

Normal Weight Gain in Growing Children

By Robert Malina, PhD

Height and weight (body mass) are the two body dimensions most commonly used to monitor the growth of children and adolescents.

What makes up weight? Body weight is most often partitioned into its lean and fat components: Body weight equals fat-free mass plus fat mass. Fat-free mass includes skeletal muscle, bone, other connective tissues, body organs, and water. Fat mass includes subcutaneous (beneath the skin) and visceral (internal) adipose tissue.

BMI. Height and weight are often expressed in terms of the body mass index (BMI). BMI equals weight in kilograms/2(height in meters). It is primarily an indicator of heaviness and only indirectly of body fat. While body weight increases linearly during childhood, the BMI declines from infancy to about 5-6 years of age, then increases linearly with age through childhood and adolescence. Sex differences in BMI are small during childhood and are established in late adolescence. The rise in the BMI after the low point at 5-6 years has been labeled the "adiposity rebound", and may have implications for later overweight. Several studies suggest that children who experience the "adiposity rebound" early (e.g., 3-4 years of age) have a higher risk of overweight in late adolescence and early adulthood.

Changes in fat distribution. Children accumulate proportionally more subcutaneous fat on the extremities than on the trunk from infancy to about 5-6 years. Then, proportionally more subcutaneous fat accumulates gradually on the trunk until adolescence. During the adolescent spurt, males gain more subcutaneous fat on the trunk, while fat on the extremities decreases. In contrast, girls gain proportionally equal amounts of subcutaneous fat on both trunk and extremities during adolescence. These observations are based on skinfolds measured on several trunk (e.g., subscapular, suprailliac, abdominal) and extremity (e.g., triceps, biceps, medial calf) sites. Skinfold measurements must be used very carefully, if at all, in evaluating the body weight status of children for the following reasons. (1) Each skinfold site shows a different trend in growth during childhood and adolescence. (2) There is a reasonably large amount of error associated with the measurements of skinfolds.

Adolescent height spurt. Height and weight increase linearly with age during early childhood, with very minor differences between boys and girls. By about 9-10 years in girls and 11-12 years in boys, the rate of growth begins to increase. This acceleration in height marks the beginning of the adolescent growth spurt, a period of rapid growth. The rate of growth increases until it reaches a peak (peak height velocity, PHV); then gradually decreases and eventually stops. Girls, on average, start their growth spurts, reach PHV, and stop growing about two years earlier than boys. Individual children vary greatly with respect to when the growth spurt starts, when PHV is reached, and when growth stops.

Adolescent weight spurt. Body weight also shows a well-defined adolescent spurt. Peak weight velocity (PWV) occurs after PHV, and is greater in boys than in girls. The adolescent spurt in body weight in boys includes principally gains in bone tissue and

skeletal muscle, and to a lesser extent, in fat mass. Girls, on the other hand, experience a slightly less intense spurt in height, a less marked increase in skeletal muscle, but a continuous increase in fat mass.

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Overview of Growth in Children

Pre-Adolescence (about 6-10 years of age)

There is much variation among individuals. Children gain, on average, about 5-8 cm (2-3 inches) per year and about 2-3 kg (5-7 pounds) per year between 6 and 10 years of age. Sex differences are minor. As adolescence and puberty begin, growth rates increase, first in height and then in weight.

Adolescence and Puberty

Adolescence is characterized by the growth spurt and sexual maturation. There is considerable variation between when events occur and the rate at which children pass through them. Growth in height continues into the early 20s in some girls and boys.

Height Growth Spurt, Girls

- Begins around 9-10 years
- Reach maximum velocity around 12 years
- Growth rate then slows, but growth continues to about 16-18 years

Height Growth Spurt, Boys

- Begins around 11-12 years
- Reach maximum velocity around 14 years
- Growth rate then slows, but growth continues to about 18-20 years

Weight Growth Spurt, Girls and Boys

Body weight in adolescence also occurs in spurts. They occur, on average, several months after the period of peak height velocity. During the interval of maximum growth in height (about 11-13 years in girls and 13-15 years in boys) girls gain about 7 kg (15 pounds) in fat-free mass, boys gain double this value, about 14 kg (31 pounds). Girls gain, on average, more fat than boys during the interval of their growth spurt -- 3 kg (6 pounds) versus 1.5 kg (3 pounds).

Adapted from R.M. Malina and C. Bouchard (1991); *Growth, Maturation, and Physical Activity*; Champaign, IL; Human Kinetics.
