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Groups at Risk of Micronutrient Deficiencies

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Almost 40% of Canadians use a vitamin and/or mineral supplement on a regular basis[1]. Supplement users have a lower rate of smoking and better perceived health than non-users and supplement choices reflect gender- and age related heath concerns[1]. All Canadians are encouraged to follow the recommendations in *Eating Well with Canada's Food Guide*[2]. However, as outlined in Table 1, at some stages of the lifecycle, it is difficult to meet nutrient needs from food alone either because the need is too great, food intake is inadequate for some reason, or physiological changes in the body lead to inefficient nutrient utilization.

EXCLUSIVELY BREAST-FED INFANTS

Iron. A normal term infant should have sufficient iron stores to last until 4 to 6 months of age. Beginning between 4 and 6 months of age, it is recommended that breast-fed infants be given iron-fortified cereal or an iron supplement[3]. Further, it is recommended that formula-fed infants be given an iron-fortified formula from birth[3]. Iron status is a concern because low stores can impact on cognitive development.

Vitamin D. Early humans lived in regions around the equator so vitamin D needs were met through cutaneous synthesis from 7-dehyrocholesterol upon exposure to UVB light[4]. As a result of this evolutionary niche, breast milk does not provide enough vitamin D to meet needs in the absence of exposure to sunlight. Health Canada recommends that all breast-fed infants be supplemented with 400 IU (10 µg/d) of vitamin D from birth until the diet provides this amount, or until one year of age[5].

TEENAGERS WITH IRREGULAR EATING HABITS

The dominant features of adolescent development are the pubertal growth spurt and sexual maturation, both of which impact on nutrient requirements. The Adequate Intake (AI) for calcium of 1300 mg/day is the highest of all life stage groups reflecting the demands imposed by skeletal growth and maturation[4]. Reports from the Canadian Community Health Survey indicate that 83% of females and 61% of males aged 10 to 16 years do not meet the minimum recommendations for intake of dairy products[6]. Typically, with increased autonomy over food choices, teens decrease milk intake in favour of other beverages such as fruit drinks and carbonated soft drinks[7]. Adolescent males and females require more iron to support expansion of blood volume with the growth spurt. Once menstruation is established, female teens require more iron than male teens (15 mg/day versus 11 mg/day)[8].

REPRODUCTIVE AGE WOMEN

Folic Acid. Folic acid supplementation has been shown to decrease both recurrent and occurrent cases of Neural Tube Defects (NTDs)[9]. It is hypothesized that a genetic defect in folate metabolism impacts on neural tube closure[10]. Mothers and affected infants have a higher frequency of gene mutations and it is proposed that heterogeneity of gene mutations may account for variation in NTD phenotypes[11]. As an alternative mechanism, recent reports suggest that auto-antibodies against folate receptors decrease cellular uptake of folate[12,13]. A meta-analysis of prenatal multivitamin supplementation reveals that the incidence of other congenital anomalies, e.g., cleft palate, urinary tract, cardiovascular, also decreases as folic acid intake goes up[14].

All women of reproductive age are advised to consume both the Recommended Dietary allowance (RDA) for folate (400 µg Dietary Folate Equivalents (DFE)/day) and an additional 400 µg/day of synthetic folic acid either as a supplement or through fortified food[15]. Dietary folate equivalents is used to adjust for the almost 50 percent lower bioavailability of food folate compared to that of synthetic folic acid (used in fortified food and /or supplements). The mandatory fortification of flour, bread, pasta and rice introduced by Health Canada in 1998 has increased folic acid intake by ~150 µg/day[16]. This has been enough to significantly reduce the incidence of NTDs suggesting that the effective dose of folic acid is less than current recommendations[9,17]. Consistent with this, although 400 µg/day of synthetic folic acid is recommended, a dose-response relationship has yet to be established[9].

During pregnancy, folate is required to support nucleotide synthesis associated with growth of the uterus, placenta, maternal red blood cells and fetal tissue. Folate is actively transported from the mother to the fetus suggesting that maternal folate is sacrificed to support fetal development[14]. While it may be possible to achieve the RDA of 600 µg DFE/day from a varied diet that includes fortified foods, most pregnant women will benefit from a vitamin supplement providing folic acid[15].

Iron. Approximately 50% of dietary iron in Canada is from enriched grain products, and the prevalence of inadequate iron intake by non-pregnant women is estimated to range from 14 – 20%[18,19]. However, even though total intake for most women is adequate, net uptake is probably lower because of reduced bioavailability of non-heme relative to heme iron. Consistent with this, iron stores are often depleted in women of reproductive age[20].

The iron cost of pregnancy, estimated to be ~700 – 800 mg, is the amount that must be absorbed from the diet over the entire gestational period with the need being greatest in the 2nd and 3rd trimesters[8]. The body offsets the increased need by enhancing efficiency of iron absorption from the non-pregnant level of 18% to a high of 25%[8]. Even with enhanced absorption, the RDA for iron is increased by 50% over the non-pregnant value and most women will require a supplement to achieve this recommendation.

Calcium. During pregnancy the maternal skeleton starts to accrue calcium very early[4]. To accommodate this, the efficiency of calcium absorption increases secondary to an increase in total and free 1,25(OH)2D such that the AI for calcium of 1000 mg/d (1300 mg/d for adolescent females) applies to both pregnant and non-pregnant women. Calcium deposited in maternal bones during early pregnancy is transferred to the fetus mostly during the 3rd trimester; and it is further mobilized during lactation, regardless of the amount of calcium consumed in the diet[4]. Although women do not need 'extra' calcium during pregnancy and lactation, they should at least meet the AI by consuming dairy products, fortified soy beverage, fortified orange juice, or a calcium supplement.

MEN AND WOMEN OVER AGE 50

Calcium. Both men and women experience age-related bone loss but it is more apparent in women because of the rapid rate of loss and their smaller skeletal mass. Decreased estrogen production with the onset of menopause initiates accelerated demineralization particularly of trabecular bone in the lumbar spine due to a specific effect on osteoblast/osteoclast cycling[4]. It is estimated that 15% of total skeletal mass is lost during the first 5 years after menopause. In early post-menopause the loss of bone is related to hormonal factors and extra calcium will have little effect on trabecular bone but cortical bone may retain some responsiveness. After five years, loss of bone slows and is related to age factors. Increasing calcium intake can slow age-related demineralization in both men and women[21,22].

Vitamin D. With advancing age, the efficiency of cutaneous vitamin D synthesis is reduced while poor mobility, institutional living, and wearing multiple layers of clothing limit exposure to sunlight[23,24]. To compensate for this, the AI is 10 µg/d (400 IU) for those aged 51 to 70 and 15 µg/d (600 IU) for those over 71. Considering the limited number of dietary sources, it is virtually impossible to meet these recommendations without taking a vitamin D supplement. Failure to meet the requirement for vitamin D will further compromise bone health in this population.

Magnesium. The efficiency of magnesium metabolism decreases with advancing age. Magnesium plays a role in bone health and calcium balance. It is estimated that ~45% of older Canadians have inadequate dietary intake[18]. While magnesium supplementation is of some benefit, its usefulness is limited by osmotic diarrhea at higher levels of intake[4].

Vitamin B12 and Folate. From 10 to 20% of adults over age 50 have inefficient vitamin B12 absorption secondary to atrophic gastritis. This limits absorption of food-bound vitamin B12 but not crystalline vitamin B12[15]. The RDA for men and women older than age 50 recommends that vitamin B12 be taken as crystalline vitamin B12 either as a supplement or through fortified foods (as of this date, Health Canada does not mandate addition of vitamin B12 to food). Given the neurological symptoms associated with clinical vitamin B12 deficiency (motor dysfunction and cognitive changes ranging from loss of concentration, to disorientation and frank dementia), older Canadians can suffer significant morbidity if this nutritional deficiency is not prevented and/or treated[15].

Folate and vitamin B12 have been implicated in depressive symptoms in older adults and in those prone to depression. Hyperhomocysteinemia and the mutated methylenetetrahydrofolate reductase genotype are associated with depression[25]. Folate levels are low in subjects recently recovered from depression and subjects with low vitamin B12 status are two times more likely to suffer from depression. A meta-analysis of clinical trials on folate and depressive disorders suggests that folic acid supplementation may have a potential role as an adjuvant to other treatments for depression[26]. Further, recent evidence suggests that elevated homocysteine may be an early marker of dementia in elderly patients[27].

VEGETARIANS

Vegan diets that exclude all animal products increase risk of vitamin B12 deficiency because this nutrient is only found in foods of animal origin. Those following a vegan diet are advised to take a vitamin B12 supplement, or to consume nutritional yeast or other foods fortified with vitamin B12. Vegetarian diets are also limited in the amount of zinc and iron because of low content and poor bioavailability. In the case of iron, bioavailability may be as low as 10%, or even 5% in a vegan diet[8]. Absorption of non-heme iron is enhanced by including ascorbic acid with meals, but this beneficial effect may be negated if the source is calcium fortified orange juice due to competition with iron for absorption[28]. Women following vegetarian diets who do not take a supplement will find it difficult to meet iron requirements.

DIETERS AND THOSE WHO AVOID ENTIRE FOOD GROUPS

Not surprisingly, reducing total energy intake will increase the probability of inadequate nutrient intake from food sources especially if daily intake falls below the recommendations in *Canada's Food Guide*[29]. As outlined in Table 1, the impact of eliminating entire food groups from the diet will depend on the food group. For example, it will be virtually impossible to meet calcium and vitamin D requirements if dairy products (and fortified replacement beverages) are excluded from the diet.

DEFICIENCY DISEASES, ABSORPTIVE DISORDERS, OR NUTRITION-RELATED GENETIC DISORDERS

An array of medical conditions can impact on vitamin and mineral requirements. For example, physiologic changes in the body may lead to inefficient nutrient utilization. While use of vitamin and mineral supplements may be beneficial, implementation of such a treatment plan should be done under the care of a physician.

MEN AND WOMEN OF ANY AGE WHO SMOKE

Smokers have decreased plasma and leukocyte levels of vitamin C, a response which is probably related to oxidative stress although the exact mechanism has not been established[30]. Turnover studies show that smokers need 35 mg more vitamin C a day in order to maintain the same pool of vitamin C as non-smokers. Increased vitamin C turnover has also been observed in nonsmokers who are exposed to secondhand smoke on a regular basis[30].

CONCLUSION

All Canadians are advised to eat a varied diet that follows *Eating Well with Canada's Food Guide* for the best assurance of meeting essential nutrient requirements. At some stages of the life cycle, and with advancing age, it will be difficult to meet nutrient needs from food alone and use of an age appropriate vitamin/mineral supplement may improve nutritional status. Use of a supplement should be in addition to, not in place of, healthful food choices.

Table 1. Nutrients of Concern by Life Stage and Age Group

Population Group	Nutrients
Exclusively breast fed infants	Vitamin D, iron
Teenagers with irregular eating habits	Calcium, iron (females)
Reproductive age women	Iron, folic acid, calcium
Men and women over age 50	Vitamin B12, folic acid, calcium, vitamin D, magnesium
Vegetarians who consume no animal products	Iron, zinc, vitamin B12
Dieters and men and women who avoid entire food groups	Depends on total energy intake and food group(s) avoided, e.g., grains (folic acid, iron), dairy (calcium, vitamin D), meat (iron, vitamin B12, zinc), vegetables/fruit (vitamin C, folate, carotenoids)
Men and women with deficiency diseases or absorptive disorders or nutrition-related genetic disorders	Depends on medical condition and/or food excluded
Men and women who smoke at any age	Vitamin C

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