Vegetarian diets in children and adolescents

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A well-balanced vegetarian diet can provide for the needs of children and adolescents. However, appropriate caloric intake should be ensured and growth monitored. Particular attention should be paid to adequate protein intake and sources of essential fatty acids, iron, zinc, calcium, and vitamins B_{12} and D. Supplementation may be required in cases of strict vegetarian diets with no intake of any animal products. Pregnant and nursing mothers should also be appropriately advised to ensure that the nutritional needs of the fetus and infant are adequately met. Recommendations are provided. Adolescents on restricted vegetarian or other such diets should be screened for eating disorders.

Key Words: *Adolescent; Child; Infant; Vegetarian diets*

Les régimes végétariens chez les enfants et les adolescents

Un régime végétarien bien équilibré peut répondre aux besoins des enfants et des adolescents. Il faut toutefois s'assurer d'un apport calorique suffisant et prévoir une surveillance de la croissance. Il faut accorder une attention particulière à un apport suffisant de protéines et aux sources d'acides gras essentiels, de fer, de zinc, de calcium, de vitamine B_{12} et de vitamine D. Des suppléments peuvent être nécessaires en cas de régime strictement végétarien sans consommation de produits animaux. Les femmes enceintes et qui allaitent doivent également obtenir des conseils pour bien respecter les besoins nutritionnels du fœtus et du nourrisson. Des recommandations sont fournies. Les adolescents qui suivent un régime végétarien restreint ou d'autres régimes de ce genre devraient faire l'objet d'un dépistage de troubles alimentaires.

Vegetarianism as a lifestyle choice is becoming more popular among Canadian families. A 2002 survey (1) in Canada revealed that 4% of adults claimed to be vegetarian. Approximately 2% of six- to 17-year-olds in the United States are described as vegetarians, and approximately 0.5% of this age group professes to be strictly 'vegan' (2). A variety of influences are acknowledged by vegetarians including concern for the environment, long-term health benefits, religious beliefs and economic concerns (3,4). In addition, the influence of a diverse ethnic population now seen in North America has had some effect (5). Restaurants and the retail food industry have responded to this interest by offering a great variety of products.

A PubMed search (1980 to 2008) using the key words "children", "adolescents", "vegetarian diets", "growth" and "nutritional problems" was conducted on this topic.

The concept that a well-balanced vegetarian diet can provide for the needs of a growing child and adolescent is supported by Canada's Food Guide (6), the American Dietetic Association and Dietitians of Canada (7), and the American Academy of Pediatrics (8). There is sufficient evidence from well-developed studies (9-14) to conclude that children and adolescents grow and thrive well on vegetarian diets that are well designed and supplemented appropriately.

However, certain components of these diets and some required nutrients may be in short supply and need specific attention. This is particularly true in the case of strictly vegan diets and other very restrictive diets in which significant medical consequences could result from inattention to nutrient needs. The present statement highlights some of these areas and recommends appropriate interventions.

DEFINITIONS

- Lacto-ovo-vegetarians: No meat, fish, fowl or products containing these foods, but include dairy and eggs. (Lacto-vegetarian: dairy; ovo-vegetarian: eggs.)
- Vegans: Excludes all meat, fish, dairy and eggs – no animal products at all.
- Macrobiotic diets: Not necessarily vegetarian, but based largely on grains, legumes and vegetables. Many also include some animal products.
- Others: Rastafarian and fruitarian – extremely restrictive vegan diets.
- Serving: Recommended quantity (in units) of a particular food – see Canada's Food Guide (6).

ENERGY NEEDS AND GROWTH

While vegetarian diets can be relatively low in caloric density, studies (15,16) have documented vegetarian children to have adequate energy intake compared with non-vegetarians. Restrictive vegan diets, however, may cause energy deficits because of low energy density and excessive bulk, presenting challenges in feeding smaller children (15).

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The inclusion of soy products, nuts and nut butters will provide more concentrated sources of energy and will support appropriate growth (16). Many long-term studies (8-11,17,18) on populations of lacto-ovo-vegetarian children have documented appropriate growth and development from infancy through adult life. There are, however, insufficient studies on energy intake and long-term growth of strict vegans to permit conclusions. See Canada's Food Guide (6), as well as the vegetarian food guide pyramid and rainbow (19), for age-appropriate servings and varieties of vegetarian foods to provide for energy needs. At the time of writing, the vegetarian food guide pyramid and rainbow were based on a previous version of Canada's Food Guide. (A revised version is expected.)

PROTEIN AND ESSENTIAL AMINO ACIDS

Research indicates that a variety of plant foods can provide all of the essential amino acids required for healthy adults (8,20,21). However, based on the lower digestibility of plant proteins, others have suggested that protein intake may need to be increased by 30% to 35% for infants up to two years of age, 20% to 30% for two- to six-year-olds and 15% to 20% for those older than six years of age (22). Therefore, recommended protein intakes are adjusted upward for children in the range of 10% to 15% compared with nonvegetarians (23,24). As well, while soy protein can meet needs as effectively as animal protein, wheat protein consumed alone may contain up to 50% less usable protein than animal protein (25). The major plant food sources of protein are legumes (beans and lentils), cereals, nuts and seeds, and their butters. Each variety has different qualities, digestibilities and compositions of essential amino acids. Therefore, combinations of several of these groups promote good nutrition, especially if small amounts of animal protein are included (20). A detailed dietary history, with specific attention to the variety of foods supplied (especially in cases of strict vegan or other restrictive diets), needs to be taken and appropriate advice given. Combining complementary proteins in each meal, however, is not believed to be necessary for children who eat often throughout the day (20).

MINERALS – IRON, ZINC AND CALCIUM

Iron

Several studies (13,26,27) of strict vegan preschoolers and school-age children have documented adequate iron intake, and comparable studies (27) indicate that there is no evidence of documented cases of anemia. Vegans and lacto-ovo-vegetarians, however, require 1.8 times the iron intake of nonvegetarians because of differential bioavailability (28,29). Vitamin C and other components found in vegetables enhance the absorption of nonheme iron (13,26,27,30). Other substances such as dietary fibre, phytates and tannins may inhibit absorption, and, therefore, a balance must be achieved. Recognizing that iron deficiency is the most common nutritional deficiency in children, it is essential that caregivers identify food sources rich in iron for this population (8,22,27). Options available include iron-fortified cereals, grain products, dried beans and peas, or supplementation. Supplementation may be essential during rapid growth phases (22,31,32). Health care providers should take a very specific and detailed dietary history to ensure adequate intake.

Zinc

Phytates found in larger quantities in vegetarian diets bind zinc, reducing its bioavailability (33). Fifty per cent of usual zinc intake comes from animal protein (27). Human milk contains an adequate amount of zinc for infants up to seven months of age, after which, additional sources are required (8,27). The differences in bioavailability dictate that the intake required for strict vegans may also be 50% greater than for omnivores. Zinc deficiency, however, appears to be quite rare and additional supplementation is not recommended (8,27), although attention needs to be given to including zinc-rich foods such as legumes, nuts, yeast-leavened breads, fermented soy products, etc (7). Some food preparation techniques such as fermenting and sprouting seeds and grains improve the bioavailability of zinc (29,34,35).

Calcium

The high intake of dairy products in lacto-ovo-vegetarians make deficiency unlikely in this group (36,27). However, strict vegans may require careful consideration. Data on strictly vegan children have demonstrated intakes of calcium below recommendations (13,26,37,38). Calcium content of breast milk is unaffected by a vegan diet in the mother. However, after weaning, it is essential to ensure adequate intake of calcium-fortified foods such as fortified soy products, cereals, juices and leafy vegetables. Low-oxalate greens (bok choy, Chinese cabbage, kale, collards, etc) provide highly bioavailable calcium for the older child (19). All vegetarians should meet the recommended intake of calcium appropriate for their age, as indicated in the vegetarian food guide pyramid and rainbow (19). Strictly vegan children and adolescents may require additional supplementation to ensure recommended intakes.

FAT AND FATTY ACIDS

Vegan children appear to consume less fat than omnivore and lacto-ovo-vegetarians in the range of 30% to 31.5% of total energy intake (9,13,39). Effects on growth, however, are negligible (40,41). Vegan diets are relatively deficient in the long-chain omega-3 fatty acids docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) (13,22), which are found largely in fish, seafood and eggs. Vegans, therefore, have no direct access to these long-chain omega-3 fatty acids unless large amounts of sea vegetables or algae are consumed. Higher levels of omega-6 fatty acids found in vegan diets may also inhibit the conversion of the precursor linolenic acid to DHA and EPA (42). Low blood levels of DHA and EPA have been documented in vegan adults (9). It is therefore recommended that adequate sources of the precursor linolenic acid (flaxseed and canola oils, walnuts

and soy products) be included in the diets of vegan children, which would then be converted into EPA and DHA (7,8,22). Also, vegetarian sources of DHA from microalgae are available as supplements. Trans fatty acids contained in semisolid fats (shortening and hydrogenated margarine) may also inhibit synthesis of long-chain omega-3 fatty acids and, therefore, should be limited (17). In Canada, it is recommended that omega-3 fatty acids provide 1% of the total caloric intake of vegetarians (found in 5 mL of flaxseed oil, 45 mL of walnuts or 15 mL of canola oil for the average adult) (23). Preterm infants have a limited capacity to convert precursors and may need supervised supplementation with DHA (8).

VITAMINS

Vitamin B_{12}

Strict vegans are at risk of vitamin B_{12} deficiency because this compound is only found in animal products. Supplementation or intake of fortified food is therefore essential. Lacto-ovo-vegetarians can obtain B_{12} from dairy products and eggs if consumed regularly (7). Breast milk of strict vegan mothers can be low in B_{12}; therefore, their infants should be supplemented (43).

Appropriate sources of B_{12} include fortified soy formula and cereals appropriate for the needs of infants and children. Other sources of B_{12} include yeasts, fortified soy and nut beverages, and cereals (7,8,22). Vegetarian diets are usually high in folic acid intake, which could mask B_{12} deficiency anemia but still leave children at risk for neurological compromise (7,44). Therefore, all strict vegan infants, children and adolescents should be assessed regarding the adequacy of their intake of fortified foods and/or supplements (8,13,22,33). It is recommended that at least three servings of food rich in vitamin B_{12} be included in the daily diet or supplementation be provided at 5 µg to 10 µg per day (19). Infants of vegan mothers are at particular risk of this deficiency (7,8,22).

Vitamin D

Vitamin D occurs naturally in animal products such as liver, fatty ocean fish and egg yolks, and, therefore, may be lacking in vegan diets. Limitations of sunlight exposure in Canada require that all breastfed infants be supplemented with vitamin D (45). Infant formula and all commercial brands of cow's milk (as well as many soy and rice milk products) are also fortified. Strictly vegan infants and children will require supplementation in the form of vitamin D_2 (ergocalciferol – a nonanimal product) (46) if fortified food intake is inadequate (7,8,22). Supplementation is also required for all breastfed infants, and for infants and children consuming less than 500 mL of fortified milk each day (47). A dose of 400 U of vitamin D from all sources is recommended for Canadian children one year of age or younger. In addition, Canadian children younger than two years of age living above a northern latitude of 55°, those with dark skin and those avoiding sunlight should be supplemented with 800 U of vitamin D in the winter months from October to April (48). Sunlight exposure to the face and hands for 20 min to 30 min three times a week is considered adequate for light-skinned children (47). Pigmented skin and the use of sunscreen diminish the effect of sunlight on the synthesis of vitamin D in skin. For children older than one year of age through adolescence, Health Canada recommends 200 U of vitamin D per day (23). However, recent research suggests that these figures may need to be revised to ensure vitamin D sufficiency as well as to prevent rickets (48).

Riboflavin

Clinical deficiency has not been observed (23), although intake may be lower than in nonvegetarians. Riboflavin is found in many vegetable products (7).

Vitamin A

Preformed vitamin A is only found in animal products. Therefore, strict vegans will have to convert dietary carotenoids – found in yellow and orange vegetables, leafy green vegetables and fruits rich in beta-carotene – into vitamin A. Three servings a day of such vegetable and fruit products is adequate (7).

FIBRE

A maximum fibre intake of 0.5 g/kg/day is recommended by the American Academy of Pediatrics (8). However, many vegan children may sometimes have an actual fibre intake that is three times higher than this recommendation (13). This may present problems in young children when low energy density may limit intake of adequate calories and interfere with absorption of minerals (8).

SUPPORTING PREGNANT AND BREASTFEEDING MOTHERS

Well-planned vegan and lacto-ovo-vegetarian diets can both meet the nutritional needs of pregnancy (7,8,22). Infants of vegetarian mothers have birth weights comparable with those of nonvegetarians (10,27,49). In strictly vegan mothers, adequate sources of vitamin B_{12} (from fortified foods) should be assured (7,8), and supplementation offered if necessary. Maternal vitamin D deficiency is now recognized to be a common condition in the northern hemisphere and a major risk factor for deficiency in infancy (48,50). In strict vegans, vitamin D needs will require adequate intake of fortified products or supplementation during pregnancy and lactation (7,8). It is now recommended that all pregnant and lactating mothers ingest 2000 U (50 µg/day) of vitamin D through the winter months to maintain sufficiency (48). Similarly, iron supplementation may be required. The recommendation for folate supplementation in the periconceptional period applies to vegan and lacto-ovo-vegetarian mothers as well (51). The long-chain fatty acid DHA levels in cord blood and blood plasma of infants of vegetarian mothers, as well as in breast milk, have been documented to be low, although its significance is unknown (52,53). However, in light of the significant role of essential fatty acids in brain and eye development, it is recommended that pregnant and lactating vegan mothers include food with linolenic acid (eg, flaxseed, soybean and canola oils), a

precursor of DHA, in their diets or use supplements (7). Also, intake of foods containing inhibitors of DHA production (linoleic acid and trans fatty acids [shortening and stick margarines]) should be limited (8,54). Calcium content of breast milk is unaffected by vegan diets (8). However, supplementation of the mother will likely be required to meet her needs (55). Breast milk in vegan mothers does not contain an adequate amount of zinc for infants after the age of seven months (8).

ADOLESCENCE

Interest in alternative lifestyles and diets, including vegetarianism, is a growing phenomenon in this age group. It is not uncommon to find a strict vegan adolescent in an otherwise omnivorous family (7). Limited data suggest no significant impact of vegan or vegetarian diets on the growth of adolescents (12). However, there is concern that a vegetarian diet may mask eating disorders (56,57), although it is not believed to be causally associated (58,59). Therefore, particular attention to details of diet, general health and mental health should be covered in the assessment of vegetarian adolescents. Useful screening tools for assessing the risk of an eating disorder are available (60). Vegetarian diets do offer some advantages in terms of healthy living. There is evidence of healthier intakes of total fat, saturated fats, servings of vegetables and fruits, as well as fewer intakes of fast foods, salt, and consumption of regular soda and fruit drinks (6,32,61). However, the intake of vitamin B_{12}, calcium, vitamin D and iron-containing food needs to be reviewed with each adolescent and appropriate guidance offered (7,8,22).

ATHLETES

Vegetarian diets can meet all the needs of competitive athletes (62). The position statement of the Dietitians of Canada (7) provides appropriate guidance. Protein requirements may be increased for endurance training (1.2 g/kg to 1.4 g/kg) and weight training (1.6 g/kg to 1.7g/kg) (7), which can be met with a variety of plant-based products. Energy, calcium and iron needs also require educated supervision to ensure adequate intake. Female athletes, particularly those presenting with recent changes in diet, a stress fracture or amenorrhea, should be screened for eating disorders (56,57,63).

OTHER ATYPICAL VEGETARIAN-BASED DIETS

The macrobiotic diet is often referred to as a vegetarian diet, but one that is particularly challenging and needs close supervision and education of adult caregivers. For macrobiotic diets and other diet variations (such as Rastafarian and fruitarian diets), referral to an experienced paediatric clinical dietitian is likely necessary (7,8,63).

CONCLUSION

Well-planned vegetarian and vegan diets with appropriate attention to specific nutrient components can provide a healthy alternative lifestyle at all stages of fetal, infant, child and adolescent growth (7,8,22). Appropriate education of the family and follow-up over time are essential. There are many useful tools and excellent guides to assist families and professionals.

RECOMMENDATIONS

The levels of evidence reported in the recommendations have been described using the evaluation of evidence criteria outlined by the Canadian Task Force on Preventive Health Care (64).

- A well-balanced vegetarian diet as a health lifestyle choice is an acceptable option to provide for the needs of growth and development in the young (BII).
- Lacto-ovo-vegetarian diets should be adequate to meet all nutrient needs comparable with omnivores (standard recommendations regarding supplementation) (BII).
- Energy needs in strict vegans may require intake of calorie-dense foods to provide for adequate growth. Growth should be monitored closely (CIII).
- Protein requirements in strict vegans will need to be increased to account for the lower digestibility of plant protein (CIII).
- Both lacto-ovo-vegetarian and vegan diets have increased iron needs (1.8-fold) compared with omnivores, and caregivers will require sound knowledge of food sources that are iron fortified or rich in iron. Iron supplementation may be required during periods of rapid growth (BII).
- Zinc needs for breastfed infants of vegan mothers will require fortified foods after seven months of age. Strict vegans will need to consume 50% more zinc to account for bioavailability (BII).
- Calcium intake in strict vegans needs careful attention to assure recommended consumption of fortified foods or supplements (BII).
- Foods containing the precursor of the essential fatty acid linolenic acid should be included in strict vegan diets (flaxseed, canola, nut oils and soya products) (BIII).
- Vitamin D recommendations for infants in Canada are standard. Children and adolescents who consume less than 500 mL of vitamin D-fortified milk product per day should be supplemented with 400 U daily. For children younger than two years of age living above a northern latitude of 55°, those with dark skin and those avoiding sunlight, 800 U of vitamin D per day should be provided in the winter months (BII).
- Fibre intake should be limited to 0.5 g/kg/day to avoid dilution of calories and interference with absorption of minerals and essential nutrients (CIII).
- Strictly vegan pregnant women should ensure adequate intake or supplementation of vitamin B_{12}, vitamin D, iron, folic acid, linolenic acid and calcium (BII).
- Infants, children and adolescents on vegan diets should ensure adequate intake of vitamin B_{12}-fortified food or be provided with 5 µg to 10 µg of daily supplement.

- Adolescents and athletes who develop restrictive vegan or other dietary habits should be closely monitored to ensure adequate intake of essential nutrients and to detect a possible eating disorder (CIII).
- Individuals on atypical or very restrictive diets, as well as those who are strictly vegan should be referred to a clinical nutritionist for assessment and advice. Careful follow-up of growth and development should be ensured.

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ADDITIONAL RESOURCE: A handout to print and share with parents and caregivers titled "Feeding your vegetarian child" is available at <www.caringforkids.cps.ca>.

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