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## Keywords

Adolescent · Adolescent nutrition · Disordered eating · Adolescent obesity

## Key Points

- Rapid changes in body weight, shape, and composition due to pubertal growth place adolescents at high risk for body dissatisfaction, disordered eating, and health-compromising eating behaviors.
- Many adolescents skip meals but frequently snack.
- Adolescence is often a time of increased athletic activities, disordered eating behaviors, experimentation with smoking and alcohol and other factors that all impact nutritional needs.
- A stepped approach to obesity treatment is recommended for adolescents, with strategies in each step based on the degree of obesity and the presence of comorbid conditions.
- Screening for body mass index and hypertension should be performed at least annually.
- Screening for hyperlipidemia and insulin resistance is recommended only for adolescents who are obese or those with a family history of cardiovascular disease and/or type 2 diabetes.

## Nutrition, Growth, and Development

Adolescence is a time of dramatic physical, social, and cognitive development, which directly affects nutritional status. Since the chronological age of sexual maturation varies dramatically, Tanner's stages are generally used to describe periods of adolescent growth and development based on the assessment of secondary sexual characteristics. Approximately 15–25% of adult height is gained during early to middle adolescence (typically within Tanner stages 2 and 3); the average gain among females is 9.5 in (24.1 cm) with up to 12 in (30.5 cm) gained by males [1]. Up to half of adult body weight is gained during the growth spurt. In females, gains in height precede weight gain by about 3–6 months, dramatically slowing around the onset of menses. Girls will gain an average of 18 lb (8.1 kg) per year during the active growth spurt, with up to 14 lb (6.3 kg) gained after menses [1]. Body fat levels rise among females throughout adolescence as a result. Consequently, body composition changes tremendously within females which places them at risk for body dissatisfaction, dieting,

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and disordered eating [2]. In males, peak weight and height accretion occur simultaneously [1]. Males will gain about 20 lb (9 kg) per year during the peak of growth; however, body fatness decreases due to the larger percentage of lean body mass which is gained reflecting the increase in testosterone.

Approximately half of adult bone mass is gained during adolescence, with more than 90% of adult bone mass formed by age 18 [1, 3]. Adolescence is a critical time for bone development, and bone accretion is sensitive to adequate intakes of many nutrients including calcium, vitamins D and K, phosphorus, boron, strontium, magnesium, iron, and protein [3]. Nutrient and energy needs are higher during adolescence than at any other period in life as a result of the velocity of physical development. The growth spurt ceases by age 16 in females but may continue in small increments in males until age 20 [1].

Social and cognitive development also occurs rapidly during adolescence. The teenage years are a time during which individuals develop a sense of personal identity and a moral and ethical value system [4]. Self-esteem is critical during adolescence and can be dramatically affected by changes in body shape and size and the timing of development in comparison to other adolescents. Peer pressure peaks between the ages of 13 and 16; thus, teens are very self-conscious about their appearance and strive to adopt behaviors consistent with their peer group [4]. In terms of nutrition, this can place adolescents at risk of nutrition deficiencies and disordered eating. Some of the common behaviors are described below.

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## Nutrition Behaviors and Their Effects on Nutritional Status

US adolescents do not consume adequate amounts of many nutrients including folate; vitamins A, B6, C, D, and E; and iron, zinc, magnesium, phosphorus, potassium, and calcium [5]. Dietary fiber intake is generally low, while teens exceed recommendations for total and saturated/solid fats, sodium, and added sugar. Only about 11% of teens meet recommendations for fruit intakes, and less than 2% meet recommendations for vegetable intake (even with the inclusion of starchy vegetables such as fried potatoes) [5, 6]. Alarming, more than 6% of teens consume no fruit, and up to 8% consume no vegetables on an average day [5–7]. About half of adolescents consume less than the recommended amounts of total protein foods, and only 20% of teen males and less than 5% of teen females consume the recommended amounts of dairy each day.

Meal skipping is common among adolescents and increases with age. Between 14% and 27% of teens skip breakfast on an average day, with one-third reporting daily breakfast consumption [6–9]. Almost one in every four teens skips lunch and about 8% skip dinner on any given day [6–9]. Skipping meals can reduce the intakes of many nutrients. As a result of skipped meals, adolescents frequently snack.

Snacking is reported by 83% of teens with almost half reporting three or more snacks per day [5, 6–12]. Snacks provide about 25% of the daily energy intake, but nearly 50% of daily added sugar intake [5, 6, 9–12]. Soft drinks are the most common snack reported by adolescents and are the single largest source of energy and added sugar in their diets [5, 6, 10–12]; soda accounts for 9% of daily calories and 45% of daily sugar intake alone [5, 6, 10, 12]. It is imperative that teens be encouraged to consume snacks wisely and that parents be advised to provide easy access to healthy snack foods, such as flavored or sparkling water, baked chips with salsa, crackers, low-fat cheese, whole grain ready-to-eat cereal and low-fat milk, or hummus with vegetables or pita chips.

The prevalence of disordered eating behaviors among adolescents, and in particular among adolescent girls, tends to be alarmingly high. In fact, the Youth Risk Behavior Surveillance Survey (YRBS) suggests that 66% of Hispanic, 59% of White non-Hispanic, and 55% of Black non-Hispanic girls report dieting [7]. Among males, 46% of Hispanic, 29% of Black, and 31% of White males report dieting. This is particularly concerning given unhealthy food patterns that are often associated with dieting such as fasting and severely restricting energy intake which may result in fatigue, impaired growth and sexual maturation, irritability, poor concentration, impulse to binge, and increased risk for disordered eating.

Dieting is a known risk factor for developing eating disorders and disordered eating patterns. Eating disorders are defined by the frequency, intensity, and individual patterns noted below [9, 13, 14]. They are discussed in more detail in Chap. 23.

- Anorexia nervosa: An eating disorder characterized by extreme weight loss, poor body image, and irrational fear of weight gain and obesity.
- Bulimia nervosa: A disorder characterized by repeated bouts of uncontrolled rapid ingestion of large quantities of food (binge eating), followed by self-induced vomiting, fasting, vigorous exercise to prevent weight gain, or use of laxatives or diuretics.
- Binge-eating disorder: A disorder characterized by periodic binge eating, which normally is not followed by vomiting or the use of laxatives. People must experience eating binges twice a week on average for over 6 months to qualify for this diagnosis.

Disordered eating behaviors is a term that encompasses many health-compromising behaviors seen with actual eating disorders, such as binge eating, purging, fasting, and excessive exercise to burn calories, but are present at a level that does not meet with full classification for eating disorders [13, 14]. It is estimated that such unhealthy and extreme weight-control behaviors are used by approximately 10–20% of the adolescent population; however, estimates for some behaviors can exceed 40% [13, 14]. Although not all disordered eating behaviors meet the formal criteria needed to be defined as an eating disorder, they can still negatively impact adolescents' health and development. Therefore, adolescents who have been found to have a nutrition-related health risk, such as an eating disorder, should be referred for in-depth medical assessment and nutrition counseling.

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## Nutrition Concerns of Athletes

Sports nutrition enhances the athletic performance of adolescent athletes and enables them to optimize their training and recovery. Therefore, dietary intakes of athletes should follow the general healthy eating recommendations while also recognizing that high levels of training and competitive physical activity, combined with growth and development, increase adolescents' needs for carbohydrate, protein, and select vitamins and minerals (e.g., vitamin D, calcium, phosphorous, iron). Athletes should be encouraged to eat a pre-event meal containing proper amounts of carbohydrates to increase body glycogen stores but should not consume foods high in fat, protein, and/or dietary fiber for at least 4 hrs prior to exercise as those foods may bring about indigestion and physical discomfort [15]. Post-event meals (up to 4 hrs) should contain 1–1.2 g/kg/h of foods high in carbohydrate and adequate amounts of non-caffeinated fluids (e.g., water, milk) [15]. Teen athletes should start exercise hydrated and maintain optimal hydration status during and after sports participation. The type, timing, and amount of foods and fluids in the pre- and post-event meals should be individualized not only according to the teen's needs but also to their preferences and tolerance.

In certain instances, such as during prolonged, vigorous sports participation, the use of ergogenic aids to improve energy availability (such as sports drinks, carbohydrate, creatine, caffeine) and promote recovery (carbohydrate, protein, and essential amino acids) may be recommended by coaches or trainers [15]. However, they are not always safe or effective. The consumption of sports drinks in place of water may lead to excessive energy intake consumption, which increases youth risk for overweight and obesity [16]. Common ergogenic aids used by teens include creatine, amino acids or protein powders, caffeine, carnitine, anabolic steroids, anabolic steroid precursors such as dehydroepiandrosterone (DHEA) and androstenedione, beta-hydroxy-beta-methylbutyrate, growth hormone, and Xenadrine [17]. Steroids and ergogenic aids including high (physiologically active) doses of caffeine from supplements are forbidden by national and the National Collegiate Athletic Association (NCAA) regulations, yet few high school athletic programs test athletes for their use.

## Nutrition Management of Chronic Health Issues

### Overweight and Obesity

Appropriateness of weight status for teens is assessed by calculating body mass index (BMI), a measure of a person's weight (kg) divided by their height<sup>2</sup> (m<sup>2</sup>). The Centers for Disease Control and Prevention (CDC) BMI calculator, available online at <https://www.cdc.gov/healthyweight/bmi/calculator.html> [18], is an accurate and quick way to calculate and find corresponding BMI-for-age percentiles for youth aged 2 through 19 years to determine the appropriateness of weight status. Adolescents with a BMI > 85th but <95th percentile are considered overweight, while those with a BMI ≥95th percentile are considered obese [19]. Growth curves based on the CDC BMI values are available and should be incorporated into the medical records of all teens.

In 2015–2016, the prevalence of obesity was 21% among youth aged 12–19 years [20]. Obesity prevalence was higher among Black (18%) and Hispanic (18%) students than among White students (13%). A range of medical and psychosocial complications accompanies overweight and obesity among adolescents, including hypertension, dyslipidemia, insulin resistance, hyperglycemia, type 2 diabetes mellitus, sleep apnea and other hypoventilation disorders, orthopedic problems, liver disease, body image disturbances, and lowered self-esteem [19, 21, 22]. Longitudinal studies of obesity and chronic disease risk among youth suggest an increased risk of morbidity and premature mortality from coronary heart disease, stroke, hypertension, type 2 diabetes, and asthma among adults who were overweight or obese during adolescence [21].

All adolescents should be screened for appropriateness of weight-for-height yearly, or more frequently if there are concerns about excessive weight gain (or loss) for height. Teens with multiple risk factors for obesity require an in-depth medical assessment to diagnose potential comorbid complications [19, 22]. Adolescents who are assessed as overweight or obese should have their medical and family history (e.g., maternal history of diabetes type 2 or gestational diabetes, dyslipidemia, family history of diabetes in first- or second-degree relative, signs of insulin resistance [hypertension, dyslipidemia, polycystic ovary syndrome]) assessed and screened for cardiometabolic risk factors (e.g., glucose, cholesterol, triglycerides, blood pressure, alanine aminotransferase [ALT]), associated with adolescent overweight or obesity [22–25]. Adolescents with overweight or obesity should also have panel pancreatic antibodies tested to rule out the possibility of type 1 diabetes.

Table 5.1 lists common cardiometabolic biomarkers and their respective cut-points for screening pediatric overweight- and obesity-related cardiometabolic risk factors. Table 5.2 provides an overview of assessment and referral recommendations based on an adolescent's personal risk factors.

**Table 5.1** Recommended indices for common chronic health issues in adolescents

	Acceptable	Borderline	Unacceptable
Fasting plasma glucose	<100 mg/dL	≥100–<126 mg/dL	≥126 mg/dL
Hemoglobin A1c	5.7%	<6.5%	≥6.5%
Fasting cholesterol			
Total cholesterol (mg/dL)	<170 (<4.4 mmol/L)	170–199 (4.4–5.15 mmol/L)	≥200 (≥5.18 mmol/L)
Non-HDL cholesterol (mg/dL)	<120 (<3.11 mmol/L)	120–144 (3.11–3.73 mmol/L)	≥145 (≥3.76 mmol/L)
LDL cholesterol (mg/dL)	<110 (<2.85 mmol/L)	110–129 (2.85–3.34 mmol/L)	≥130 (≥3.37 mmol/L)
HDL cholesterol (mg/dL)	>45 (>1.17 mmol/L)	40–45 (1.04–1.17 mmol/L)	<40 (<1.04 mmol/L)
Triglycerides (mg/dL)	<90 (<2.33 mmol/L)	90–129 (2.33–3.34 mmol/L)	≥130 (≥3.37 mmol/L)
ALT			
Boys	>25 U/L		
Girls	>22 U/L		

Source: Based on Refs [22–25]

Notes: Fasting is defined as no caloric intake for at least 8 hrs

**Table 5.2** Assessment and screening recommendations for health promotion among adolescents

Health concern	Screening and assessment recommendation
Anthropometric measurements	Measure and plot height, weight, and BMI Review weight status with teen and family Teens who are overweight: provide step 1 counseling or refer to a registered dietitian/nutritionist for weight management counseling; schedule follow-up appointments Adolescents who are obese: refer to a comprehensive weight management program for step 2 counseling
Family history of premature cardiovascular disease, diabetes, or obesity	Assess for risk factors for chronic health conditions (hypertension, hyperlipidemia, diabetes) based on family history and weight status as necessary
Blood pressure	Review blood pressure with teen and family In the presence of elevated blood pressure, counsel adolescents and caregivers to follow DASH dietary pattern based on energy needs to achieve ideal body weight Assess changes in blood pressure at follow-up and institute management with medication as needed, if dietary changes have not been successful Refer teens who are overweight and obese to an appropriate weight management program
Blood lipids	Review blood lipid indices with teen and family Order blood lipid panel for overweight or obese adolescents Adolescents who are overweight: provide counseling regarding DASH diet based on energy needs to achieve ideal body weight or refer to a registered dietitian/nutritionist for medical nutrition therapy Adolescents who are obese: refer to a comprehensive weight management program Up to 2 g/day of plant sterols or stanols can be recommended for use by adolescents Manage dyslipidemia with medication if dietary changes and weight loss are not effective
Dietary intake and eating behaviors	Assess usual food intake using 24-h recall or 3- to 7-day food diary Provide appropriate nutrition counseling or refer to a registered dietitian/nutritionist for medical nutrition therapy as needed
Physical activity and sedentary activity	Review usual daily physical and sedentary behavior patterns Discuss recommendation for at least 60 min/day of moderate-to-vigorous physical activity Emphasize the importance of limiting sedentary activity, for example, limiting screen time to no more than 2 hrs/day
Diabetes	Assess for family history of diabetes, presence of acanthosis nigricans, and symptoms consistent with diabetes among overweight or obese adolescents Review fasting blood glucose levels with teens and caregivers or refer to a primary care provider for treatment and measurement of a fasting blood glucose level if laboratory data are not available Provide medical nutrition therapy and nutrition counseling as appropriate Refer teens who are overweight and obese to a comprehensive weight management program

Adapted from the US Department of Health and Human Services, National Institutes of Health, National Heart, Lung, and Blood Institute [24]

Treatment for overweight and obesity among adolescents is based on the degree of excessive body fat and the presence of comorbid health conditions [26]. Overweight teens with no personal risk factors or significant family history should follow Step 1 treatment guidelines which includes advice to:

- Consume five or more servings of fruits and vegetables each day.
- Remove sugar-sweetened beverages from the diet including soft drinks, sports drinks, energy drinks, fruit drinks, lemonade, and fruit punch.

- Limit fruit juice to 6 oz. (180 mL) per day or less of 100% fruit juice.
- Participate in at least 60 min of moderate to vigorous physical activity daily. Muscle- and bone-strengthening physical activity should also be performed at least 3 days a week.
- Limit discretionary screen time; many parents opt for 2 hrs or less per day.
- Limit intake of fast foods, convenience foods, and foods with added fats and/or sugars.

If Step 1 has not resulted in weight maintenance or modest weight loss within 2–3 months, teens should move on to Step 2 treatment. All adolescents who are overweight and with personal risk factors should begin treatment at Step 2 as should all teens who are obese. Recommendations for Step 2 include all of those in Step 1 plus:

- Keep discretionary screen time to 1 hour or less.
- Introduce a structured meal plan of 1400–1800 kcal/day that follows DASH dietary guidelines (see Table 5.3).
- Monitor daily food intake and physical activity to assure that adolescents are meeting their goals.

Step 2 should be implemented for 6–8 weeks to determine if weight is maintained or modest weight loss has occurred. If necessary, teens should move to Step 3 (as should all teens who are obese who have significant risk factors), which includes all recommendations from Step 2 plus:

- Weekly visits for at last 8–12 weeks that include structured behavior modification techniques; more frequent contact may be desired or required by some teens.
- Supervised physical activity may be provided to assure that teens are safely able to exercise vigorously.
- Mental health screening with a referral for depression or other identified issues.
- Further structure to meal plans or reduction to 1400 kcal/day may be required; teens should be monitored weekly when on low-calorie diets.

Step 4 treatment is implemented when Step 3 is not effective, or for teens who are significantly obese and have comorbid conditions that require intensive intervention. This level of care is provided only in a tertiary care center that specializes in pediatric obesity and may include medication management, meal replacement, very-low-calorie or protein-sparing-modified fast diets, or bariatric surgery.

## Hypertension

Screening for hypertension is recommended at each medical visit [27]. Classification of resting blood pressure based on the average of three readings are presented in Table 5.4.

Adolescents with a family history of hypertension or hyperlipidemia, who are overweight or obese, who use tobacco, and who report a poor dietary intake and inactive lifestyle should be considered at risk for hypertension [19, 22, 24, 25]. Nutrition counseling according to the DASH diet which encourages teens to decrease sodium intake, to limit fat intake to 35% or less of calories, to reduce the intake of added sugars, and to consume adequate amounts of fruit, vegetables, whole grains, and low-fat dairy products should be provided when hypertension is diagnosed (Table 5.3). Weight loss according to national guidelines (outlined previously in this chapter) should be recommended for teens who are overweight or obese.

**Table 5.3** DASH eating plan to reduce hypertension and other chronic diseases: servings per day by food group and total energy intake

Food group	Serving size	1400 kcal	1600 kcal	1800 kcal	2000 kcal
Grains (with whole grains the majority of choices)	One slice bread 1 oz. (28 g) dry cereal 1/2 C (0.12 L) cooked rice, pasta, or cereal	6	6	6	6–8
Vegetables	1 C (0.24 L) raw leafy greens 1/2 C (0.12 L) raw or cooked vegetable 1/2 C (0.12 L) vegetable juice	3–4	3–4	4–5	4–5
Fruits	1 medium fruit, 1/4 C (0.06 L) dried fruit 1/2 C (0.12 L) fresh, frozen, or canned fruit 1/2 C (0.12 L) fruit juice	4	4	4–5	4–5
Milk and milk products (fat-free or low-fat choices) or substitutes	1 C (0.24 L) milk or yogurt 1 C (0.24 L) soy, almond, rice, or other milk substitute 1.5 oz. (42 g) cheese	2–3	2–3	2–3	2–3
Lean meats, poultry, or fish	1 oz. (28 g) cooked meats, poultry, or fish 1 egg	3–4	3–4	≤6	<6
Nuts, seed, and legumes	1/3 C (0.08 L) or 1.5 oz. nuts 2 Tb (30 mL) peanut or other nut butter 2 Tb (30 mL) or 0.5 oz. (14 g) seed 1/2 C (0.12 L) cooked legumes	3/week	3–4/week	4/week	4–5/week
Fats and oils	1 tsp. (5 mL) margarine 1 tsp. (5 mL) vegetable oil 1 Tb (15 mL) mayonnaise 2 Tb (30 mL) salad dressing	1	2	2–3	2–3
Sweets and added sugars	1 Tb (15 mL) sugar 1 Tb (15 mL) jelly or jam 1/2 C (0.12 L) sorbet or gelatin 1 C (0.24 L) lemonade	≤3/week	<3/week	<5/week	<5/week

Source: Based on the US Department of Health and Human Services, National Institutes of Health, National Heart, Lung, and Blood Institute [24]

**Table 5.4** Classification of blood pressure children aged 1–13 years [27]

Blood pressure	Children aged 1–13 years	Adolescents aged 13 years or older
Normal	<90th percentile	Systolic: <120 mmHg Diastolic: <80 mmHg
Elevated	>90th and <95th percentile	Systolic: 120 to 129 mmHg Diastolic: <80 mmHg
Stage 1 Hypertension	>95th and <95th percentile +12 mmHg or 130/80 to 139/89 mmHg	Systolic: 120 to 139 mmHg Diastolic: 80 to 89 mmHg
Stage 2 Hypertension	≥95th percentile +12 mmHg or ≥140/90 mmHg	Systolic: ≥140 mmHg Diastolic: 90 mmHg

Notes: Percentiles are for age, gender, and height

## Hyperlipidemia

About 25% of US teens have hyperlipidemia [24, 25, 27]. Table 5.1 outlines suggested cut-points for blood lipids and other biomarkers for cardiovascular disease (CVD) specific to teens. Total and LDL cholesterol levels drop by up to 20% during the growth spurt; thus, screening for hyperlipidemia at age 10 and after age 17 will provide the most accurate measures [24, 25]. Youth who have a family history of premature CVD or who are overweight or obese should be screened for blood lipids and CVD biomarkers; however, routine screening for all adolescents is not necessary [24, 25].

The National Institutes of Health, National Heart, Lung, and Blood Institute (NHLBI) has developed the CHILd 1 (Cardiovascular Health Integrated Lifestyle Diet-1) and nutrition guidelines which integrate dietary approaches to prevention hypertension, hyperlipidemia, and obesity [24]. These guidelines include the DASH dietary guidelines (Table 5.3) as well as recommendations for dietary fiber (14 g/day/1000 kcal), limited intake of juice (4–6 oz or 120–180 mL/day), limited sodium intake, limiting fast food meals and salty/savory snacks (such as chips and crackers), and eating breakfast daily.

## Diabetes and the Metabolic Syndrome

It is estimated that 215,000 people aged 20 years or younger have diabetes with the majority of the cases being type 1 (a rate of 1.7 per 1000 youth) [28]. The majority of adolescents treated for type 2 diabetes have obesity and a family history of the disease. The disorder among teens appears to be highest among 15–19-year-old American-Indian youth (5.4/1000 among all tribes and 50.9/1000 among Pima Indian teens) [28]. Prevention of type 2 diabetes among youth includes early intervention for overweight or obesity, 60 min of daily activity, and the DASH diet or the Diabetes Prevention Program approach with careful attention paid to removing sugar-sweetened beverages and foods from the diet (Table 5.3).

Metabolic syndrome, the clustering of risk factors for CVD, affects between 2% and 9% of US adolescents; rates are much higher among youth who are obese, estimated at 12–44% [24, 27]. Teens who are overweight and obese and those with a strong family history of CVD and/or diabetes should undergo screening for the metabolic syndrome. Females who are diagnosed with polycystic ovary syndrome may also be at higher risk for the metabolic syndrome. Dietary recommendations to prevent CVD should be encouraged for teens that show evidence of developing the metabolic syndrome.

## Nutrition Education and Counseling of Teens

Adolescents make many of their own food choices outside of the home; thus, nutrition counseling should focus on the busy lives of teens and should incorporate strategies for eating at school and other venues away from home. Adolescents should be encouraged to engage in decision-making processes during nutrition counseling. Setting too many goals may seem overwhelming to the adolescent and may reduce the likelihood of following through with changes in behavior. Accordingly, no more than two goals should be set during a counseling session. Communication methods such as text messaging, podcasts, YouTube, and social media (e.g., Instagram) are popular with adolescents and can be a highly engaging way to convey reliable nutrition information. Mobile apps also hold the potential to promote healthy nutrition behaviors and can be suitable to support the quality of nutrition care and counseling delivered by the clinician [29].



## Summary

Adolescence is a period of rapid physical and mental growth and development, which requires important nutritional consideration. Health professionals should appropriately educate and counsel teens in healthy eating behaviors, achieving and maintaining a healthy weight, and screen for chronic health issues. Addressing the physical and psychological changes that take place during the adolescence life stage can positively impact current health and wellness, as well as shape health in later stages of the life cycle.

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