children to see physicians and the children were not immunized.

It is important to consider that the number of subjects is small in the majority of the negative studies cited above, and long-term consequences were not often discussed. Nevertheless, these reports are alarming enough to suggest that extra time is warranted by the physician caring for infants following atypical diets, with institution of appropriate laboratory investigation and supplementation as required.

While appropriately planned vegan diets can satisfy the nutrient needs of infants, a lack of communication with their parents and, in some cases, with the spiritual leaders of their community can hinder the identification of infants at risk. It is important for parents to receive education from reliable sources of information, such as paediatricians, nutritionists and nurses, on the diet that they have chosen. It is also important that these children be kept within the medical care system because it is not uncommon for these diets to be associated with cultures that shy away from orthodox medical treatments. An earlier survey (26) showed that only 9% of British vegans approved of routine childhood immunization and only 38% sanctioned blood transfusions, compared with 91% and 97%, respectively, for the population at large. The authors believe that this 36-year-old study warrants re-evaluation in the 21st century.

TABLE 1
Guidelines recommended for children being weaned onto a vegetarian diet

Protein	Inclusion of one or more servings of 150 g/day to 250 g/day of dairy products in nonvegans. Vegan alternate: Use more bean and soy products that are higher in lysine compared with cereals. Ensure a variety of plant foods and cereal-legume combinations to achieve 1.5 g/kg/day for children younger than four years of age, and 1.0 g/kg/day thereafter.
Energy	Addition of dietary fat to increase energy intake by 25% to 30% by including 20 g/day to 25 g/day of vegetable oil or 40 g/day to 50 g/day of nuts and seeds.
Vitamin D	Inclusion of 100 g/week to 150 g/week of fatty fish supplies 2 µg/day to 3 µg/day. Vegan alternate: 250 mL of vitamin D-fortified soymilk provides 1.5 µg/day to 3 µg/day. Added supplements of vitamin D: 2 µg/day to 3 µg/day as required.
Vitamin B ₁₂	Inclusion of 100 g/week to 150 g/week of fatty fish. Vegan alternate: 125 mL vitamin B ₁₂ -fortified soymilk supplies the current recommended requirement of 0.9 µg/day to 1.3 µg/day.
Iron	Vegetarian and nonvegetarian children require 1.0 mg/kg/day after four to six months of age. Iron-rich foods include soy foods, legumes, nuts, breads and cereals. The addition of sources of vitamin C to meals increases iron bioavailability (eg, citrus fruit, tomatoes, potatoes, strawberries and spinach).
Calcium	Six to 12 servings of calcium-rich foods should be consumed every day, which may include one serving of dairy products at 150 g/day to 250 g/day. Vegan alternate: 125 mL of calcium-fortified soymilk. Reduction of fibre intake to 0.5 g/kg/day to increase calcium absorption.

Data from references 4, 27 and 28

SUMMARY

Table 1 summarizes current recommendations for children being weaned onto a vegetarian diet (4,27,28). Children consuming atypical diets are not uncommon and are on the rise, as judged by the plethora of information on veganism directed to those caring for children. For example, an Internet search of the terms 'vegan' and 'children' produced 1,380,000 hits. Without the appropriate monitoring and supplementation, these diets may have deleterious effects on a child's health outcomes. Nutritional deficiencies, particularly early in life, may adversely affect growth, bone mineral content, and motor and cognitive development. Most significantly, it is important to recognize that although it is the 21st century, children may still die as a consequence of being placed on these atypical diets by their parents without appropriate care and supervision. Because these deleterious affects can be avoided, it is highly recommended that child health practitioners carefully review dietary intake, including all supplements, when interviewing parents who provide these atypical diets (especially during infancy and early childhood) and make the appropriate interventions.

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