

NUTRIENTS: Essential Ingredients for Adolescent Growth

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Overview

Adolescence is a time of rapid growth and change in body composition. Diet furnishes the fuel and materials needed for growth, building new tissues, and maintaining the larger body.

Nutrient Needs Parallel Changes In Size, Body Composition, and Function

The first phase of adolescence is puberty; this period of sexual development ends with the emergence of the capacity for sexual reproduction. It includes the very rapid rates of growth in weight, height, and changes in body composition that accompany the pubertal growth spurt. Puberty occurs at younger ages in North American children today than ever before--as early as age 9 in girls. Therefore nutrient recommendations for early adolescence now start at ages 9-13 years rather than at age 10 (Table 1). The pubertal growth spurt varies in its timing by sex and from one individual to another. Sex differences in body size and in nutrient needs become pronounced at puberty. The increase in body size and the year of maximal growth in height occurs about two years later in boys than in girls but it is larger in boys.

Requirements for energy, protein, and several other nutrients are closely associated with physiological age, as measured by sexual development or bone age. Physiological age more closely tracks the growth-related alterations in body composition and functions that drive these needs than calendar years. However, because there is no simple, practical, and acceptable way to easily estimate it recommendations are stated by chronological age (Table 1).

During ages 9-13 years, sex differences in calorie needs are small because girls are growing rapidly while most boys have not yet begun their growth. Boys have rapid gains in lean body mass and in the skeleton, with resulting increases in needs for constituents such as protein, iron, calcium, magnesium, and zinc that are rich in these tissues. Girls have smaller increases in lean body mass but greater increases in adipose tissue, and their needs for some of these nutrients are thus somewhat less.

The second phase of growth is adolescence, the period after the emergence of the capacity for sexual reproduction. In tables of nutrient recommendations, the age category of 14-18 years roughly corresponds to this phase. However, most adolescents, and particularly late maturing boys, continue to grow until at age 20, so there is no sharp cessation of adolescent growth at age 18. During adolescence, growth is slower. Chiefly because of boys greater lean body mass and size their energy needs rise to about 500 calories higher than girls' by 14-18 years. Sex differences in body composition and size are conserved. After menarche, iron needs remain high to cover menstrual iron losses while they remain low in boys. Since girls of this age are capable of becoming pregnant, folic acid needs also rise.

Needs for Many Nutrients Increase More than Energy Intakes, Especially in Girls

Adolescents' needs for most nutrients rise more than do energy needs, especially among girls. Therefore, teen diets must be higher in quality and provide more of these nutrients per calorie than in childhood. Intakes of some nutrients such as iron that occur in small amounts in many foods generally rise as energy intakes rise. This accounts for the greater iron intakes of adolescent boys than girls. One benefit of increasing physical activity levels is that intakes of energy as well as of many other nutrients can increase while weights are maintained at healthy levels. Girls with low energy intakes who are physically inactive often fail to meet their needs for iron; more physically active lives and choices of iron rich foods can help to increase iron intakes.

New Recommendations for Nutrient Needs of Adolescents

New standards for assessing and planning nutrient intakes are now available, and others are being formulated. These are the Dietary Reference Intakes (DRI) that have been developed under the auspices of Health Canada and the Food and Nutrition Board of the National Academy of Sciences in the USA^{1,4}.

The Estimated Average Requirement (EAR) is the experimentally determined intake at which half of a group fails to meet its requirements. The greater the gap between an individual's intake of a nutrient and the EAR, the greater the risk of inadequacy. However, the EAR is based on requirements of groups of people, not individuals, so it is not a useful goal for planning diets for individuals. For individual teens, the Recommended Dietary Allowance (RDA) or, when the RDA is not available, the Adequate Intake (AI) is the nutrient target to aim for in planning diets. The RDA and AI values are set higher than the EAR to be sure to meet or exceed the nutrient requirements of virtually all individuals. Nutrient intakes that exceed the RDA or AI confer no known health advantage, and at very high intakes the risks of adverse health effects rise, so guarding against excess is important. A new DRI value, the Upper Tolerable Level (UL) of intake, is useful for these purposes. The UL for a nutrient is the highest level known to have no adverse effects when it is consumed on a usual basis.

Intakes of Some Nutrients Need Improvement

Adolescents need 45 nutrients to sustain their rapid growth and development. Surveys of adolescents show that intakes of some nutrients are particularly likely to fall short of recommended levels because of their increased needs and inappropriate food choices. Some of these are discussed below.

Folic Acid

Folate is a cofactor for many enzymes that are essential in cell division and one carbon unit metabolism of nucleic and amino acids. The requirement for folic acid is based on amounts needed to maintain red

blood cell folate levels, plasma homocysteine and folate concentrations at normal levels.

The RDA for folic acid is similar for adolescents of both sexes. However, once adolescent girls pass puberty and are capable of becoming pregnant, a special recommendation is made for additional amounts over and above obtaining the RDA from foods. 400 µg folate from a supplement or fortified foods in addition to food folate from a varied diet is recommended. The goal is to minimize potential risks of neural tube defects that might occur if folic acid nutritional status was low in the periconceptual period. The recommendation for pregnancy is also higher than the nonpregnant state because of folate's essential role in cell division and hematopoiesis.

Surveys in the early 1990's found that many adolescent girls had inadequate folic acid intakes. Public health measures such as the fortification of flour and cornmeal are now in place, and are expected to increase intakes by about 80-100 µg for girls and women and even more for men. The folate UL is based on the adverse effect of precipitation or exacerbation of neuropathy in Vitamin B-12 deficient individuals. The UL applies only to intakes from fortified foods or supplements. It is 600 µg for 9-13 yr., 800 µg from 14 -18 yr. and higher (1000 µg) during pregnancy and lactation.

Vitamin D

Adolescents need vitamin D to enhance intestinal calcium absorption to provide adequate calcium for their rapidly growing skeletons. During winter and in far northern latitudes the synthesis of vitamin D in skin and stores may not be enough to meet nutrient requirements, and therefore vitamin D intake is critical. The AI is 5 µg². Intakes of vitamin D are difficult to estimate because food composition data are not available. Estimates are that median intakes of young women are probably about 2.9 µg (114 IU) per day from food (1 µg cholecalciferol=40 IU vitamin D). The UL of 50 µg for teenagers, pregnancy and lactation is based on the adverse event of hypercalcemia.

Calcium

The acceleration in skeletal and muscular growth during puberty and adolescence increases calcium needs. About a third of the bone mineral that is laid down during adolescence is calcium. There is some evidence that among younger adolescents intakes of calcium above what is usually eaten increases bone mineral density. Some epidemiological studies also suggest that calcium consumption is positively related to bone density in adulthood. Calcium also plays other critical roles in metabolism⁵. One recent study suggests that to achieve desirable levels of retention girls must consume well over a gram of calcium a day⁶. Based on these and other considerations, the AI for calcium was set at 1300 mg per day. Many teenagers in North America, particularly girls, are not achieving these levels². The calcium UL of 2500 mg

for teenagers is based on the risk of hypercalcemia and renal insufficiency.

Magnesium

During adolescence needs for magnesium increase. It is an important constituent of bone, which contains over half of the magnesium in the body. Recent surveys suggest that the intakes of some adolescents, particularly girls 14-18 years, are not meeting magnesium needs². The UL for magnesium is based on diarrhea as the adverse effect. It is 350 mg from supplements, food fortificants and pharmacological agents only and does not include intake from food and water.

Other Problem Nutrients Now Being Reviewed to Establish DRI

Evidence on other nutrients that are of particular concern in adolescent diets is currently being evaluated by DRI committees. Only the 1989 RDA are currently available⁷. Updated recommendations including UL are expected in 2001.

Iron

Iron needs increase during adolescence to sustain increase in lean body mass and hemoglobin. In girls, enough iron must also be consumed to offset menstrual losses and during pregnancy to provide iron to the fetus without depleting maternal stores. The 1989 RDA for iron of males was 12 mg from 11-14 years and 10 mg from 15-18 years, while it was 15 mg for females of both ages, 30 mg of elemental iron for pregnancy, and 15 mg for lactation.

Vitamin A

Vitamin A is essential for vision, growth, cellular differentiation and proliferation, reproduction and the integrity of the immune system. Vitamin A need during the rapid growth of adolescence exceeds what is necessary for the maintenance of adequate reserves in adults. Therefore, the RDA for adolescents is similar to that of adults although their body size is smaller.

The current (1989) RDA is 1000 µg RE/day (equivalent to 3300 IU/day) for boys and 800 µg RE/day for girls 9-18 years and pregnant women^{6,7}. It is 1300 µg for the first 6 months of lactation and 1200 µg thereafter.

Zinc

Zinc is a constituent of bone and muscle that is essential for sexual maturation. Needs for it rise during the rapid growth of adolescence. Needs of the growing fetus are also high, and so adolescent girls who become pregnant have even higher needs.

The current (1989) RDA is 15 mg/day for boys and 12 mg/day for girls 9-18 years, and pregnant women. It is 19 mg for the first 6 months of lactation, and 16 mg thereafter.

Dietary Fiber

Currently there is no recommendation for dietary fiber. In addition to promoting normal laxation, it may

be important in reducing risks of colon cancer⁸. A useful guide for fiber intakes based on expert opinion is "age plus 5 grams of fiber a day", not exceeding 35 gm⁹.

Conclusions

Another recent report resulting from the Canadian-American collaboration provides details on applying the DRI for the assessment of individuals and groups¹⁰, and a second report is in process on dietary planning. Dietary assessment of individuals is imprecise unless a very large amount of information is available on intakes. An adolescent's typical diet should meet the RDA or AI, but not exceed the UL. When it provides lower amounts of a nutrient than the AI or RDA, adjustments are needed. These include increasing consumption of usual foods rich in the nutrient, use of fortified foods, dietary supplements,

or combinations of these approaches. Each strategy has its pros and cons. The best method for increasing intakes depends on the nutrient in question, individual preferences and the presence of public health measures such as fortification of foods that alter food supplies for everyone.

Teens who make food choices that are in line with Canada's Food Guide, an eating pattern that meets the RDA without exceeding the UL, will have nutrient intakes that fall in the healthy range. Although Canadian adolescents are better nourished and healthier today than ever before, national goals call for additional efforts to foster healthy diets, food security, healthy weights, higher physical activity levels, and personal health practices to insure that they remain so throughout their lives¹¹.

Table 1 Selected New Dietary Reference Intakes for Adolescents

Age, yr.	Height, cm (in.)	Weight, kg (lb)	Calcium, mg (AI)	Magnesium, mg (RDA)	Vitamin D µg (IU), AI**	Folic acid, µg Dietary Folate Equivalents*
Males						
9-13	147 (58)	40 (88)	1300	240	5.0 (200)	300
14-18	174 (68)	64 (142)	1300	410	5.0 (200)	400
Females						
9-13	148 (58)	40 (88)	1300	240	5.0 (200)	300
14-18	163 (64)	57 (125)	1300	360	5.0 (200)	400
Pregnancy						
<18			1300	400	5.0 (200)	600
Lactation						
<18			1300	360	5.0 (200)	500

* Dietary folate equivalents, or DFE are used for estimating the folate content of foods to adjust for the greater degree of absorption of folic acid (in the free form) compared with folate naturally found in foods (1 µg food folate equals 0.6 µg folate added to foods or taken with food, or 0.5 µg folate supplements taken on an empty stomach).

** In the absence of adequate exposure to sunlight

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