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## ADOLESCENT GROWTH AND DEVELOPMENT

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Biological, psychosocial and cognitive changes that begin during puberty and continue throughout adolescence directly affect nutritional status and nutrient needs. Adolescents experience dramatic physical growth and development during puberty, which in turn appreciably increases their requirements for energy, protein, and many vitamins and minerals. Adolescents also experience significant changes in their ability to assess and comprehend complex situations and information and in their desire to become independent, unique individuals. The increased need for energy and nutrients among adolescents, combined with increasing financial independence, increasing need for autonomy when making food choices, and immature cognitive abilities, places adolescents at nutritional risk. Therefore, it is vital that health care providers who provide nutrition education and counseling have a thorough understanding of adolescent physical and psychosocial growth and development.

### NORMAL PHYSICAL GROWTH AND DEVELOPMENT

The beginning of biological growth and development during adolescence is signified by the onset of puberty, which is often defined as the physical transformation of a child into an adult. A myriad of biological changes occur during puberty including sexual maturation, increases in height and weight, completion of skeletal growth accompanied by a marked increase in skeletal mass, and changes in body composition. The succession of these events during puberty is consistent among adolescents, however, there may be a great deal of deviation in the age of onset, duration, and tempo of these events between and within individuals. For this reason, adolescents of the same chronological age can vary greatly in physical appearance. This has direct relevance for the nutrition requirements of adolescents. A 13-year-old male who has nearly completed the linear growth spurt associated with puberty and has experienced significant muscular development will have remarkably different energy and nutrient needs than those of a 13-year-old male who has not yet experienced puberty. Consequently, sexual maturation should be used to assess the extent of biological growth and development and the individual nutritional needs of adolescents in place of chronological age.

Sexual Maturation Rating (SMR), also known as Tanner Staging, is based upon a scale of secondary sexual characteristics that permits health professionals to gauge the degree of pubertal maturation that has occurred among adolescents, regardless of chronological age (Table 1). SMR is based on the appearance of pubic hair, the development of breasts, and the occurrence of menarche among females; and on the degree of testicular and penile development and the appearance of pubic hair among males. SMR stage 1 corresponds with prepubertal growth and development, while stages 2-5 indicate the progression of puberty. By SMR stage 5, sexual maturation has been completed. Sexual maturation correlates remarkably well with linear growth, changes in weight and body composition, and hormonal changes.<sup>1</sup>

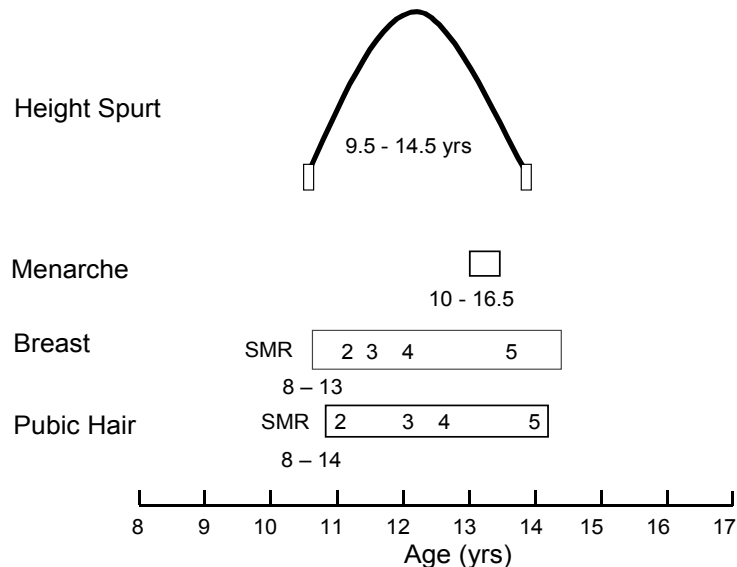
**TABLE 1**  
**Sexual Maturity Rating**

<b>GIRLS</b>		
<b>Breast Development</b>	<b>Stage</b>	<b>Pubic Hair Growth</b>
Prepubertal; nipple elevation only	1	Prepubertal; no pubic hair
Small, raised breast bud	2	Sparse growth of hair along labia
General enlargement of raising of breast and areola	3	Pigmentation, coarsening and curling, with an increase in amount
Further enlargement with projection of areola and nipple as secondary mound	4	Hair resembles adult type, but not spread to medial thighs
Mature, adult contour, with areola in same contour as breast, and only nipple projecting	5	Adult type and quantity, spread to medial thighs
<b>BOYS</b>		
<b>Genital Development</b>	<b>Stage</b>	<b>Pubic Hair Growth</b>
Prepubertal; no change in size or proportion of testes, scrotum and penis from early childhood	1	Prepubertal; no pubic hair
Enlargement of scrotum and testes; reddening and change in texture in skin of scrotum; little or no penis enlargement	2	Sparse growth of hair at base of penis
Increase first in length then width of penis; growth of testes and scrotum	3	Darkening, coarsening and curling, increase in amount
Enlargement of penis with growth in breadth and development of glands; further growth of testes and scrotum, darkening of scrotal skin	4	Hair resembles adult type, but not spread to medial thighs
Adult size and shape genitalia	5	Adult type and quantity, spread to medial thighs

Source: Data from Tanner JM. Growth at adolescence. Oxford: Blackwell Scientific Publications, 1962.

Figure 1 depicts the occurrence of the linear growth spurt and the onset of menarche relative to the occurrence of secondary sexual characteristics among females during puberty. The first signs of puberty among females are the development of breast buds and sparse pubic hair, which occurs between ages 8-13 on average (SMR stage 2). The onset of menstruation occurs 2-4 years after the initial appearance of breast buds and pubic hair, usually during SMR stage 4. The average age of menarche is 12.4 years for females in the United States, but the age at which it occurs is highly variable; menarche can occur as early as 9 or 10 years of age or as late as 17 years of age. The onset of menstruation may be delayed in females who restrict their caloric intake and body weight or who are competitive athletes.

**FIGURE 1**  
**Sequence of Physiological Changes During Puberty in Females**



\*An average female is represented: the range of ages within which some of the events may occur is given by the figures placed directly below them.

Source: Adapted from Tanner JM. *Growth at adolescence*. Oxford: Blackwell Scientific Publications; 1962. Reprinted with permission. <http://www.blackwell-synergy.com/>

There appear to be ethnic and racial differences in the initiation of sexual maturation among US females. Research indicates that African American girls may enter puberty earlier than their white peers. Among females in a large study, 48% of African American girls had reached SMR stage 2 by age 8, compared to 15% of their white peers.<sup>2</sup> Among African American girls in that study, the average age of initial breast development was 8.8 years, while it was 9.9 years for white females. Pubic hair growth began at age 8.7 years in African American females, occurring almost 2 years earlier than their white peers. Menarche, however, occurred at approximately the same time in both groups— 12.2 years for African American and 12.8 for white females. The findings of that study suggest that, on average, puberty may begin earlier and last longer among African American females than among white females.

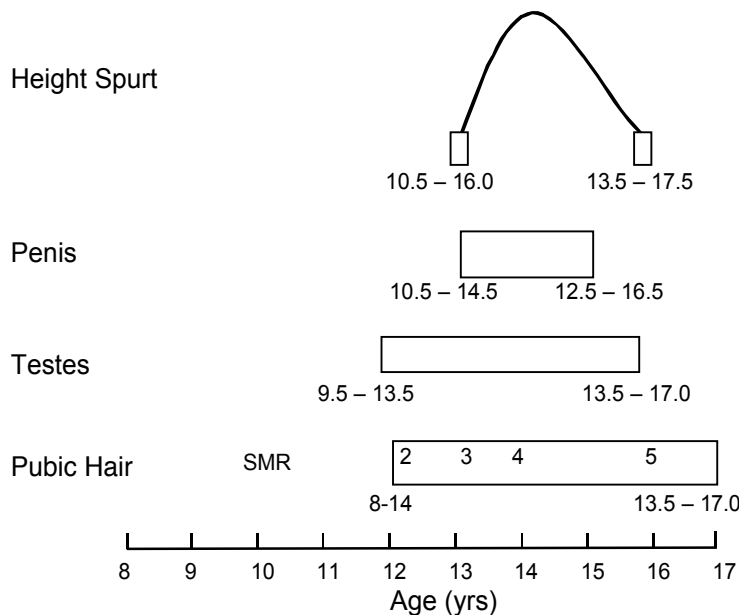
Testicular enlargement and change in scrotal coloring are the first signs of puberty among males, usually occurring between 10.5 and 14.5 years of age (11.6 on average) during SMR stage 2 (Figure 2). The development of pubic hair is also observed during SMR stage 2. Testicular enlargement starts between 9.5 and 13.5 years of age in most males (SMR 2 to 3), concluding between the ages of 12.7 and 17 (SMR stage 5). Spermarche, or the onset of sperm production, occurs at approximately age 14 among males. The onset of puberty among males is highly variable, thus nutritional needs of male adolescents of the same chronological age are also highly variable.

The linear growth spurt begins most commonly during SMR stage 2 in females, between 9.5 and 14.5 years of age. Peak velocity of linear growth takes place at the end of SMR stage 2 and during SMR stage 3, approximately 6 to 12 months prior to menarche. It is estimated that 15 to 25% of

final adult height is gained during the growth spurt of puberty.<sup>3</sup> The average increase in height is estimated at 8.24 in (20.5 cm), with a range of 2-10 in (5-25 cm) seen in most females.<sup>3,4</sup> During the peak of the linear growth spurt, females gain roughly 3.5 in (8 - 9 cm) per year. The linear growth spurt lasts 24 to 26 months, ceasing by 16.5 years of age in most females. Some adolescent females experience small increments of growth past age 19 years, however. Linear growth may be delayed or slowed among females who severely restrict their caloric intake.

Peak velocity of linear growth occurs later in puberty among males than among females, most often during SMR stage 4, at 14.4 years of age on average. The greatest rates of linear growth among males coincide with or closely follow testicular development and the growth of facial hair. Adolescent males experience increases in height of 4-12 in (10-30 cm) during puberty, with an average of 2.8 - 4.8 in (7 - 12 cm) attained each year.<sup>3,4</sup> Linear growth continues throughout adolescence, at an increasingly slower rate, ceasing between 18 and 21 years of age.

**FIGURE 2**  
**Sequence of Physiological Changes During Puberty in Males**



An average male is represented: the range of ages within which each event charted may begin and end is given by the figures placed directly below its start and finish.

Source: Adapted from Tanner JM. Growth at adolescence. Oxford: Blackwell Scientific Publications; 1962. Reprinted with permission. <http://www.blackwell-synergy.com/>

Approximately half of maximal adult bone mass is accumulated during adolescence. By 18 years of age, more than 90% of adult skeletal mass has been accrued.<sup>1</sup> Many factors play a role in the accrual of bone mass including genetic potential, hormonal fluctuations, weight bearing exercise, cigarette smoking, alcohol consumption, and intakes of vitamins and minerals such as vitamin D, calcium, phosphorous, boron and iron. It should be noted that more than one-third of adult bone mass is thought to accrue during and immediately following puberty.<sup>5,6</sup> After adult height is achieved, the accumulation of significant amounts of additional bone mass is unlikely.

## Changes in Weight and Body Composition

Approximately half of adult ideal body weight is gained during adolescence. Peak weight gain follows the linear growth spurt by 3 to 6 months in females and by approximately 3 months in males. Girls will gain approximately 18.3 lb (8.3 kg) per year during peak rates of weight gain, (12.5 years of age on average).<sup>3,4</sup> Average weight gains during puberty among females are between 15-55 lb (7-25 kg), with a mean gain of 38.5 lb (17.5 kg). Weight gain slows around the time of menarche, but will continue into late adolescence. Adolescent females may gain as much as 14 lb (6.3 kg) during the latter half of adolescence.<sup>3,4</sup>

Adolescent males gain an average of 20 lb (9 kg) per year during puberty.<sup>3,4</sup> Overall, male teens gain 15-65 lb (7-30 kg) during puberty, with a mean gain of 52.2 lb (23.7 kg).<sup>3,4</sup>

Body fat levels decrease among males during adolescence, dropping to an average of 12% body fat by the end of puberty. Body composition changes more significantly among females during puberty. The average lean body mass of teen females falls from 80%-74% while average body fat levels increase from 16%-27% by the end of adolescence. Females experience a 120% increase in body fat during puberty. On average, teen females acquire approximately 2.5 lb (1.14 kg) of body fat mass each year during puberty.<sup>7</sup>

While the accretion of body fat mass is a normal, physiologically essential process, adolescent females often view it with negativity. Weight dissatisfaction is widespread among teenage females, leading to an increased risk of health-compromising behaviors such as excessive caloric restriction, frequent dieting, use of diet pills or laxatives, severe body image distortions and eating disorders.

## NORMAL PSYCHOSOCIAL AND COGNITIVE DEVELOPMENT

During adolescence teens develop a stronger recognition of their own personal identity, including recognition of a set of personal moral and ethical values, and greater perception of feelings of self-esteem or self worth. Psychosocial and cognitive development is best understood when divided into three periods: early adolescence (11-14 years), middle adolescence (15-17 years), and late adolescence (18-21 years). Each of these distinct periods of development is marked by the mastery of new emotional, cognitive and social skills (Table 2).

**TABLE 2**  
**Psychosocial Processes and the Substages of Adolescent Development**

<b>Substage</b>	<b>Emotionally Related</b>	<b>Cognitively Related</b>	<b>Socially Related</b>
<b>Early adolescence</b>	Adjustment to a new body image, adaptation to emerging sexuality	Concrete thinking; early moral concepts	Strong peer effect
<b>Middle adolescence</b>	Establishment of emotional separation from parents	Emergence of abstract thinking, expansion of verbal abilities and conventional morality; adjustment to increased school demands	Increased health risk behavior; sexual interests in peers; early vocational plans
<b>Late adolescence</b>	Establishment of a personal sense of identity; further separation from parents	Development of abstract, complex thinking; emergence of post-conventional morality	Increased impulse control; emerging social autonomy; establishment of vocational capability

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## **Psychosocial Development**

Adolescents experience dramatic biological changes related to puberty; these biological changes can significantly affect psychosocial development. An increased awareness of sexuality and a heightened preoccupation with body image are fundamental psychosocial tasks during adolescence. Dramatic changes in body shape and size can cause a great deal of ambivalence among adolescents, especially among females, leading to the development of poor body image and eating disturbances or disorders if not addressed by family or health care professionals. Similarly, a perceived delay in sexual maturation and biological development, especially among males, may lead to the development of poor body image and lowered self-esteem. It is imperative that health professionals who work with adolescents have a clear understanding of how normal psychosocial and cognitive development relate to biological growth and development, and are able to appreciate how these processes affect nutritional intake and status.

Peer influence is a dominant psychosocial issue during adolescence, especially during the early stages. Young teens are highly cognizant of their physical appearance and social behaviors, seeking acceptance within a peer group. The desire to conform can influence food intakes among teens. Focus groups comprised of adolescent females have revealed that food is divided into two classification groups: junk foods and healthy foods.<sup>8</sup> Eating junk foods, according to these focus groups, was associated with being with friends, having fun, gaining weight, and guilt, whereas eating healthy foods was associated with family, family meals, and home life. Obviously, teens adopt or develop food preferences and make food choices based on associations with feelings of being accepted and having fun with peers and may use food as a way to exert independence from families and parents.

The broad chronological age range during which biological growth and development begins and advances can become a significant source of personal dissatisfaction for many adolescents as they struggle to conform to their peers. Males who enter puberty at a later age may consider themselves to be late bloomers, and may feel physically inferior to their peers who mature earlier. This sense of dissatisfaction may lead to the use of anabolic steroids and other supplements in an effort to increase linear growth and muscle development and to gain weight. Such dissatisfaction can also lead to markedly reduced self-esteem. For females, however, it is often early maturation that is associated with poor body image, poor self-esteem, frequent dieting, and, possibly, disturbed or disordered eating behaviors. Early maturing female teens are also at increased risk for engaging in other unhealthy behaviors such as smoking, alcohol consumption, and early sexual intercourse.<sup>9-11</sup> Young adolescents should be educated on normal variations in initiation and progression of biological growth and development in an effort to facilitate the development of a positive self-image and body image and to reduce the likelihood of early initiation of health compromising behaviors.

## **Cognitive Development**

The early stage of adolescence is a time of great cognitive development. At the beginning of adolescence, cognitive abilities are dominated by concrete thinking, egocentrism, and impulsive behavior. The ability to engage in abstract reasoning is not highly developed in most young teens, limiting their capacity to comprehend nutrition and health relationships. Young adolescents also lack the skills necessary to problem solve in an effort to overcome barriers to behavior change and the ability to appreciate how current behaviors can affect future health status.

Middle adolescence is characterized by growth in emotional autonomy and increasing detachment from family. The bulk of physical growth and development is completed during this stage, however body image concerns may continue to be a source of trepidation, especially among males who are

late to mature and females who have experienced great changes in body composition and size. Conflicts over personal choice, including food choices, become increasingly common during this stage of adolescence. Peer groups become more important than family and their influence with regard to making food choices peaks. Coinciding with the increased importance of peer acceptance, the initiation of health compromising behaviors such as smoking, alcohol consumption, using street drugs, and engaging in sexual activities often occurs during middle adolescence. Teens may consider themselves invincible and often still display impulsive behaviors.

Abstract reasoning skills begin to emerge among most teens during middle adolescence, however, these skills may not be highly developed. Adolescents will often regress to concrete thinking skills when faced with overwhelming emotions or stressful situations. Teens start to comprehend the relationship between existing health behaviors and future health status but their desire to fit in with peers may make it difficult for adolescents to make health related choices based upon knowledge rather than peer pressure.

The late stage of adolescence is characterized by the development of a strong personal identity. Biological growth and development has concluded among most teens and body image issues are less common. Older adolescents are able to manage increasingly sophisticated social situations, are able to suppress impulsive behaviors, and are less affected by peer pressure. Economic and emotional dependence upon family is markedly decreased and conflict over personal issues, such as food choices, also decreases. Relationships with a single individual become more influential than those with a group of peers as a stronger sense of personal identity emerges.

The expansion of abstract reasoning skills continues to occur during late adolescence, which assists teens in developing an ability to comprehend how current health behaviors affect long-term health status. This is an especially important skill for adolescent females who plan to have children or who become pregnant during late adolescence. Older teens are now capable of learning problem solving skills that can assist them in overcoming barriers to behavior change.

## **IMPLICATIONS FOR NUTRITION INTERVENTION**

Because adolescence is a time of tremendous biological, psychosocial and cognitive growth and development, nutrition interventions need to be tailored to the developmental level of each individual adolescent. Health professionals should allow adequate time during the first session with a teen to determine his/her degree of biological maturity and level of cognitive development. These characteristics should be used to determine the individual nutritional needs and the type of educational messages that are given when counseling the adolescent.

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