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November 2012

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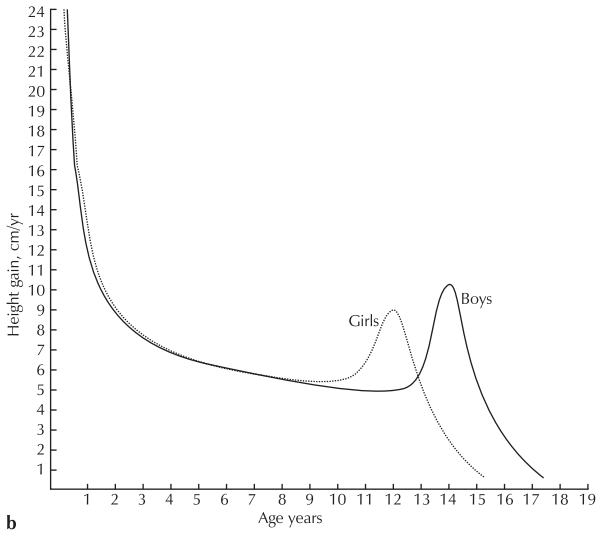
5
Nutritional Needs During Adolescence

In adolescence, a second period of rapid growth may serve as a window of opportunity for compensating for early childhood growth failure, although the potential for significant catch-up is limited. Adult size, measured by height and weight, also reflects an entire range of physiological measurements that determine work capacity, safety, ease of childbirth and decreased obstetric risk to mother and decreased incidence of low birth weight. Survival itself, for both mother and child is affected by maternal body size. Research evidence suggests that optimal nutrition during the brief period of pre-pubertal growth spurt, some 18 to 24 months immediately preceding menarche, results in catch- up growth from nutritional deficits suffered earlier in life (Spear, 2002).

During adolescence, the relatively uniform growth of childhood is suddenly altered by an increase in the velocity of growth (Fig. 2). The graph shows the height attained and velocity curves of a boy and a girl. Growth is faster than at any other time in the individual's life except the first year (Brasel, 1982). Over 80% of adolescent growth (attained weight and height) is completed in early adolescence (10-15 years), with a marked deceleration in weight and height velocity in the post-pubertal phase (Srikantia, 1989). This adolescent growth spurt is also associated with cognitive, emotional and hormonal changes. An important feature is the great variability that exists in the timing and magnitude of the growth spurt both between genders and among individuals (Tanner and Davis 1985, Tanner 1987). The girl begins her adolescent growth spurt at an average of about 10 years and grows at peak velocity at about 12 years. These ages vary from country to country, being lowest in developed countries and highest in poorest countries. The boy starts his adolescent growth spurt around 12 years of age and in a year or two overtakes the girl. The girl

Figure 2: Velocity curve for height in boys and girls, from birth to 18 years



Source: Tanner, 1962

attains her adult height at about 16 years, the boy at 18 years. Adolescents of a given chronological age usually vary widely in physiological development. Because of this variability among individuals, age is a poor indicator of physiological maturity and nutrition needs (Spear, 2002).

The hormones mediating the pubertal growth spurt are sex steroids and growth hormone, which are modulated to a great extent by nutritional factors. All these changes create special nutrition needs. The requirement of some of the nutrients is as high as, or higher in adolescents than in any other age groups (WHO, 2000), and therefore many micronutrients, including vitamin A, thiamine, riboflavin, niacin, folic acid, vitamin B 12, vitamin C, and iodine, reach levels required by adults (For RDAs see Annex 2).

Adolescence is considered as a nutritionally critical period of life for several reasons.

- Firstly, the dramatic increase in physical growth and development puts greater pressure on the need for nutrients. During this period, adolescents will experience a weight gain equivalent to 65% of their weight at the beginning of the period or 40% of their final weight, and a height gain equivalent to 15% of their adult height (Brasel, 1982).

- Secondly, there may be socio-cultural factors or change of life-style and food habits of adolescents that can affect both nutrient intake and needs (Spear, 2002).
- Thirdly, growing adolescents have increased nutrient requirements during pregnancy and illness (Scholl et al., 1994, Story et al., 1999).
- Fourth, adolescence can be the second opportunity to catch up growth if environmental conditions, especially in terms of nutrient intake are favourable (Gopalan, 1989).
- Finally, psychological changes and development of their own personality can impact on their dietary habits during a phase when they are very influence-able.

The box shows the major changes in height, weight and body composition during adolescence.

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5.1 Are Nutritional Needs of Boys and Girls the Same?

The nutritional needs of males and females of the same age differ little in childhood but diverge after the onset of the pubertal growth spurt. After puberty, the differences in nutrient needs persist (Table 6). The reason for the sex differences in nutrient recommendations after the age of 10 include earlier maturation of females (protein requirements of 11-14 year old girls are higher than the boys of the same age group but are much less for 15-18 year old girls as compared to their male counterparts), and variations in physiological needs for some nutrients by sex e.g., difference in the requirement of iron. Besides differences in height and weight, boys gain proportionately more muscle mass than fat as compared to girls. They experience increased linear growth to produce a heavier skeleton and develop greater red blood cell mass than girls. Girls on the other hand have more fat than muscle tissues. These differences in body composition have important implications for nutritional needs of male and female adolescents as shown in Table 6.

Changes in height, weight and body composition during adolescence

The time and tempo of changes in height, weight and body composition can vary greatly between and among adolescents.

Changes in height

- 15-20% of adult height is gained during adolescence.
- Growth spurt starts later in boys than girls and has a higher peak velocity than in girls. Linear growth can be slowed or delayed in adolescence if diet is severely restricted in energy or energy expenditure is increased as in highly competitive athletes.

Changes in weight

- 25-50% of final adult ideal weight is gained during adolescence.
- The timing and amount of weight gain can be greatly affected by energy intake and energy expenditure.

Changes in body composition and skeletal mass

- In the pre-pubertal period the proportion of fat and muscle in boys and girls is similar, and lean body mass is equal in both sexes.
- Growing boys gain proportionately more muscle mass than fat, and more lean body mass as compared to girls.
- As adults the normal percentage of body fat is about 23% for women and 15% for men.
- Approximately 45% of skeletal mass is added during adolescence. By the end of the second decade of life, 90% of total bone mass is gained.
- Females with delayed puberty fail to gain bone mass at a normal rate and show lower mineral density as adults. Nutrition is one of the environmental factors that determines onset of puberty.
- The pubertal growth can be monitored by using height-for-age, weight-for-age and body mass index (BMI)-for-age (weight/height^2).

Table 6: *Recommended dietary allowances (RDA) for selected nutrients during adolescence*

Nutrients	Female		Male	
	11-14 yr	15-18 yr	11-14 yr	15-18 yr
Energy (kcal)	2200	2200	2500	3000
Protein (g)	46	44	45	59
Iron (mg)	15	15	12	12
Calcium (mg)	1200	1200	1200	1200
Zinc(mg)	12	12	15	15
Vitamin A (µg RE)	800	1000	800	1000
Vitamin D (µg)	10	10	10	10
Vitamin C (mg)	50	60	50	60
Folic acid (mcg)	150	180	150	200

Source: Food and Nutrition Board, National Academy of Science National Research Council, Recommended Dietary Allowances, 10th ed, Washington DC (1989)

Nutrition during adolescence should meet the following objectives:

- Provide the necessary nutrients to meet the demands of physical and cognitive growth and development.
- Provide adequate stores for illness or pregnancy.
- Prevent adult onset of diseases related to nutrition e.g., cardiovascular diseases, diabetes, osteoporosis and cancer
- Encourage healthy eating habits and lifestyle.

5.2 Energy and Protein Requirements

Adolescence is an important time for gains in height as well as weight. While both muscle and fat increase, girls gain relatively more fat, and boys gain relatively more muscle. Thus, the requirement of energy as well as proteins increases considerably during this period. Energy and protein needs correlate more closely with the growth pattern than with the chronological age (Spear, 2002). The peak in energy and protein requirements coincides

with the peak in growth of adolescents. Actual needs also vary with physical activity. Therefore, monitoring weight and height and body mass index [BMI (weight/height^2)] is essential to determine the adequacy of energy intake for individual adolescents. Generally, the requirement of protein is met even in economically disadvantaged populations if caloric intake is sufficient. However, if energy intake is limited, dietary protein may be used to meet energy needs and be unavailable for synthesis of new tissues or for tissue repair. This may result in reduction of growth rate and muscle mass despite an apparent adequate protein intake (Spear, 2002).

5.3 Mineral and Micronutrient Requirements

Minerals play a crucial role in adolescent nutrition. Adolescents, at the peak of their growth velocity, require large quantities of nutrients. The increment in skeletal mass, body size and body density, associated with pubescence, highlights the role of minerals in the growth process (Daniel, 1977). The role of iron, calcium, iodine and zinc in the growth and nutrition of adolescents is explained briefly below.

Iron requirements

Iron requirements peak during adolescence due to rapid growth with sharp increase in lean body mass, blood volume and red cell mass which increases iron needs for myoglobin in muscles and haemoglobin in blood (Beard, 2000). In boys, there is a sharp increase in the iron requirements from approximately 10 to 15 mg/day. After the growth spurt and sexual maturation, there is a rapid decrease in growth spurt and need for iron (Dallman, 1989). As a result, there is an opportunity to recover from an iron deficiency that might have developed during this peak growth. In girls, however, the growth spurt is not as great, but menstruation typically starts about one year after peak growth and some iron is lost during menstruation. The mean requirement for iron reaches a maximum of approximately 15 mg/day at peak growth but settles to approximately 13 to 15 mg/day because of the need to replace menstrual iron losses (Strasburger and Brown, 1991).

Iron requirements in adolescence are greater in developing countries because of infectious diseases and parasitic infections that can cause iron loss, and because of low bio-availability of iron from diets. (Brabin and Brabin, 1992).

Other benefits of iron for adolescents: Iron helps in improving cognition which leads to better academic performance that may be an incentive for girls to remain in school (Bruner et al., 1996).

Calcium requirements

Dietary calcium has been identified as a nutrient of great potential concern for adolescents (Haddad and Johnston, 1999). The adolescent years are a window of opportunity to influence lifelong bone health. Because of the accelerated muscular, skeletal and endocrine development, calcium needs are greater during puberty and adolescence than in any other population age group except pregnant women (Spear, 2002). At the peak of the growth spurt, the daily deposition of calcium can be twice that of the average between 10 to 20 years. In fact, 45% of the skeletal mass is added during adolescence (Spear 2002, Sentipal et al., 1991). By the end of the second decade of life, 90-95% of the total body peak bone mass is attained (Cadogan et al., 1997). Bone mineral content must be maximized during puberty to prevent osteoporosis (risk of fracture in later life) (Lytle, 2002). Low calcium intake in early life may account for as much as 50% of the difference in hip fracture rates in postmenopausal years (Matkovic et al., 1995). Consumption of calcium rich products with every meal goes a long way towards ensuring that requirements are met for calcium and many other nutrients e.g., phosphorus, magnesium and vitamin D needed for bone health (Weaver et al.,1999, Weaver, 2000).

Zinc requirements

Zinc is known to be essential for growth and sexual maturation during puberty. It enhances bone formation and inhibits bone loss. Limited intake of zinc-containing foods may affect physical growth as well as development of secondary sex characteristics (Thompson, 1986).

Iodine requirements

Iodine is important during adolescence for two reasons. These are the high growth velocity of adolescents, and the increased iodine requirements during pregnancy. As a large percentage of adolescent girls get married early and bear children during adolescence, their requirements for iodine increase to provide for their own growth as well as for the needs of the

foetus. Severe iodine deficiency in children results in learning disability and lowered achievement (Tiwari et al., 1996). In fact, even moderate iodine deficiency can lead to loss of 10-13 IQ points. Iodine deficiency during pregnancy has been associated with increased incidence of miscarriages, still births, birth defects and mental retardation, and if severe, may result in cretinism in the offspring (Levander and Whanger 1996).

Other minerals

Although the roles of other minerals in the nutrition of adolescents have not been studied extensively, the importance of magnesium, phosphorus, copper, chromium, cobalt and fluoride is well recognized. The possibility of interactions among these nutrients cannot be overlooked (Spear, 2002).

5.4 Vitamins

The requirements for vitamins are also increased during adolescence. Because of higher energy demands, more thiamine, riboflavin and niacin are necessary for the release of energy from carbohydrates. The increased rate of growth and sexual maturation increases the demand for folic acid and vitamin B-12 (Spear 2002, Haddad and Johnston, 1999). With increasing evidence of the role of folic acid in the prevention of birth defects, all adolescent girls of childbearing age should be encouraged to consume the recommended amount of folic acid from supplements in addition to intake of food folate from varied diet (Food and Nutrition Board, 1998). The Center for Disease Control and Prevention recommend 400 ìg of folate for all females of childbearing age (1992). The rapid rate of skeletal growth demands more vitamin D. Vitamins A, C, and E are needed in increased amount for new cell growth. Adolescents' vitamin needs are also associated with the degree of maturity rather than chronological age because of demands of growth.

5.5 Nutrition and Adolescent Pregnancy: Why are Adolescents at Higher Risk?

Early pregnancy not only focus major health risks for the adolescent girl and her child, but also disrupts the physiological, social and intellectual development of young girls. When the adolescent becomes pregnant, her needs for energy and nutrients may be in direct competition with those of

her foetus (Stang, 1999). The risk of anaemia is greater for girls during pregnancy (Jolly et al., 2000; Konje et al., 1993). Recent research has shown that growth during pregnancy does occur in adolescent females and that it can have negative effects on pregnancy outcome if additional dietary and weight gain allowances are not made (Scholl et al., 1994). The risk of LBW and preterm delivery increases among iron-deficient anaemic adolescents (Scholl et al., 1992; Scholl and Hediger, 1994). As pregnant adolescents often receive inadequate antenatal care, their anaemia during labour and the postpartum period may be worse than in older women (WHO, 2003). Severe anaemia is an important cause of maternal mortality among adolescents (Brabin et al., 2001).