



iStock.com/LuckyBusiness

Copyright ©2021 by SAGE Publications, Inc.

This work may not be reproduced or distributed in any form or by any means without express written permission of the publisher.

2

Biological Development

Learning Objectives

- 2.1** Summarize the physical changes that accompany puberty in boys and girls.
- 2.2** Describe adolescents' experience of puberty and its influence on their relationships with parents.
- 2.3** Examine the effects of pubertal timing on adolescents.
- 2.4** Analyze influences on pubertal timing.
- 2.5** Discuss common health problems in adolescence and ways of promoting health.

Chapter Contents

- Puberty
 - The Endocrine System
 - Hypothalamus-Pituitary-Gonadal Axis*
 - Adrenarche*
 - Body Shape and Size
 - Secondary Sex Characteristics
 - Primary Sex Characteristics
- Psychological and Social Effects of Puberty
 - Subjective Experience of Pubertal Events
 - Sleep Patterns
 - Parent-Adolescent Relationships
- Pubertal Timing
 - Early Maturation
 - Late Maturation
 - Context and the Effects of Pubertal Timing
- Biological and Contextual Influences on Pubertal Timing
 - Genetics
 - Nutrition and Health
 - Stress
 - Socioeconomic Status and Ethnicity
 - Secular Trend
- Health in Adolescence and Emerging Adulthood
 - Nutrition
 - Physical Activity and Exercise
 - Obesity
 - Eating Disorders
 - Anorexia Nervosa and Bulimia Nervosa*
 - Binge Eating Disorder*
 - Mortality
 - Health Promotion
 - Health Care Access*
 - Health Literacy*

Adolescents experience dramatic changes during puberty. They may grow several inches taller over a summer or experience unexpected shifts in weight, size, and strength. Boys' shoulders tend to broaden, and girls' hips do the same. **Puberty** is the biological transition to adulthood, in which adolescents mature physically and become capable of reproduction.

Puberty is often considered the hallmark of adolescence. The physical changes of puberty are also accompanied by social changes. As adolescents appear more mature, they are treated more like adults. The physical changes serve as a signal to others of entry into a new life stage and convey personal and social meaning about new roles, expectations, and status.

PUBERTY

Although many people view puberty as an event, it is a process that includes many physical changes that occur over about 4 years but can vary dramatically from 1 to 7 years (Mendle, 2014). Puberty entails the development of reproductive capacity, but that is not the whole story. Puberty influences a great variety of physical changes—not simply those typically associated with sexual maturity—such as changes in body size, shape, and function. The brain triggers the onset of puberty through its influence on the endocrine system.

The Endocrine System

In late childhood, by about age 8 or 9 in girls and roughly 2 years later in boys, the brain signals the endocrine system to gradually increase the release of hormones that trigger the onset of puberty (Berenbaum, Beltz, & Corley, 2015). The **endocrine system** produces and regulates levels of **hormones**, chemical substances that are released into the bloodstream to influence body processes. Hormones drive puberty as well as many other functions, including growth, appetite, stress responses, and sexual responses.

Hormone levels in the body are regulated by a feedback loop that can be likened to a thermostat. Levels of a particular hormone are set to a certain point. When the levels drop below the set point, the endocrine system releases hormones into the bloodstream. This process is similar to setting a thermostat to maintain a room temperature at 70 degrees, for example. When the temperature drops below 70 degrees, the heat turns on, warms the room, and stops when the room temperature reaches 70 degrees. Hormone levels are regulated by a similar feedback loop, with the brain instructing the endocrine system to release hormones when they fall below a particular set point.

Hypothalamus-Pituitary-Gonadal Axis

The feedback loop that regulates the sex hormones that drive puberty is known as the **hypothalamus-pituitary-gonadal axis (HPG)** (Figure 2.1). The endocrine system receives messages to control the levels of hormones in the body by the **hypothalamus**, a region at the base of the brain that is responsible for maintaining basic body functions such as eating, drinking, temperature, and hormone production. The hypothalamus releases **gonadotropin-releasing hormone (GnRH)**, which causes the **pituitary gland**, located adjacent to the hypothalamus, to stimulate the **gonads**, or sex glands (ovaries in females and testes in males) to mature, enlarge, and in turn

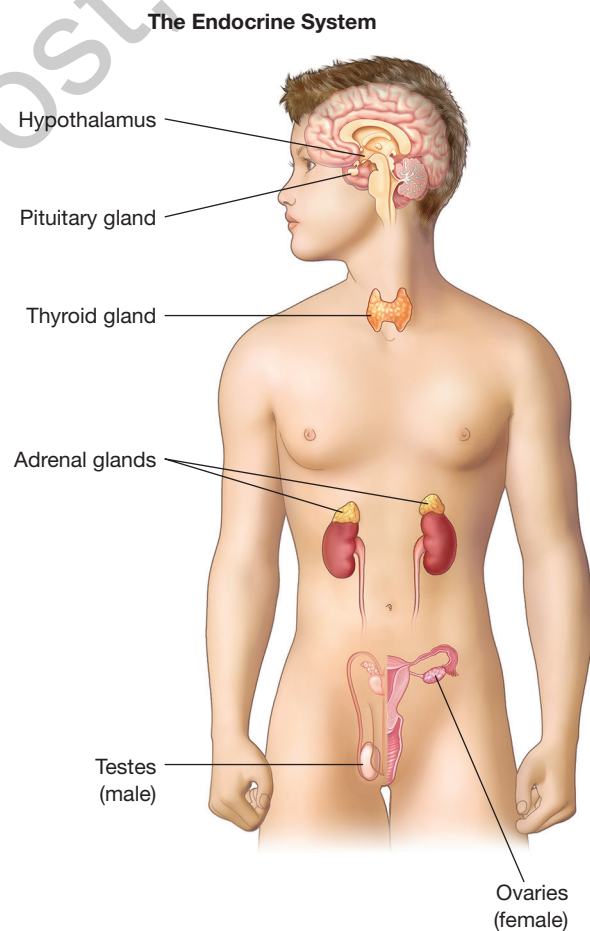
begin producing hormones themselves (Aylwin, Toro, Shirtcliff, & Lomniczi, 2019; Schulz, Molenda-Figueira, & Sisk, 2009). Levels of **testosterone**, a hormone responsible for male sex characteristics, and **estrogen**, responsible for female sex characteristics, increase in both boys and girls. However, testosterone is produced at a much higher rate in boys than girls and estrogen is produced at a much higher rate in girls than boys, leading to different patterns in reproductive development (Bogin, 2011). The physical maturation that comprises puberty is known as **gonadarche**.

Adrenarche

A separate but related hormonal process occurs prior to puberty, at about age 6 to 8, when a shift in hormones triggers **adrenarche**, the activation of the adrenal glands, which are located above the kidneys (Witchel & Topaloglu, 2019). The adrenal glands

FIGURE 2.1

Hypothalamus-Pituitary-Gonadal Axis



Source: Carolina Hrejsa/Body Scientific Intl

secrete low levels of testosterone and hormones that stimulate body growth, the eruption of the first permanent molars, and the development of body hair and odor (Auchus & Rainey, 2004; Utriainen, Laakso, Liimatta, Jaaskelainen, & Voutilainen, 2015). Adrenal hormones influence the body's metabolism, leading to an increase in fat that is needed to cause the onset of puberty, or sexual maturation. Although some of the body changes that accompany adrenarche are often associated with puberty, the two processes are independent (Del Giudice, 2018). Adrenarche is also thought to influence interests and behavior. For example, the brain converts adrenal androgens into estrogen and testosterone, feminizing and masculinizing hormones, which may influence the timing of initial sexual attraction (Campbell, 2011; Witchel & Topaloglu, 2019). Many adults recall their first memorable sexual attractions to peers occurring at about age 9 or 10 (Diamond, Bonner, & Dickenson, 2015).

The adrenal glands are also implicated in stress responses throughout the lifespan because they release cortisol, the hormone responsible for the “fight-or-flight” response. Adrenarche is thought to be a sensitive period in which adolescents are more vulnerable to stress and experience heightened cortisol responses (Del Giudice, Ellis, & Shirtcliff, 2011). This vulnerability is one of the reasons why mental health issues often emerge first in adolescence (Byrne et al., 2017). Stress responses acquired during adolescence, such as elevated cortisol secretion, may persist into adulthood and over the lifespan (Blakemore, Burnett, & Dahl, 2010).

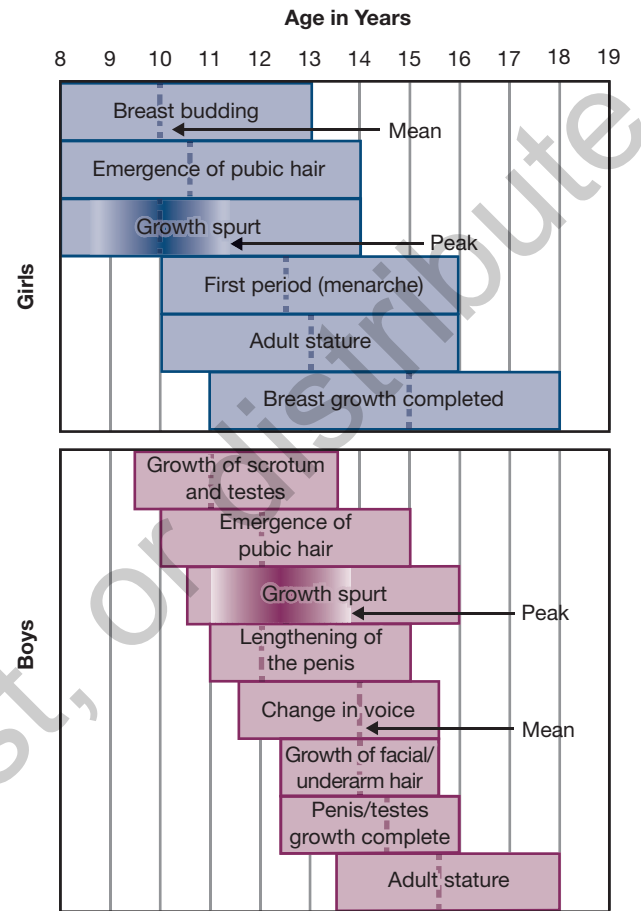
Body Shape and Size

The first outward sign of puberty is the **adolescent growth spurt**, a rapid gain in height and weight that generally begins in girls at about age 10 (as early as age 7 and as late as 14) and in boys at about age 12 (as early as age 9 and as late as 16) (Tinggaard et al., 2012). The pattern and pace of growth, as shown in Figure 2.2, is similar across most children (Sanders et al., 2017). Girls begin their growth spurt about 2 years before boys, so 10- to 13-year-old girls tend to be taller, heavier, and stronger than boys their age. By starting their growth spurts 2 years later than girls, boys begin with an extra 2 years of prepubertal growth on which the adolescent growth spurt builds, leading boys to end up taller than girls (Yousefi et al., 2013). On average, the growth spurt lasts about 2 years, but growth in height continues at a more gradual pace, ending by about 16 in girls and 18 in boys. Adolescents gain a total of about 10 inches in height.

Different parts of the body grow at different rates. For example, the extremities grow first, the fingers and toes; then hands and feet; then arms and legs; and finally, the torso (Sheehy, Gasser, Molinari, & Largo,

FIGURE 2.2

Sequence of Physical Changes With Puberty



Source: Carolina Hrejsa/Body Scientific Intl

2009). Adolescents' bodies therefore tend to appear lanky and awkward, contributing to a temporary increase in clumsiness as adolescents attempt to control their quickly changing bodies. Adolescents' bodies become taller and heavier before their muscles grow stronger and their internal organs mature (DeRose & Brooks-Gunn, 2006; Seger & Thorstensson, 2000).

Sex differences in body shape emerge during the growth spurt. Boys and girls gain fat and muscle, but in different ratios. Girls gain more fat overall, particularly on their legs and hips, so that fat comes to comprise one-fourth of their body weight—nearly twice as much as that of boys. Boys gain more muscle than do girls, especially in their upper bodies, doubling their arm strength between ages 13 and 18 (Payne & Isaacs, 2016). Bone density increases in both boys and girls, and the respiratory and cardiovascular systems mature.

The adolescent growth spurt is accompanied by increases in lung size and capacity, leading adolescents to breathe more deeply. The heart doubles in size



Boys gain more muscle than girls, especially in their arms and upper body.

iStock.com/piyaset

and the total volume of blood in the body increases. These changes increase the amount of oxygen that circulates through the bloodstream to the muscles, improving physical performance and endurance. Boys become much better at taking in and using oxygen as their hearts and lungs grow larger and function more effectively and the number of red blood cells increases (Sadler, 2017). Consequently, once puberty has begun, boys generally tend to outperform girls in athletics (Tønnessen, Svendsen, Olsen, Guttormsen, & Haugen, 2015).

Secondary Sex Characteristics

Most people associate puberty with the development of **secondary sex characteristics**, body changes that indicate physical maturation but are not directly related to fertility. Examples of changes in secondary sex characteristics include breast development, deepening of the voice, growth of facial and body hair, and, for many, the emergence of acne (Hodges-Simeon, Gurven, Cárdenas, & Gaulin, 2013).

Rapid increases in estrogen cause the budding of breasts, which tends to accompany the growth spurt in

girls as the first signs of puberty (Emmanuel & Bokor, 2017). Testosterone causes boys' voices to deepen. As their voices change, boys may occasionally lose control over their voices and emit unpredictable changes in pitch often experienced as high squeaks (Hodges-Simeon et al., 2013). Girls' voices also deepen, but the change is not as noticeable as in boys. Oil and sweat glands become more active, resulting in body odor and acne (Sadler, 2017). Hair on the head, arms, and legs becomes darker, and pubic hair begins to grow, first as straight and downy, and later becomes coarse (Figures 2.3 and 2.4).

Primary Sex Characteristics

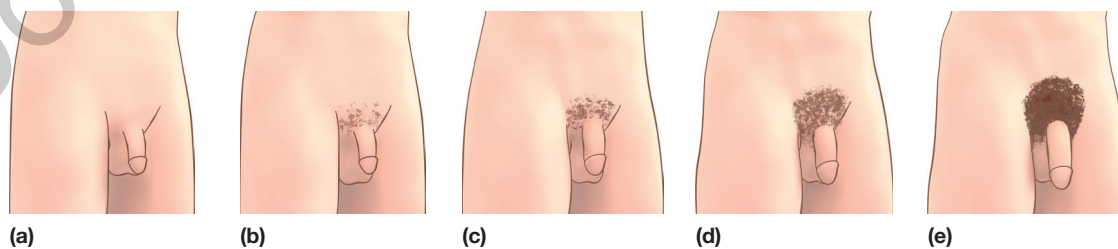
Maturation of the **primary sex characteristics**, the reproductive organs, is less noticeable than secondary sex characteristics but is the most important developmental change that accompanies puberty. In females, primary sex characteristics include the ovaries, fallopian tubes, uterus, and vagina. In males, they include the penis, testes, scrotum, seminal vesicles, and prostate gland. During puberty, the reproductive organs grow larger and mature.

The onset of menstruation marks sexual maturity in girls. **Menstruation** refers to the monthly shedding of the uterine lining, which has thickened in preparation for the implantation of a fertilized egg. **Menarche**, the first menstruation, occurs toward the end of puberty, yet most adolescents and adults view it as a critical marker of puberty because it occurs suddenly and is memorable (Brooks-Gunn & Ruble, 2013).

In North America, the average European American girl experiences menarche shortly before turning 13 and the average African American girl shortly after turning 12 (Emmanuel & Bokor, 2017). Generally, African American girls tend to be heavier and enter puberty about a year earlier, reaching pubertal milestones such as the growth spurt and menarche earlier than other girls (Emmanuel & Bokor, 2017).

FIGURE 2.3

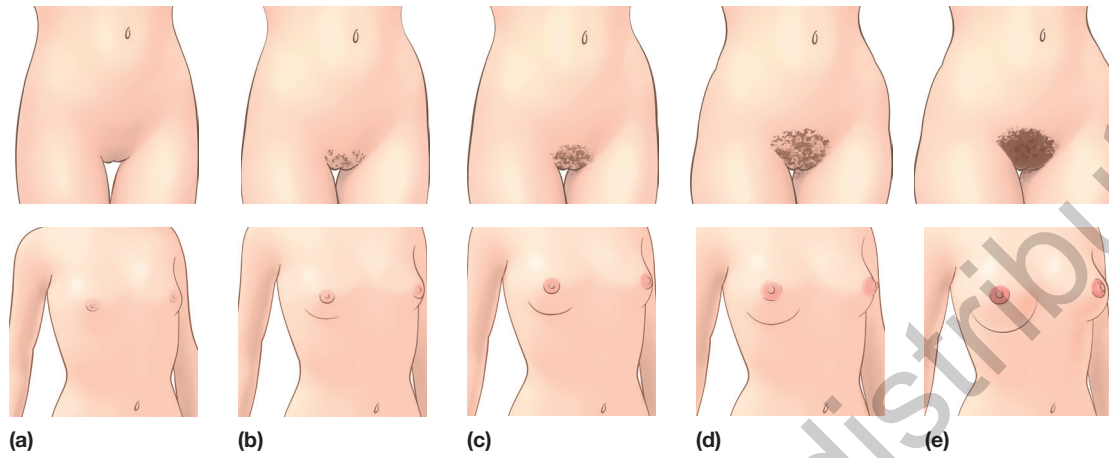
Pubertal Stages for Penis and Pubic Hair Growth



Source: Carolina Hrejsa/Body Scientific Intl

FIGURE 2.4

Pubertal Stages for Breast and Pubic Hair Growth



Source: Carolina Hrejsa/Body Scientific Intl

Hispanic American girls enter puberty at about the same time as African American girls, with some studies suggesting earlier menarche and others later (Biro et al., 2018; Deardorff, Abrams, Ekwaru, & Rehkopf, 2014). Frequently, during the first few months after menarche, menstruation takes place without ovulation, the ovaries' release of an ovum (Lacroix & Whitten, 2017). However, this period of temporary sterility is variable and unpredictable.

In boys, the first primary sex characteristic to emerge is the growth of the **testes**, the glands that produce sperm (Tinggaard et al., 2012). About a year later, the penis and scrotum enlarge, and pubic hair, a secondary sex characteristic, appears. As the penis grows, the prostate gland and seminal vesicles begin to produce **semen**, the fluid that contains sperm. At about age 13, boys demonstrate a principal sign of sexual maturation: the first ejaculation, known as **spermarche** (Gaddis & Brooks-Gunn, 1985; Tomova, Lalabonova, Robeva, & Kumanov, 2011). The first ejaculations contain few living sperm. Many boys experience spermarche in the form of **nocturnal emissions**, or wet dreams, involuntary ejaculations that are sometimes accompanied by erotic dreams.

REVIEW 2.1

1. What is the hypothalamus-pituitary-gonadal axis?
2. Describe adrenarche.
3. What triggers puberty?
4. What are some of the ways in which adolescents' bodies change?

5. Identify examples of primary and secondary sex characteristics.

THINKING IN CONTEXT 2.1

1. In what ways might pubertal changes, such as the growth spurt or emergence of secondary sex characteristics, influence adolescents' behavior?
2. What are some of the implications of sex differences in body growth? For example, might girls' earlier maturation contribute to sex differences in behavior? What are other social implications of pubertal growth?

APPLY 2.1

"Wow, I haven't seen her in a couple of months—and, wow, your daughter's growing so fast," remarked Sondra to her friend Tesa. "You may not have noticed, but your 9-year-old little girl does not look like a little girl," Sondra said. "I know. Her body is filling out very quickly, much faster than I'd like," Tesa replied.

1. What does Tesa's daughter need to know about her body? What should Tesa tell her daughter about puberty, if anything?
2. What information, if any, should schools provide children and preadolescents about puberty?

PSYCHOLOGICAL AND SOCIAL EFFECTS OF PUBERTY

Puberty, specifically menarche and spermatarche, represents the transition to reproductive maturity. How do adolescents perceive these changes and how does puberty affect adolescents' lives?

Subjective Experience of Pubertal Events

Girls' experience is influenced by their knowledge about menstruation and their expectations (Brooks-Gunn & Ruble, 2013). Generations ago, girls received little to no information about menarche. Understandably, they were often surprised by it, viewed it negatively, and were often afraid (Costos, Ackerman, & Paradis, 2002). Today, surprise is often the first emotion girls express, but most girls are not frightened by menarche because they have been informed about puberty by health education classes and parents who are more willing to talk about pubertal development than parents in prior generations (Stidham-Hall, Moreau, & Trussell, 2012).

The extent to which adolescents discuss menarche and sexuality varies by context and culture. A study of 12- to 16-year-old Bangladeshi girls revealed that they generally were not informed about menarche, and over two-thirds reacted with fear (Bosch, Hutter, & van Ginneken, 2008). Their mothers also tended to lack an adequate understanding of pubertal processes. Other research has suggested that girls in low and middle income countries, such as India, Turkey, Pakistan, Nigeria, and Malaysia, often know little about menarche and, for religious and cultural reasons, may feel shame about menstruation (Behera, Sivakami, & Behera, 2015; Chandra-Mouli & Patel, 2017). In some cultures, girls can be excluded from interaction with others, including attending school, when they are menstruating. Girls who view menstruation negatively are at risk to experience menstruation negatively, with more menstrual symptoms and distress (Rembeck, Möller, & Gunnarsson, 2006).

We know less about boys' experience of puberty because they lack easily determined objective markers, such as menarche (Herman-Giddens et al., 2012). Research with small groups of adolescent boys suggests that most boys react positively to their first ejaculation, although many experience uneasiness and confusion, especially if they are uninformed about this pubertal change (Frankel, 2002; Stein & Reiser, 1994). Boys who know about ejaculation beforehand are more likely to show positive reactions, such as feeling pleasure, happiness, and pride. Unfortunately,

many boys report that health education classes and parents generally do not discuss ejaculation (Omar, McElderry, & Zakharia, 2003; Stein & Reiser, 1994). Parents sometimes report discomfort talking with their sons about reproductive development, particularly ejaculation, because of the close link with sexual desire, sexuality, and masturbation (Frankel, 2002). Perhaps because of its sexual nature, boys are less likely to tell a friend about spermatarche than girls are to discuss their own reproductive development (Downs & Fuller, 1991).

Sleep Patterns

Puberty entails many physical changes. One surprising change is a shift in adolescents' sleep patterns and preferred sleep schedule, known as a **delayed phase preference** (Carskadon, 2009; Crowley, Acebo, & Carskadon, 2007). Delayed phase preference is triggered by a change in the nightly release of **melatonin**, a hormone that influences sleep. Adolescents who have experienced puberty tend to show a nightly rise in melatonin (and sleep) about 2 hours later than those who have not begun puberty (Carskadon, Acebo, & Jenni, 2004). When adolescents are allowed to regulate their own sleep schedule, they tend to go to bed at about 1:00 a.m. and sleep until about 10:00 a.m. (Colrain & Baker, 2011). As a result, adolescents stay up later, miss out on sleep, and report sleepiness (Carskadon et al., 2004; Loessl et al., 2008). Adolescents need about 9 hours of sleep each night to support healthy development, but most get far less sleep. From ages 13 to 19, the average number of hours of sleep reported by adolescents in Western countries, such as the United States and Germany, tends to decrease from about 8 to 7 hours, with greater reductions in sleep with each year of age (Carskadon, 2009; Loessl et al., 2008).

Contextual factors also influence adolescents' sleep patterns. The tendency for adolescents to go to bed later has increased over the last 3 decades, along with the increased availability of television and electronic media that compete with sleep for adolescents' time (Bartel, Gradisar, & Williamson, 2015; Carskadon & Tarokh, 2014). Most adolescents have electronic devices such as cellphones, video games, and computers and many report using electronic devices in bed. Greater bedtime device use is associated with less sleep (Vernon, Modecki, & Barber, 2018). Screen use has biological implications for adolescents' sleep. Early in puberty, adolescents show more sensitivity to light and melatonin production is more easily suppressed by exposure to light in the evening (such as by the use of computer, tablet, and smartphone screens) (Crowley, Cain, Burns, Acebo, & Carskadon, 2015).

Poor sleep in adolescence is associated with anxiety, irritability, and depression (Fulgini, Arruda, Krull, &



Evening screen use is associated with poor sleep.
iStock.com/banusevim

Gonzales, 2018; Wong & Brower, 2012). It increases the probability of health problems, including illnesses, obesity, and accidents (Darchia & Cervena, 2014; Mitchell, Rodriguez, Schmitz, & Audrain-McGovern, 2013b). Poor sleep duration predicts less engagement in extracurricular school activities and declines in academic performance (Fuligni et al., 2018; Minges & Redeker, 2016). Sleep problems are also associated with risky behaviors, including cigarette smoking and substance use (Pieters et al., 2015; Telzer, Fuligni, Lieberman, & Galván, 2013; Wong, Robertson, & Dyson, 2015), and predict the onset of heavy drinking and marijuana use up to 5 years later (Miller, Janssen, & Jackson, 2017; Nguyen-Louie et al., 2018). Moreover, “catching up” on missed sleep by sleeping longer on the weekends may be ineffective in reducing the sleep deficit. For example, fluctuations in sleep length (“catching up”) were associated with more internalizing and externalizing symptoms in a sample of Mexican American adolescents (Fuligni et al., 2018) and poor performance on attention tasks in a sample of Korean adolescents (Kim et al., 2011).

Most middle and high schools start earlier than elementary schools, often to allot time for after-school sports and activities. Earlier school starting times are associated with less total sleep and students generally do not make up for lost sleep on the weekends (Paksarian, Rudolph, He, & Merikangas, 2015). Delaying school start times improves student school attendance, grades, and disposition. For example, in one study, students reported getting 30 minutes more sleep each night and showed significant improvements in measures of adolescent alertness, mood, and health 3 months after a 50-minute delay in school start time (Owens, Belon, & Moss, 2010; Owens, Dearth-Wesley, Herman, Oakes, & Whitaker, 2017). A metaanalysis suggested that when school times were delayed 25 and up to 60 minutes, total sleep time increased from 25 to as much as 77 minutes per week-night (Minges & Redeker, 2016). Later start times were

associated with reduced student daytime sleepiness, depression, caffeine use, tardiness to class, and trouble staying awake. In 2017, the American Academy of Sleep Medicine (Watson et al., 2017a) issued a policy statement calling on communities, school boards, and educational institutions to implement start times of 8:30 a.m. or later for middle schools and high schools to ensure that every student arrives at school healthy, awake, alert, and ready to learn.

In addition to the school context, sleep is influenced by other contexts such as the home and family. For example, under contexts of family stress, more parental support and cohesive parent-child relationships are linked to longer sleep duration, less sleep variability, and less time spent awake during the night (Tsai et al., 2017). Relatedly, a study of adolescents showed that neighborhood factors, specifically greater perceived neighborhood cohesion, were associated with better sleep and the effect was greater for those of lower socioeconomic status, especially those with lower levels of maternal education (Troxel et al., 2017).

Parent-Adolescent Relationships

As adolescents begin puberty, parent-child interactions tend to change. Puberty is associated with an increase in conflict and distance in parent-child relationships, especially between adolescents and mothers (Ellis, Shirtcliff, Boyce, Dearth-Dorff, & Essex, 2011). Early pubertal changes such as the adolescent growth spurt are associated with a rise in negative parent-child interactions, such as complaining and anger, and a decline in positive interactions (Graber, Nichols, & Brooks-Gunn, 2010). The change in parent-child interactions varies with pubertal timing, occurring earlier in early maturers and later in late maturers. Although there is little recent research examining ethnic differences in these relationships, existing work suggests that these patterns tend to vary with ethnicity and sex (Sagrestano, McCormick, Paikoff, & Holmbeck, 1999). Specifically, one 7-year study of children from age 8.5 to 15.5 demonstrated that White girls show increases in lability, or fluctuations, in conflict with their mothers compared with Black or Hispanic girls (Marceau, Ram, & Susman, 2015). In contrast, both White and Black boys who matured more quickly tended to show more lability in conflict with their fathers than those who matured slowly.

However, puberty is one piece of the puzzle, as changing relationships between adolescents and parents are influenced by a variety of factors, as we will discuss in Chapter 8. As adolescents' bodies change, their peer relationships shift and they become interested in dating, potentially a source of conflict with parents. Moreover, parents' reactions to their teens' changing bodies, such as expectations for adolescents' help at home, worries about the potential

dangers of dating and sexual relations, and feelings of loss for the child they once had, can influence their perceptions and interactions. As we will discuss in Chapter 8, parent–child relationships improve by the end of puberty, yet the relationships are different than they were in childhood.

REVIEW 2.2

1. Compare girls' and boys' experience of puberty.
 2. How do adolescents' sleep patterns change with puberty and what are the implications of these changes?
 3. Describe adolescents' relationships with parents during puberty.
-

THINKING IN CONTEXT 2.2

1. How might adolescents' cognitive and social abilities influence their understanding and comfort with their changing bodies?
 2. What role do interactions with others play in influencing adolescents' experience of puberty?
 3. Do experiences at school and in the community influence adolescents' views of their changing bodies? Why or why not?
 4. Do these factors influence boys and girls differently? Why or why not?
-

APPLY 2.2

Fourteen-year-old Juan feels exhausted nearly every day. His alarm barely wakes him. After a few minutes of hearing Juan's alarm, his mother pounds on the door to his room and Juan finally gets out of bed. When Juan's mother is working the early shift, he often oversleeps and gets to school several periods late. Juan can hardly concentrate until about his third or fourth class of the day. Juan's mother reminds him to go to bed early; sometimes he tries, but he's usually wide awake until a few hours before he has to wake for school.

1. What are some of the possible reasons for Juan's sleep problems?
 2. What can be done to help adolescents like Juan?
 3. What advice do you have for Juan's mother?
 4. What can she expect in the coming years?
-

PUBERTAL TIMING

Casual observations of adolescents reveal that although most tend to progress through puberty at about the same time, some begin much earlier or later than others. Children who show signs of physical maturation before age 8 (in girls) or 9 (in boys) are considered early-maturing, whereas girls who begin puberty after age 13 and boys who begin after age 14 are considered late-maturing adolescents (Dorn, Dahl, Woodward, & Biro, 2006). Longitudinal research suggests that boys and girls who matured off-time, early or late relative to their peers, were more likely to show anxiety and depressed mood than their on-time peers in late adolescence and early adulthood (Mendle & Ferrero, 2012; Natsuaki, Biehl, Ge, & Xiaoja, 2009; Rudolph et al., 2014). Early maturation, in particular, poses challenges for both girls' and boys' adaptation (Stroud & Davila, 2016; Ullsperger & Nikolas, 2017).

Early Maturation

Adolescents who mature off-time relative to their peers are often treated differently by adults and peers, with consequences for their development. For example, adolescents who look older than their years are more likely to be treated in ways similar to older adolescents, which adolescents may perceive as stressful (Rudolph et al., 2014). Around the world, early-maturing boys and girls show higher rates of risky activity, including smoking, abusing alcohol and substances, and displaying aggressive behavior, than do their same-age peers (Mrug et al., 2014; Schelleman-Offermans, Knibbe, & Kuntsche, 2013; Skoog & Stattin, 2014).

Early maturation poses specific risks to girls' development. Girls who mature early relative to peers tend to feel less positive about their bodies, physical appearance, and menstruation itself and show higher rates of depression, anxiety, and low self-esteem than do girls who mature on time or late (Benoit, Lacourse, & Claes, 2013; Carter, 2015; Stojković, 2013). Although early-maturing girls are often popular, they are also more likely to be victims of rumor-spreading and sexual harassment, which is associated with feelings of depression, anxiety, and poor self-esteem (Carter, Halawah, & Trinh, 2018; Reynolds & Juvonen, 2011; Skoog, Özdemir, & Stattin, 2016). Early-maturing girls tend to date earlier than their peers, are at higher risk of dating violence, and experience more sexual harassment than their peers (Chen, Rothman, & Jaffee, 2017; Skoog & Özdemir, 2016). One recent study of African American and Caribbean Black girls found that girls who perceived their pubertal development as earlier than their same-aged peers tended to report more experiences with racial discrimination (Seaton & Carter, 2019). Early-maturing Black girls



Girls who mature earlier than their peers sometimes experience social difficulties, such as gossip.

iStock.com/fstop123

who attend schools where they are numerical minorities may experience heightened risk for discrimination, suggesting that the effects of pubertal timing may vary with race and ethnicity as well as peer and school context.

Interestingly, girls' view of their own early pubertal timing, whether they view themselves as maturing much earlier than their peers, is often only loosely related to their actual development (Dorn & Biro, 2011; Rasmussen et al., 2015). That is, girls are likely to hold inaccurate views of their bodies, seeing themselves as more or less developed than they are. Moreover, research suggests that girls' self-perceptions are not related to their peers' physical development; their views of their own physical development are independent of their peers' development (Kretsch, Mendle, Cance, & Harden, 2016a). Yet girls' views of their own physical development are often a better predictor of their age at first intercourse, as well as their engagement in sexual risk-taking and substance use and their likelihood of experiencing depression and anxiety, than actual pubertal development (Kretsch, Mendle, & Harden, 2016b; Moore, Harden, & Mendle, 2014).

In males, earlier timing of puberty historically has been viewed as advantageous because it conveys physical advantages for athletic activities. Early-maturing boys tend to be athletic, popular with peers, school leaders, and confident (Stojković, 2013). There is less research on boys than on girls, but it appears that early-maturing boys also experience some internalizing and externalizing symptoms (Rudolph et al., 2014; Stroud & Davila, 2016), especially when they judge their peer relationships as stressful (Benoit et al., 2013; Blumenthal, Leen-Feldner, Trainor, Babson, & Bunaciu, 2009). Early maturers tend to show higher rates of problematic drinking, including consuming

alcohol more frequently and in greater quantities, and becoming intoxicated more often than their on-time and late-maturing peers (Biehl, Natsuaki, & Ge, 2007; Schelleman-Offermans, Knibbe, & Kuntsche, 2013). Moreover, these patterns of problematic alcohol use often persist into late adolescence and early adulthood, suggesting that early pubertal maturation may hold long-term implications for young people's health.

Although all early-maturing adolescents tend to experience more problems, early-maturing girls are at higher risk for early sexual activity and for alcohol and substance use and abuse than boys (Ullsperger & Nikolas, 2017). Late maturation shows a different pattern of outcomes.

Late Maturation

In contrast to early maturation, the effects of late maturation tend to differ more dramatically for boys and girls. Late maturation appears to have a protective effect on girls with regard to depression (Negri & Susman, 2011). In one study, late-maturing girls experienced less teasing about their appearance and lower rates of appearance-related anxiety compared with other girls (Zimmer-Gembeck, Webb, Farrell, & Waters, 2018). Findings regarding the effects of late maturation on boys are mixed and less consistent (Mendle & Ferrero, 2012). Late-maturing boys may experience more social and emotional difficulties. Similar to girls, perception may matter. For example, in one study, African American boys who perceived themselves as late maturers showed more symptoms of anxiety than their peers (Carter, 2015). During early adolescence, they may be less well liked by their peers and may be more likely than their peers to experience a poor body image, overall body dissatisfaction, and depression, but these effects tend to decline with physical maturation (Negri & Susman, 2011). Other research suggests that late-maturing boys do not differ in anxiety or depression from their on-time peers (Crockett, Carlo, Wolff, & Hope, 2013; Marceau et al., 2011) or that it is only late-maturing boys with poor peer relationships who experience depression (Benoit et al., 2013).

Context and the Effects of Pubertal Timing

Contextual factors are thought to amplify the effects of pubertal timing on behavior (Natsuaki, Samuels, & Leve, 2015; Seaton & Carter, 2018). For example, some

of the problems that early-maturing boys and girls experience arise because they tend to seek relationships with older peers who are more similar to them in physical maturity than their classmates (Kretsch et al, 2016a). Spending time with older peers makes early-maturing adolescents, especially girls, more likely to engage in age-inappropriate behaviors such as early and risky sexual activity (Baams, Dubas, Overbeek, & van Aken, 2015; Moore et al., 2014). The composition of the peer group may also matter. For example, in one study, early pubertal development was associated with a higher risk for experiencing adolescent dating abuse when the early-maturing girls' friendship groups comprised a higher percentage of boys but not when the friendship groups contained few boys (Chen et al., 2017).

The school context may also influence the effects of pubertal timing. For example, in one study, elementary school teachers shown drawings of girls at varying stages of pubertal development expected early-developing girls to have more academic and social problems relative to other girls (Carter, Mustafaa, & Leath, 2018). In addition, they expected Black early developers to experience more problems than White early developers, possibly suggesting that race and ethnicity may influence how early puberty is experienced by girls. Other research also suggests that racial identity can influence the effects of pubertal timing. In one study of Black adolescents, early-maturing girls were more likely to experience depressive symptoms when they attended mixed-race schools and believed that others held Blacks in poor regard (Seaton & Carter, 2018). The stress that accompanies perceived discrimination may pose serious risks to adaptation. In contrast, and perhaps surprisingly, a strong sense of racial identity was associated with increased depressive symptoms among late-maturing Black girls who attended schools with a mixed-race population. Late-maturing Black girls who identify with their race may value the earlier maturation common to Black girls and may feel dissatisfied with their bodies. Pubertal development influences girls' sense of self and may interact with their other self-relevant beliefs, as well as the social and racial contexts in which they are immersed, to influence their responses (Seaton & Carter, 2018).

REVIEW 2.3

1. Compare the effects of early maturation in boys and girls.
2. What are some of the effects of late maturation for boys and girls?
3. How might the peer and school context influence the effects of the timing of pubertal maturation?

THINKING IN CONTEXT 2.3

1. How might the neighborhood context influence how early and late maturation is experienced by boys and girls? Identify at least three influences in the neighborhood that might affect adolescents' experience of early and late maturation.
2. Consider the effect of neighborhood socioeconomic status. Might early- and late-maturing adolescents living in high, low, or middle income neighborhoods have different experiences? Why or why not?
3. How might the effects vary with race and ethnicity, factors that are associated with pubertal timing and also socioeconomic status?

APPLY 2.3

Sacha zips her sweatshirt up over her chest as she walks into class. "You look like you're wearing a potato sack," kids her friend Jana. "Everything you wear is so baggy," Jana says. Sacha moves to the back of the classroom and sits without saying a word. Later that day, she overhears her mother on the phone. "I don't know what to do about Sacha," her mother says. "She seems like a different kid. She's unsure of herself and I think she's depressed. But the biggest problem is that boy she's hanging out with. He's older—a senior. I don't think she's ready for a relationship and definitely not ready for sex! Sometimes I swear Sacha smells like beer."

1. Given what you know about pubertal development, how would you explain Sacha's behavior?
2. What role might pubertal timing have in this case, if any?
3. What should Sacha's mother know about girls' experience of puberty?
4. What advice do you have for Sacha's mother?

BIOLOGICAL AND CONTEXTUAL INFLUENCES ON PUBERTAL TIMING

In the school locker room, Monique quickly removes her T-shirt and jeans and speedily changes into her gym clothes. At 10 years old, Monique's adult-like figure sets her apart from her peers. Her friend Kaitlyn will not experience similar body growth until age 14. Why does the timing of puberty vary so dramatically for Monique and Kaitlyn? As we discussed, puberty is controlled by the HPG axis, which is responsible for regulating testosterone

and estrogen, the hormones that drive puberty. These hormones circulate in the body before birth but they are maintained at a low level throughout infancy and much of childhood. In late childhood, however, the set point for estrogen and testosterone shifts and puberty begins. What triggers this shift? The timing of puberty reflects the interaction of biological and contextual influences.

Genetics

Genetics plays a role in puberty, but puberty is a complex trait influenced by many genes that interact with contextual factors (Day et al., 2017; Zhu, Kusa, & Chan, 2018). In support of the role of genetics, pubertal timing for both boys and girls tends to be similar to that of their parents (Wohlfahrt-Veje et al., 2016). Identical twins (who share 100% of their genes) experience menarche more closely in time than fraternal twins (who share only 50% of their genes) (Kretsch et al., 2016b).

Some children are genetically programmed to experience puberty earlier than others. Heredity sets the boundaries of pubertal timing, the earliest and latest age when we might begin puberty. Yet the onset of puberty and whether it is early or late relative to our inherited range is influenced by more than genes. Contextual influences and life experiences play a role in determining when a child begins puberty.

Nutrition and Health

The availability and consumption of calories and corresponding weight gain determines the onset of puberty (Das et al., 2017). Puberty is triggered by achieving a critical level of body weight, specifically body fat. From an evolutionary perspective, the link between body weight and the onset of reproductive maturation may be adaptive because it delays fertility when food and resources are scarce and unlikely to support offspring (Roa & Tena-Sempere, 2014). The ratio of body fat to weight is a particularly important influence on pubertal timing. Specifically, the accumulation of **leptin**, a protein found in fat, signals the brain to release **kisspeptin**, a brain chemical that stimulates the hypothalamic-pituitary-gonadal axis to increase the production and secretion of hormones (Aylwin et al., 2019; Manfredi-Lozano, Roa, & Tena-Sempere, 2018). Leptin receptors have been identified in the hypothalamus as well as in cells in the ovaries and testicles (Shalitin & Kiess, 2017). Girls with a greater **body mass index (BMI)**, especially those who are obese, mature earlier than do their peers, and girls who have a low percentage of body fat, whether from athletic training or severe dieting, often experience menarche late relative to other girls (Tomova, 2016; Villamor & Jansen, 2016). For example, research with

girls in 34 countries has shown that obesity predicted early puberty (Currie et al., 2012).

In contrast, extreme malnutrition can prevent the accumulation of adequate fat stores needed to support pubertal development so that menarche is delayed. In many parts of Africa, for example, menarche does not occur until age 14 to 17, several years later than in Western nations (Tunau, Adamu, Hassan, Ahmed, & Ekele, 2012). Similarly, some research suggests that weight affects the onset and tempo of puberty in boys, with higher BMI associated with earlier puberty (Lee et al., 2016; Song et al., 2016), but less so as compared with girls (Tinggaard et al., 2012), and the mechanism is not well understood (Cousminer et al., 2014). Swift declines in the age of menarche accompanied the rapid economic growth and advances in the standard of living in South Korea over the last half of the 20th century, illustrating the role of context in biological development (Sohn, 2016).

Stress

Adolescents' social contexts, especially exposure to stress, also influence pubertal timing (Joos, Wodzinski, Wadsworth, & Dorn, 2018). In fact, stress affects hormone production throughout the lifespan; it can trigger irregular ovulation and menstruation in females and reduce sperm production in males (Toufexis, Rivarola, Lara, & Viau, 2014). Early life stress and the experience of severe stress, such as the experience of sexual abuse and maltreatment, can speed the onset of menarche (Negri, Blankson, & Trickett, 2015; Noll et al., 2017; Worthman, Dockray, & Marceau, 2019).

Similarly, poor family relationships, harsh parenting, family stress and conflict, parents' marital conflict, and anxiety are associated with early menarche in North American and European girls (Graber et al., 2010; Rickard, Frankenhuis, & Nettle, 2014). In industrialized countries such as the United States, Canada, and New Zealand, girls who are raised by single mothers experience puberty earlier than those raised in two-parent homes (Mendle et al., 2006).

In addition, the absence of a biological father and the presence of a biological unrelated male, such as a stepfather or a mother's live-in boyfriend, in the home is associated with earlier onset of menarche (Deardorff et al., 2011; Webster, Graber, Gesselman, Crosier, & Schember, 2014). Animal studies show a similar trend: The presence of a biologically related male delays reproductive maturation and functioning, while the presence of unrelated males speeds female reproductive maturation (Neberich, Penke, Lehnart, & Asendorpf, 2010). Household stress and economic adversity may hold similar implications for boys' pubertal development, speeding it (Sun, Mensah, Azzopardi, Patton, & Wake, 2017); however,

there is much less research on boys' development (Joos et al., 2018).

Socioeconomic Status and Ethnicity

Contextual factors outside the home also influence pubertal timing. Adolescents who live in similar contextual conditions, especially those of socioeconomic advantage, reach menarche at about the same age, despite having different genetic backgrounds (Obeidallah, Brennan, Brooks-Gunn, & Earls, 2004). Low socioeconomic status (SES) is associated with early pubertal onset in the United States, Canada, and the United Kingdom and may account for some of the ethnic differences in pubertal timing (Kelly, Zilanawala, Sacker, Hiatt, & Viner, 2017; Mendle & Koch, 2019; Sun et al., 2017). For example, African American and Latina girls tend to reach menarche before White girls, but they are also disproportionately likely to live in low SES homes and neighborhoods. Ethnic differences in the timing of menarche

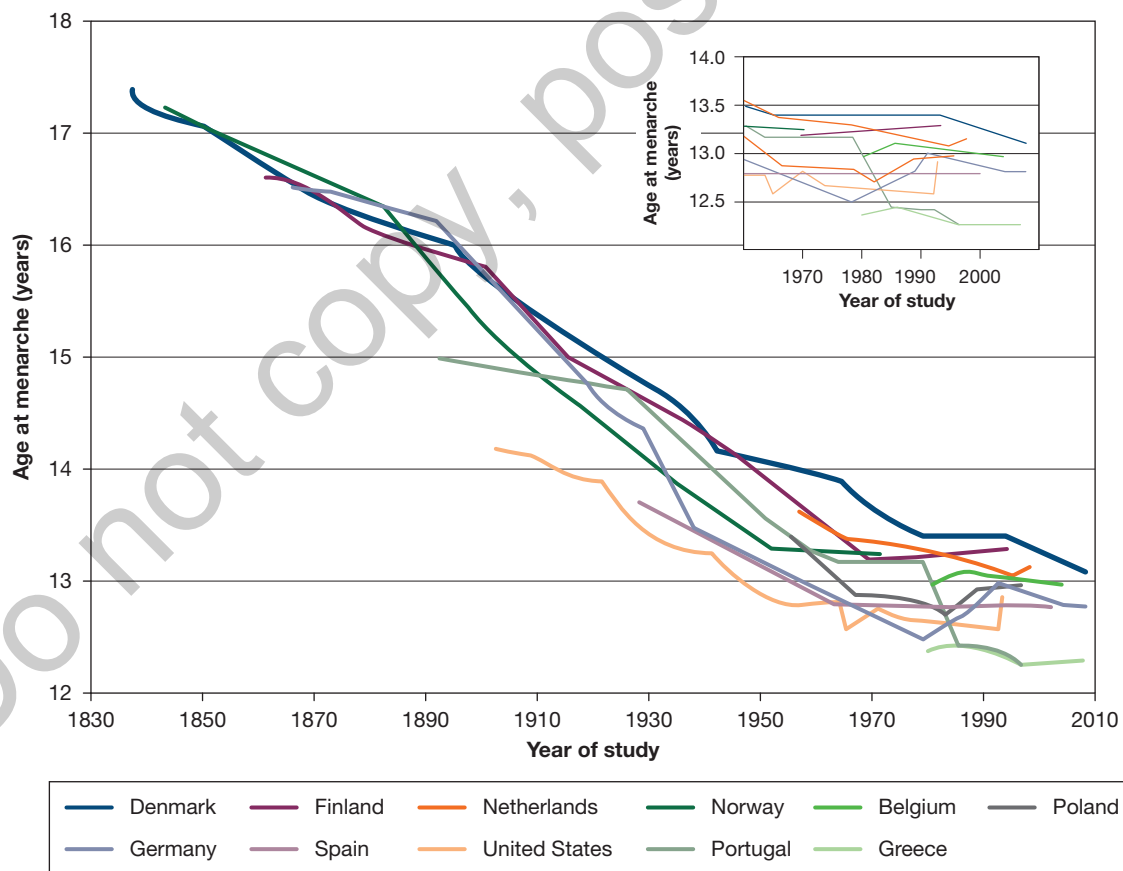
are reduced or even disappear when researchers control for the influence of socioeconomic status (Deardorff et al., 2014; Obeidallah, Brennan, Brooks-Gunn, Kindlon, & Earls, 2000). That is, girls growing up in low SES contexts may experience more stress at home and the community and may have less access to healthy foods and opportunities for safe physical activity. In support of this view, girls' perceptions of neighborhood safety and their estimates of the likelihood that they will live to age 35 predicted early menarche (Amir, Jordan, & Bribiescas, 2016).

Secular Trend

The influence of contextual conditions and physical health in triggering puberty is thought to underlie the **secular trend**, or the lowering of the average age of puberty with each generation from prehistoric to the present times (Papadimitriou, 2016a) (Figure 2.5). Through the 18th century in Europe, puberty occurred as late as age 17; between 1860 and 1970, the age of menarche declined by about

FIGURE 2.5

Secular Trend in Girls' Pubertal Development, 1830–2010



Source: Sørensen et al. (2012).

3 to 4 months per decade (Tanner, 1990). In China, the age at menarche declined from 14.25 in girls born before 1976 to 12.60 in girls born after 2000, with an estimated decline of 0.51 years per decade (Meng, Martinez, Holmstrom, Chung, & Cox, 2017). Boys in the United States and Canada begin puberty at least 1 to 1½ years earlier today than in the 1960s (Herman-Giddens, 2006; Herman-Giddens et al., 2012). Likewise, boys reached peak velocity of growth over 1 month earlier each decade between 1946 and 1991 (Bygdell, Vandenput, Ohlsson, & Kindblom, 2014). The secular trend parallels increases in the standard of living and average BMI among children in developed countries and is especially influenced by the growing problem of childhood obesity (Biro, Greenspan, & Galvez, 2012). There are some indications that the secular trend has slowed or stopped in most industrialized nations, but it is unclear when it will stop completely (Kleanthous, Dermitzaki, Papadimitriou, Papaevangelou, & Papadimitriou, 2017; Papadimitriou, 2016b). Girls have shown precocious puberty as early as age 5 (Scutti, 2015); however, it is unlikely that the average age of puberty will ever drop that low. Nevertheless, the secular trend poses challenges for young people and parents because the biological entry to adolescence is lowering at the same time as the passage to adulthood is lengthening, making the period of adolescence longer than ever before.

REVIEW 2.4

1. Discuss the contributions of genetics and health in pubertal timing.
2. How is the experience of stress related to pubertal timing?
3. How does pubertal timing vary with socioeconomic status and ethnicity?
4. How do contextual influences, such as socioeconomic status and historical time, affect pubertal development?

THINKING IN CONTEXT 2.4

1. If possible, ask a parent, grandparent, or other older relative about their pubertal timing. When did they experience the growth spurt, for example? How does their experience compare with your own, if at all? What might account for the similarities or differences?
2. In your view, which contextual factors are most relevant in influencing pubertal timing, generally?

APPLY 2.4

Wanda began a rapid growth spurt at about age 8. Her friend Clarissa entered her growth spurt just before she turned 14. What are some of the factors that might account for these differences in pubertal timing?

HEALTH IN ADOLESCENCE AND EMERGING ADULTHOOD

Adolescents continue to share many of the same health concerns they did as children, such as access to good nutrition and opportunities for physical activity, safe schools and neighborhoods, and health care. With puberty, adolescents experience new health issues, including adjusting to changing bodies, understanding sexuality, and promoting safe sex.

Nutrition

As boys and girls enter the adolescent growth spurt, their bodies require more energy and their caloric demands increase rapidly to about 2,200 and 2,700 calories a day for girls and boys, respectively (Jahns, Siega-Riz, & Popkin, 2001). Good nutrition is essential to support adolescents’ growth, yet young people’s diets tend to worsen as they enter adolescence (Frazier-Wood, Banfield, Liu, Davis, & Chang, 2015). Adolescents tend to consume only about one-half of the U.S. recommendations for vegetables, whole grains, and fruits (Banfield, Liu, Davis, Chang, & Frazier-Wood, 2016). In addition, adolescents tend to skip meals, especially breakfast, and drink less milk (Stang & Stotmeister, 2017; Vikraman, Fryar, & Ogden, 2015). One nationally representative sample of over 11,000 high school students showed that girls and Black and Hispanic adolescents are more likely to skip breakfast than boys and White non-Hispanic adolescents (Demissie, Eaton, Lowry, Nihiser, & Foltz, 2018). Skipping breakfast increased over high school, with eleventh- and twelfth-grade students more likely to skip breakfast than ninth- and tenth-grade students.

Fast food consumption tends to increase over adolescence and is associated with lower consumption of fruits and vegetables (Gopinath et al., 2016; Stang & Stotmeister, 2017). Fast food is high in calories; when adolescents eat a fast food meal, they do not appear to adjust their other meals to make up for the excess calories and instead consume more calories overall (Bowman, Gortmaker, Ebbeling, Pereira, & Ludwig, 2004). When a fast food restaurant is near school, students in the United States, United Kingdom, Australia, and Finland show more irregular eating

habits, greater consumption of fast food, and higher rates of overweight and obesity (Janssen, Davies, Richardson, & Stevenson, 2018; Virtanen et al., 2015).

Family meals are an important way of establishing healthy eating habits. At home, U.S. children and adolescents who eat an evening meal with their parents tend to have healthier diets that include more fruits and vegetables and they tend to have a lower BMI than their peers who do not share family meals (Watts, Loth, Berge, Larson, & Neumark-Sztainer, 2017). Young people who participate in preparing and eating family meals at least once or twice a week tend to have healthier eating habits 5 years later, from early to middle adolescence through young adulthood (Berge et al., 2015; Berge, MacLehose, Larson, Laska, & Neumark-Sztainer, 2016). Research with families in the Netherlands, Poland, Portugal, and the United Kingdom suggests that family meals are associated with healthier eating habits and enhanced self-control over eating (de Wit et al., 2015). However, the frequency of family dinnertimes drops sharply between ages 9 and 14, and family dinners have become less common in recent decades (Walton & Spencer, 2009; Walton et al., 2016). When family meals are irregular, parents can encourage healthy eating by educating adolescents about nutrition, providing access to fruits and vegetables in the home, and modeling fruit and vegetable consumption and healthy eating habits (Watts et al., 2017).

Physical Activity and Exercise

Regular physical activity is an important component to health throughout life. In adolescence, physical activity promotes cardiovascular health, muscle strength, motor control, cognitive performance, mental health,

and well-being (Esteban-Cornejo, Tejero-Gonzalez, Sallis, & Veiga, 2015; McMahon et al., 2017). Physical activity tends to decline beginning in middle childhood, at about age 7 (Farooq et al., 2018). Although some teens engage in competitive sports, average levels of physical activity decrease throughout adolescence, and many adolescents do not engage in regular exercise or activity (Dumith, Gigante, Domingues, & Kohl, 2011; Farooq et al., 2018). Most adolescents in the United States do not meet the federal recommendations of at least 60 minutes of moderate to vigorous physical activity every day. It is estimated that only about 8% of 12- to 15-year-old adolescents are active for 60 minutes per day on at least 5 days per week (Kann et al., 2014). Schools play a role in promoting physical fitness through physical education classes. Yet participation in physical education is highest among students in ninth grade, decreases among tenth- and eleventh-grade students, and is lowest among twelfth-grade students (Kann et al., 2014).

Longitudinal research with U.S. adolescents has shown that the reductions in physical activity during adolescence are consistent across contextual settings, whether rural or urban, and across SES (Metcalf, Hosking, Jeffery, Henley, & Wilkin, 2015). Adolescents of low SES are more likely to be sedentary and obese than their more affluent peers; this holds true for adolescents from a variety of developed nations, such as Canada, England, Finland, France, and the United States (Frederick, Snellman, & Putnam, 2014; Mielke, Brown, Nunes, Silva, & Hallal, 2017; Wang & Lim, 2012). Socioeconomic disparities may be influenced by opportunities for physical activity, such as the availability of safe parks and outdoor spaces, and opportunities for extracurricular activities in the school and community (Watts, Mason, Loth, Larson, & Neumark-Sztainer, 2016). After-school and community sports teams, for example, may be more prominent and available in middle income and affluent communities.

Obesity

Child and adolescent obesity has doubled in prevalence since the 1970s (Lobstein et al., 2015). Health care professionals determine whether someone's weight is in the healthy range by examining BMI, calculated as weight in kilograms/height in meters squared (kg/m^2 ; World Health Organization, 2009). **Overweight** is defined as having a BMI at or above the 85th percentile for height and age, as indicated by the 2000 Centers for Disease Control and Prevention growth charts, and **obesity**

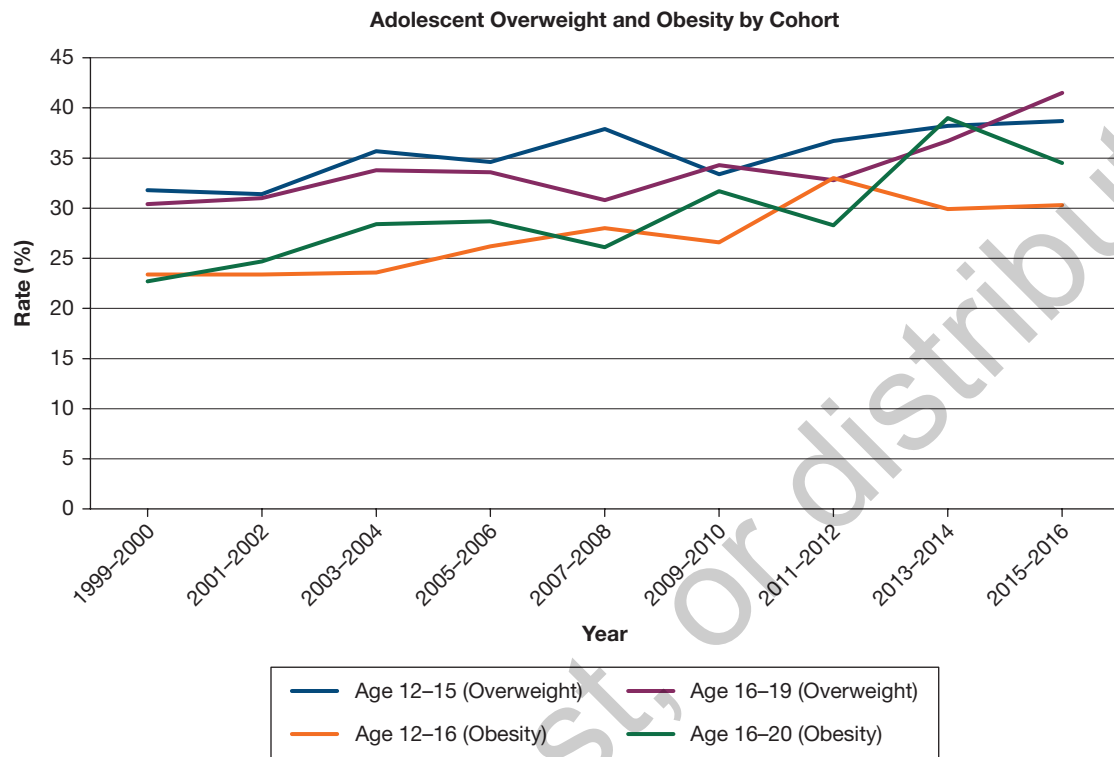


Family meals are associated with healthier eating habits in adolescence and young adulthood.

iStock.com/monkeybusinessimages

FIGURE 2.6

Overweight and Obesity in Adolescents Age 12 to 20, 1999–2016



Source: Skinner et al. (2018).

refers to a BMI at or above the 95th percentile (Skinner, Ravanbakht, Skelton, Perrin, & Armstrong, 2018; Skinner & Skelton, 2014). As shown in Figure 2.6, overweight and obesity become more common with age and the prevalence of each has increased since 1999.

Rising rates of overweight and obesity among adolescents are a problem not only in the United States but also in all other developed nations, including Australia, Canada, Denmark, Finland, Germany, Great Britain, Ireland, Japan, Hong Kong, and New Zealand (de Onis, Blössner, & Borghi, 2010; Janssen et al., 2005; Lobstein et al., 2015; Wang & Lim, 2012). Obesity is also becoming more common in developing nations, such as India, Pakistan, and China, as they adopt Western-style diets higher in meats, fats, and refined foods and as they show the increased snacking and decreased physical activity linked with watching television (Afshin, Reitsma, & Murray, 2017).

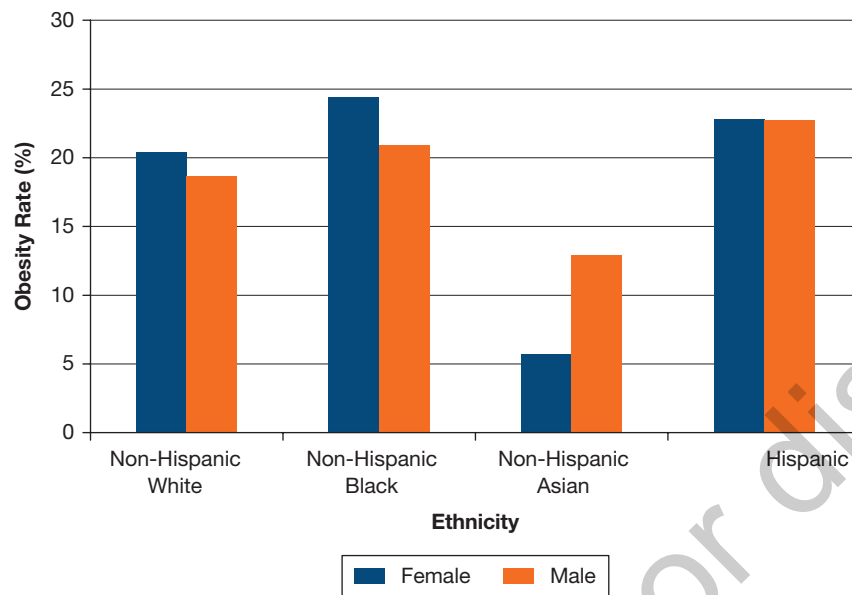
As shown in Figure 2.7, rates of obesity vary by race and ethnicity. Black and Hispanic youth show higher rates of obesity than non-Hispanic White youth and non-Hispanic Asian youth (Ogden et al., 2016). A BMI signifying overweight and obesity is generally more likely among girls, regardless of race or ethnicity. Considering both race and ethnicity, Black girls

generally show higher rates of overweight and obesity than girls and boys of all ethnicities. Race and ethnicity tend to be interwoven with other contextual factors that may influence adolescents' health and BMI, such as socioeconomic status.

Generally speaking, adolescents in low SES homes are at higher risk for obesity than their peers who live in high SES homes (Chung et al., 2016). This holds true for adolescents from a variety of countries, such as Canada, England, Finland, France, Czechoslovakia, Australia, and the United States (Frederick, Snellman, & Putnam, 2014; Hardy et al., 2017; Sigmund et al., 2018; Wang, Jackson, Zhang, & Su, 2012; Wang & Lim, 2012). Research with North American youth suggests a complex relation between socioeconomic status and obesity. One longitudinal study of over 4,800 U.S. fifth- through seventh-grade students showed that those with the highest socioeconomic status were less likely to be obese than their peers at both time points (Fradkin et al., 2015). However, when ethnicity was considered, this pattern was confirmed for Latinx and White adolescents, but not Black adolescents. Growing up in a high SES home was associated with a lower risk of obesity in Latinx and White adolescents but was unrelated to obesity in African American

FIGURE 2.7

Prevalence of Obesity in U.S. Adolescents (Age 12–19), by Sex, Race, and Ethnicity, 2011–2014



Source: Ogden et al. (2016).

adolescents. Thus, the health advantage associated with higher parental education and income may not apply consistently to boys and girls across all ethnic groups. Influences on young people's health, such as socioeconomic status, must be considered within the context of the broader social and physical environments in which youth live (Schreier & Chen, 2013). For example, the African American adolescents in the above study were less likely to report weight loss attempts than their peers (Fradkin et al., 2015). Cultural depictions of beauty may rival other contextual influences such as SES.

Other research suggests that genetic and contextual factors interact to influence BMI (Albuquerque, Nóbrega, Manco, & Padez, 2017; Goodarzi, 2018). For example, the effects of SES may vary with individuals' genetic predispositions. In one study, early adolescents who were carriers of a particular allele of the *OXTR* gene had greater BMI when reared in low SES environments but had the lowest BMI when reared in high SES homes (Bush et al., 2017). We are just beginning to examine the complex interactions among biology and context on obesity.

Contextual factors in the home and community, such as family dinners, the availability of healthy foods, and parks and opportunities for physical activity, are associated with nutrition, health eating, and exercising. Behavioral factors, specifically sedentary activities such as screen time—time spent in

front of a television, computer, or electronic device screen watching videos, playing video games, and engaging with social media are risk factors for overweight and obesity in U.S., U.K., and Canadian adolescents (Herman, Hopman, & Sabiston, 2015; Mitchell, Rodriguez, Schmitz, & Audrain-McGovern, 2013a; Pearson et al., 2017). It is estimated that American adolescents spend over 11 hours each day in front of a screen (American Academy of Pediatrics & American Academy of Pediatrics Council on Communications and Media, 2013; Rideout, 2010).

Obesity in adolescence is a serious problem because the majority of obese youngsters, about 80%, do not outgrow obesity but instead become obese adults (Simmonds, Llewellyn, Owen, & Woolcott 2016). Adolescent obesity is associated with short- and long-term health problems, including heart disease, high blood pressure, orthopedic problems, and diabetes (Pulgarón, 2013). Obese adolescents are at risk for peer rejection, depression, low self-esteem, and body dissatisfaction (Gibson et al., 2008; Harrist et al., 2016; Pulgarón, 2013; Quek, Tam, Zhang, & Ho, 2017). Obese adolescents of all ethnicities are likely to report being teased or bullied at school (Bucchianeri, Eisenberg, & Neumark-Sztainer, 2013) and are likely to experience weight-related stigma from adults and peers (Pont, Puhl, Cook, & Slusser, 2017). The social correlates of overweight and obesity, such as weight-related teasing, hold long-term implications. Adolescents who

are teased about their weight are more likely to have unhealthy eating habits and be overweight or obese as adults, 15 years later (Puhl et al., 2017). Moreover, weight-related stigma is associated with a variety of risk behaviors, including substance use, sexual risk-taking, and violence (Farhat, 2015).

Programs that effectively reduce obesity in adolescents target their screen time, increase their physical activity and time spent outdoors, and teach them about nutrition, reducing their consumption of high-calorie foods and increasing their consumption of fruits and vegetables (Bleich, Segal, Wu, Wilson, & Wang, 2013; Kumar & Kelly, 2017; Lobstein et al., 2015; Nowicka & Flodmark, 2007). For example, effective school programs couple education with opportunities to engage in an after-school exercise program (Pbert et al., 2016). At home, parents can increase the availability of healthy foods, discuss nutrition and health, and model healthy eating and an active lifestyle.

Eating Disorders

Adolescents' rapidly changing physique, coupled with media portrayals of the ideal woman as thin with few curves, leads many to become dissatisfied with their body image and the dissatisfaction often persists into emerging adulthood (Benowitz-Fredericks, Garcia, Massey, Vasagar, & Borzekowski, 2012). Girls who have a negative body image are at risk of developing **eating disorders**, mental disorders that are characterized by extreme over- or under-control of eating and behaviors intended to control weight such as compulsive exercise, dieting, or purging (American Psychiatric Association, 2013). Eating disorders, such as **anorexia nervosa**, **bulimia nervosa**, and **binge eating disorder**, pose serious challenges to health.

Anorexia Nervosa and Bulimia Nervosa

Anorexia nervosa and bulimia nervosa are both characterized by excessive concern about body weight and attempts to lose weight. However, they differ in how this concern is manifested. Those who suffer from anorexia nervosa starve themselves and sometimes engage in extreme exercise in order to achieve thinness and maintain a weight that is substantially lower than expected for their height and age (American Psychiatric Association, 2013). A distorted body image leads youth with anorexia to perceive themselves as "fat" despite their emaciated appearance, and they continue to lose weight (Gila, Castro, Cesena, & Toro, 2005; Hagman et al., 2015). Anorexia affects about 2% of girls 19 and younger; however, many more girls show similar poor eating behaviors (Smink, van Hoeken, & Hoek, 2013; Smink, van Hoeken, Oldehinkel, & Hoek, 2014).



Adolescents' rapidly changing physique is sometimes accompanied by body dissatisfaction and a distorted body image. iStock.com/ronstik

Bulimia nervosa is characterized by recurrent episodes of *binge eating*—consuming an abnormally large amount of food (thousands of calories) in a single sitting coupled with a feeling of being out of control—followed by *purging*, inappropriate behavior designed to compensate for the binge, such as vomiting, excessive exercise, or use of laxatives (American Psychiatric Association, 2013). Individuals with bulimia nervosa experience extreme dissatisfaction with body image and attempt to lose weight, but they tend to have a body weight that is normal or high-normal (Golden et al., 2015). Bulimia is more common than anorexia, affecting between 1% and 5% of females across Western Europe and the United States (Kessler et al., 2013; Smink et al., 2014) and many more young people show symptoms of bulimia but remain undiagnosed (Keel, 2014).

Both anorexia and bulimia pose serious health risks. Girls with anorexia may lose 25% to 50% of their body weight (Berkman, Lohr, & Bulik, 2007). They may not experience menarche or may stop menstruating because menstruation is dependent on maintaining at least 15% to 18% body fat (Golden et al., 2015). Starvation and malnutrition not only contribute to extreme sensitivity to cold and to growth of fine hairs all over the body; they can also have serious health consequences such as bone loss, kidney failure, heart and brain damage, and even death (Golden et al., 2015; Reel, 2012). Side effects of bulimia nervosa include nutritional deficiencies. Repeated exposure to stomach acid causes tooth damage, ulcers and even holes in the mouth and esophagus, as well as an increased risk of cancers of the throat and esophagus (Katzman, 2005).

Anorexia and bulimia occur more often in both identical twins than in fraternal twins, indicating a genetic component (Bulik, Kleiman, & Yilmaz, 2016; Strober, Freeman, Lampert, Diamond, & Kaye, 2014). These disorders are more common in girls than boys, with a prevalence of about 6% compared with about 1%

(Raevuori, Keski-Rahkonen, & Hoek, 2014). Girls who compete in sports and activities that idealize lean figures, such as ballet, figure skating, gymnastics, and long-distance running, are at higher risk for disordered eating than are other girls (Nordin, Harris, & Cumming, 2003; Voelker, Gould, & Reel, 2014). Anorexia nervosa is associated with perfectionism and strict regulation of eating, and thus it may be viewed as a way to exert control and reduce negative mood states (Kaye, Wierenga, Bailer, Simmons, & Bischoff-Grethe, 2013; Tyrka, Graber, & Brooks-Gunn, 2000). Anorexia nervosa and bulimia nervosa are associated with altered neural activity in several limbic system structures and parts of the prefrontal cortex, responsible for aspects of emotion, rewards, and decision-making (Fuglset, Landrø, Reas, & Rø, 2016; Monteleone et al., 2018; Wang et al., 2017).

Anorexia nervosa and bulimia nervosa occur in all ethnic and socioeconomic groups in Western countries and are increasingly common in Asian and Arab cultures (Isomaa, Isomaa, Marttunen, Kaltiala-Heino, & Björkqvist, 2009; Keski-Rahkonen & Mustelin, 2016; Pike, Hoek, & Dunne, 2014; Thomas et al., 2015). In the United States, White and Latina girls, especially those of higher socioeconomic status, are at higher risk for low body image and eating disorders than are Black girls, who may be protected by cultural and media portrayals of African American women that value voluptuous figures (Smink et al., 2013). Some researchers suggest, however, that ethnic differences in eating disorders are not as large as they appear. Instead, eating disorders may exist in Black girls but remain undetected and undiagnosed because of barriers to diagnosis and treatment (Wilson, Grilo, & Vitousek, 2007). This is supported by research with adult women suggesting that the prevalence of anorexia nervosa is similar, but bulimia nervosa is more common in African American and Latina women than in White women (Marques et al., 2011). In addition, lesbian, gay, and bisexual (LGB) youth report higher rates of dangerous eating behaviors, such as fasting, using diet pills, and purging to control weight, than their heterosexual peers (Watson, Adjei, Saewyc, Homma, & Goodenow, 2017b). The experience of stigma and discrimination is associated with higher rates of disordered eating behaviors in LGB youth, whereas social support and connections to family, school, and peers are associated with lower levels of disordered eating (Watson et al., 2017b).

Anorexia nervosa and bulimia nervosa are difficult to treat. Research following adolescents over time suggests continuity in disordered eating patterns. In some studies, as many as three-quarters of adolescents diagnosed with an eating disorder continued to show symptoms 5 years later (Ackard, Fulkerson, & Neumark-Sztainer, 2011; Herpertz-Dahlmann et al., 2015). Standard treatment for anorexia includes hospitalization to remedy malnutrition and ensure weight gain, anti-anxiety or antidepressant medications, and individual and

family therapy (Herpertz-Dahlmann, 2017). Therapy is designed to enhance girls' motivation to change and engage them as collaborators in treatment, providing them with a sense of control. Unfortunately, girls with anorexia tend to deny that there is a problem because they are unable to objectively perceive their bodies and they value thinness and restraint, making anorexia very resistant to treatment (Berkman et al., 2007). As a result, only about 50% of girls with anorexia make a full recovery and anorexia nervosa has the highest mortality rate of all mental disorders (Smink et al., 2013).

Bulimia tends to be more amenable to treatment because girls with bulimia often acknowledge that their behavior is not healthy. Girls with bulimia tend to feel guilty about bingeing and purging and are more likely than those with anorexia to seek help. Individual therapy, support groups, nutrition education, and anti-anxiety or antidepressant medications are the treatments of choice for bulimia nervosa (Hay & Bacaltchuk, 2007; le Grange & Schmidt, 2005). Individual and family-based therapy helps girls become aware of the thoughts and behaviors that cause and maintain their bingeing and purging behaviors, which decreases binge eating and vomiting and reduces the risk of relapse (Lock, 2011; Smink et al., 2013).

Binge Eating Disorder

It's not uncommon for people to use the word "binge" in reference to their eating (e.g., "I totally binged on pizza!"). Binge eating disorder, however, is not simply overeating. Binge eating is uncomfortable. It refers to eating an amount of food much larger than a similar person would eat in a discrete period (such as 2 hours). More important, it is associated with a sense of feeling out of control, as if one cannot stop or control what one is eating. The person eats more quickly, even when not hungry, and feels uncomfortably full. Binge eating typically occurs in private, out of embarrassment, and tends to be accompanied by a sense of guilt, shame, self-disgust, and depression afterward. Notably, the binge eating is not accompanied by compensatory behavior, such as exercising or purging, as with bulimia nervosa (Campbell & Peebles, 2014). Binge eating disorder is diagnosed when binges occur at least once a week for 3 months.

Binge eating disorder is the most prevalent eating disorder and may affect up to 5% of adolescents (Marzilli, Cerniglia, & Cimino, 2018). Although most research has examined adolescent girls, binge eating disorder may occur in 1% to 2% of boys. Similar rates of binge eating are seen in adolescents of all ethnicities (Rodgers, Watts, Austin, Haines, & Neumark-Sztainer, 2017). Binge eating disorder emerges more frequently in early adolescence and in emerging adulthood (Marzilli et al., 2018). Binge eating disorder often persists from adolescence into emerging adulthood

and even into middle adulthood (Goldschmidt, Wall, Zhang, Loth, & Neumark-Sztainer, 2016).

Like other eating disorders, binge eating disorder is associated with internalizing thin body ideals, body dissatisfaction, dieting, and negative affect (Stice, Gau, Rohde, & Shaw, 2017). Experiencing negative emotions may increase the risk for binge eating, as high-calorie “comfort” foods may become more rewarding and enticing and binge eating may be rewarding and improve mood (Lavender et al., 2016). Binge eating is associated with chronic abdominal pain, obesity, diabetes, and other health problems associated with obesity, as well as anxiety, depression, and suicidality (Ágh et al., 2016; Forrest, Zuromski, Dodd, & Smith, 2017; Micali et al., 2015). Treatment for binge eating disorder addresses eating behaviors, patients’ weight and shape concerns, and psychological conditions such as anxiety and depression (Berkman et al., 2015). A combination of medication and behavioral training can help adolescents with binge eating disorder manage emotions and learn long-term behavioral strategies for coping with strong emotions and drives.

Mortality

Although adolescence is a generally healthy time in which young people tend to report good or excellent health and low rates of illness, mortality, the death rate, rises in adolescence (Kochanek, Murphy, Xu, & Arias, 2017; U.S. Department of Health and Human Services, 2017). Adolescent mortality is largely influenced by

the risky behavior that is common in adolescence and accompanies neurological development.

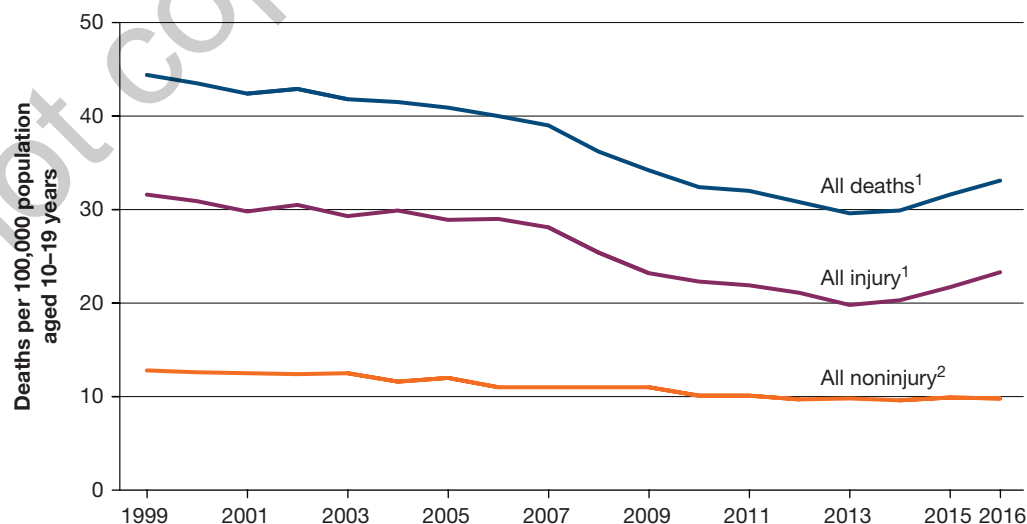
As shown in Figure 2.8, adolescent mortality showed an overall decline between 1999 and 2016 but has increased 12% since 2013. The increase in mortality is attributable to a rise in injury-related deaths. Specifically, about 70% of deaths of adolescents age 10 to 19 in 2016 were due to fatal injuries caused by unintentional injury (accident), suicide, and homicide. Each of these types of fatal injuries declined in prevalence from 1999 through 2013 and has since increased (Curtin, Heron, Miniño, & Warner, 2018). Boys and girls show similar patterns in death rates, with boys consistently showing about twice the mortality rate as girls.

As shown in Figure 2.9, older adolescents age 15 to 19 show higher rates of injury-related deaths than those age 10 to 14, but emerging adults age 20 to 24 show the highest rates of injury-related deaths. Fatal injuries—specifically, traffic accidents, suicide, unintentional poisoning, and homicide—remain the leading causes of death, respectively, into emerging adulthood.

Ethnic differences in mortality emerge in late adolescence, in both death rates and causes of fatal injuries. As shown in Figure 2.10, Black adolescents show dramatically higher rates of death by homicide than their peers. American Indian and Alaskan Native adolescents show the highest rates of unintentional injury and suicide as compared with other adolescents (Ballesteros, Williams, Mack, Simon, & Sleet, 2018). White non-Hispanic adolescents show higher rates of suicide than Black, Hispanic, and Asian

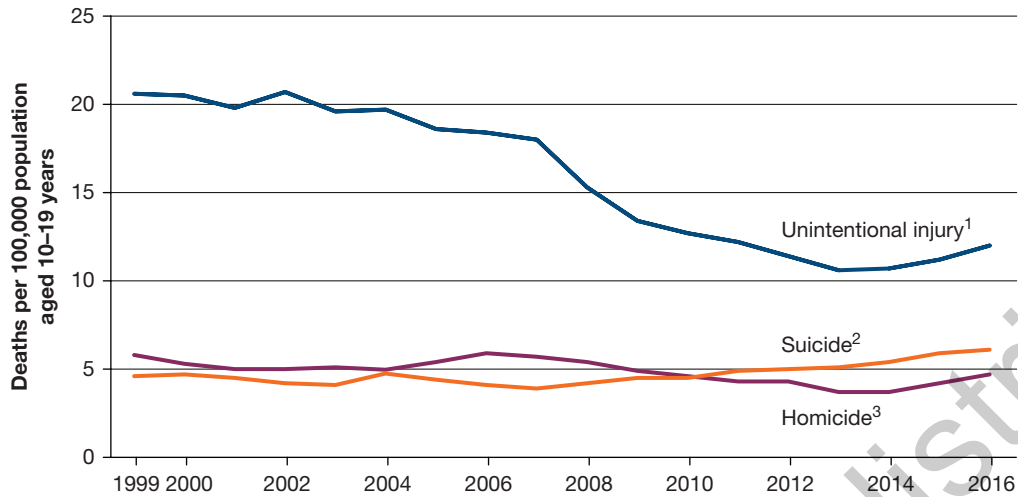
FIGURE 2.8

Total Injury and Noninjury Death Rates for Children and Adolescents Aged 10 to 19 Years: United States, 1999–2016



(Continued)

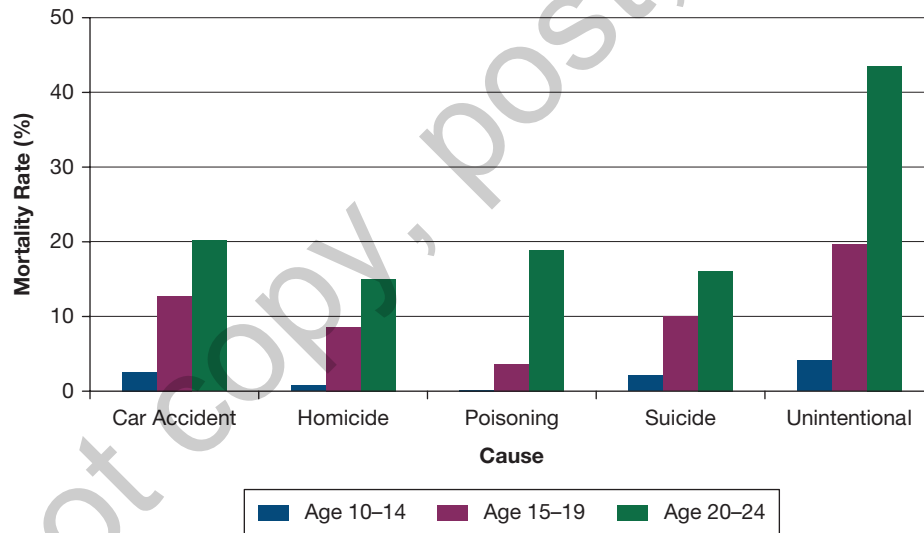
FIGURE 2.8 (Continued)



Source: Curtin et al. (2018).

FIGURE 2.9

Fatal Injuries in Adolescence and Emerging Adulthood, 1999–2016



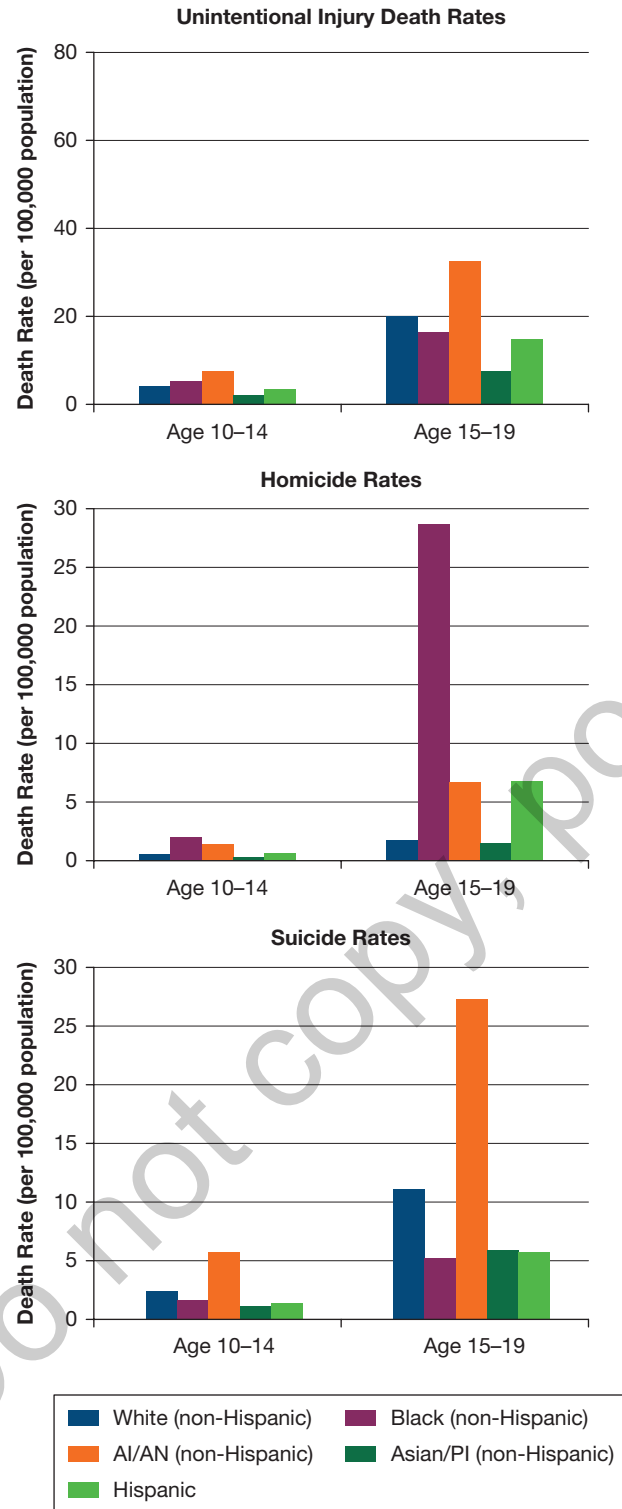
Source: Centers for Disease Control and Prevention (2017).

American and Pacific Islander American adolescents. Contextual factors contribute to ethnic differences in mortality rates during adolescence. Specifically, socioeconomic status and community factors place Black and American Indian/Alaskan Native youth, who are disproportionately at risk to live in low SES homes and communities, at risk for higher rates of mortality. Economic disadvantage is one of the most robust predictors of violence, especially in urban settings (Stansfield, Williams, & Parker, 2017). Violence

by Black adolescents may be fueled by insufficient home and neighborhood resources and exposure to violence and discrimination in the community (Rojas-Gaona, Hong, & Peguero, 2016). American Indian/Alaskan Native adolescents also experience high levels of poverty. The perception of discrimination, difficulty acculturating or integrating native customs and beliefs with popular culture, and feeling marginalized contribute to higher rates of suicide in American Indian/Alaskan Native adolescents (Jaramillo, Mello,

FIGURE 2.10

Fatal Injuries Among Youth Aged 10–19 Years, by Intent and Race, National Vital Statistics System, United States, 2013–2015



Source: Ballesteros et al. (2018).

& Worrell, 2016; Wyatt, Ung, Park, Kwon, & Trinh-Shevrin, 2015).

Health Promotion

The health behaviors established in adolescence tend to last well into adulthood. As a result, there is a growing emphasis on promoting healthy habits by improving access to health care and educating adolescents about health.

Health Care Access

Over the course of adolescence into emerging adulthood, young people become less likely to use health services. One recent study examined health care use by children, adolescents, and adults after the implementation of the Affordable Care Act in 2010, U.S. federal legislation designed to improve access to health insurance coverage (Spencer et al., 2018). From 2010 to 2016, rates of uninsured adolescents dropped from 8% to 5% in early adolescence (age 10 to 14) and 12% to 8% in late adolescence (age 15 to 18). The most dramatic changes were observed among emerging adults (age 19 to 25), dropping to 14% uninsured in 2016 from 34% in 2010. At all ages, but especially in emerging adulthood, young people were more likely to report having a regular source of medical care and having had a doctor or provider visit and in the past years, and they were less likely to report having unmet health needs in 2016 than in 2010. These findings suggest that improving access to health care can improve young people’s use of health resources, with benefits for their health.

There are large economic disparities in health care access. Adolescents of color, especially those from low SES homes and communities, experience more difficulties with health care access than White adolescents (Yoshikawa, Aber, & Beardslee, 2012). Recent research suggests that sexual minority adolescents may be less likely to use health services than their heterosexual peers. For example, in one study, males who reported same-sex, bisexual, and questioning orientations (collectively referred to as sexual minority adolescents) were three times as likely as heterosexual males to report unmet medical needs in the past year (Luk, Gilman, Haynie, & Simons-Morton, 2017). Girls with a same-sex, bisexual, or questioning orientation were nearly twice as likely to have no routine checkup in the past year relative to heterosexual adolescents. Sexual minority adolescents are more likely than their heterosexual peers to report concerns discussing sexuality with health care providers (Fuzzell, Fedesco, Alexander, Fortenberry, & Shields, 2016). Some sexual minority adolescents report the sense that doctors seem uncomfortable discussing sexuality with them and feel isolated by noninclusive language used in the



Health care providers can play an important role in promoting adolescents' health literacy.

iStock.com/Rawpixel

office and in conversations. Overall, physicians tend to discuss sexual behaviors and attractions rarely relative to other physical health topics, regardless of their patients' sexual orientation (Fuzzell, Shields, Alexander, & Fortenberry, 2017). In fact, communication about sexual topics tends to most frequently mention contraception and rarely discusses sexual attractions and orientations. Health care providers may miss out on important opportunities for helping the young people they treat.

Health Literacy

Adolescents' conceptions of health and health-related attitudes are important influences on their behaviors and have implications for health in adulthood (Michaelson, Pickett, Vandemeer, Taylor, & Davison, 2016). **Health literacy** refers to the knowledge, skills, and attitudes about health and the ability to obtain, process, and understand health information to make appropriate health decisions (Ghaddar, Valerio, Garcia, & Hansen, 2012; Manganello, 2008). Health literacy holds implications for individuals' ability to influence their own and others' health. For example, individuals with low levels of health literacy show poorer health (Peralta, Rowling, Samdal, Hipkins, & Dudley, 2017).

Adolescents and adults may conceptualize health in different ways. Adults often evaluate health based on the presence or absence of self-limiting health problems, but adolescents may emphasize different factors (Peralta et al., 2017). Adolescents tend to focus on specific behaviors and psychological states such as physical activity, nutrition, sense of well-being, and specific behaviors such as not smoking. For example, one study of Canadian adolescents

born between 1995 and 2002 suggested that they viewed good health as individualized, different for everyone (Michaelson et al., 2016). They tended to explain that good health is subjective. Specifically, how one felt about one's health state and behaviors was considered fundamental in determining one's health. In this study, the majority of adolescents reported that their health was "good" or "excellent," despite often engaging in unhealthy behaviors, in line with the theme expressed by one participant: "You can be healthy without always being healthy." Adolescents may not accurately access their health.

Educators who seek to improve health literacy are challenged with teaching adolescents the basics of health, how their bodies work, and how to promote health, while balancing adolescents' preferred individualized views of health (Peralta et al., 2017). A customized view of health, recognizing that there are individual differences among adolescents, can help young people value individual differences in health needs and offer protection from unhealthy beliefs (e.g., that everyone's body should look the same) (Michaelson et al., 2016). However, a subjective one-size-does-not-fit-all approach to health can interfere with school and community health promotion efforts that educate students about universal influences on health, such as good nutrition and exercise, as well as the hazards of drug use. ●

REVIEW 2.5

1. What challenges do adolescents face in meeting their needs for nutrition and physical activity?
2. Identify influences on and correlates of overweight and obesity.
3. Distinguish among anorexia nervosa, bulimia nervosa, and binge eating disorder.
4. Discuss mortality and injury rates in causes of mortality in adolescence and emerging adulthood, including sex and ethnic differences.
5. How does health care access influence adolescent health and what is health literacy?

THINKING IN CONTEXT 2.5

1. How physically active were you as a child? Did you play a sport, ride a bike or skate, or play at a

playground? In what ways did your interests and activities change as you entered adolescence? Do your experiences match the finding that people often become less physically active in adolescence? Why or why not?

2. What are some of the influences that determine whether someone develops an eating disorder? Consider eating disorders from Bronfenbrenner's bioecological perspective (Chapter 1).
 - a. How might adolescents' physical, cognitive, and socioemotional development influence their eating and health habits and the likelihood of developing an eating disorder?
 - b. Identify factors at the microsystem and mesosystem levels that may influence the likelihood of developing an eating disorder. What role might interactions within the home, peer, and school context play?
 - c. How might exosystem factors influence the development of eating disorders?
 - d. What macrosystems are at play?

- e. Do you think these factors influence all three eating disorders (anorexia nervosa, bulimia nervosa, and binge eating disorder) in the same way? Explain.

APPLY 2.5

Imagine that you are a health teacher preparing a curriculum for middle school students.

1. What do they need to know about exercise and nutrition?
2. What should young adolescents know about eating disorders?
3. What other health information do you think is important to share?
4. How might you present this information?
5. Next, consider high school students. How might you present the material to older adolescents? Discuss similarities and differences in your approach.

CHAPTER SUMMARY

2.1 Summarize the physical changes that accompany puberty in boys and girls.

Puberty is the process by which adolescents become reproductively mature and it entails changes in growth and body shape, emergence of secondary sex characteristics, and, most importantly, maturation of primary sex characteristics. Adrenarche occurs prior to puberty, causing the adrenal glands to secrete low levels of testosterone that influence body growth and the development of body odor. Puberty is controlled by the hypothalamus-pituitary-gonadal axis, which influences and regulates hormone levels produced by the endocrine system. Puberty begins at about age 10 in girls and 12 in boys and the process lasts about 4 years, on average. Menarche, the onset of menstruation in girls, occurs on average at about age 13, with ethnic differences. Boys experience spermarche also at about age 13.

2.2 Describe adolescents' experience of puberty and its influence on their relationships with parents.

Girls' experience of puberty is influenced by their knowledge and expectations. The extent to which adolescents and parents discuss menarche and sexuality varies by context and culture. Less is known about boys' puberty, and their preexisting knowledge appears to influence their experience. With puberty, adolescents experience a shift in their preferred sleep schedule, or delayed phase preference. Sleep changes are also related to contextual factors, such as screen use and the home environment, and changes in sleep are associated with academic, health, and behavior problems. Puberty is associated with an increase in conflict and distance in

parent-child relationships, especially between adolescents and mothers, that may vary with ethnicity and sex.

2.3 Examine the effects of pubertal timing on adolescents.

Girls who show signs of physical maturation before age 8 (or 9 in boys) are considered early-maturing, whereas girls who begin puberty after age 13 (or 14 in boys) are considered late-maturing adolescents. Adolescents who mature off-time relative to their peers are often treated differently, with consequences for their development. Early-maturing boys and girls show higher rates of risky activity, including smoking, abusing alcohol and substances, and displaying aggressive behavior, than do their same-age peers, perhaps because they tend to seek relationships with older peers. Early maturation is particularly challenging for girls. Early-maturing girls tend to feel less positive about their bodies and show higher rates of depression, anxiety, sexual harassment, and dating violence than do girls who mature on time or late. Early maturation has historically been viewed as advantageous for boys, but early-maturing boys may experience some internalizing and externalizing symptoms. Whereas late maturation has a protective effect on girls, it is associated with social and emotional difficulties in boys. Contextual factors, such as peers, the school context, and experience of stress, may amplify the effects of pubertal timing on behavior.

2.4 Analyze influences on pubertal timing.

Genetics plays a role in puberty, but puberty is a complex trait influenced by many genes that interact with contextual factors. Pubertal timing is similar in families, especially

in identical twins as compared to fraternal twins. Some children are genetically programmed to experience puberty earlier than others. Heredity sets the boundaries of pubertal timing, but the onset of puberty is also influenced by individual and contextual factors such as ethnicity, nutrition and health, exposure to stress, parenting, and socioeconomic status. Puberty is triggered by achieving a critical level of body weight, specifically body fat. Increases in the standard of living and average BMI among children in developed countries over the last century have led to a lowering of the average age of puberty with each generation, known as the secular trend.

2.5 Discuss common health problems in adolescence and ways of promoting health.

The adolescent growth spurt demands energy as adolescents' caloric demands increase. Yet adolescents' diets tend to worsen. Although some adolescents engage in competitive sports, average levels of physical

activity decline throughout adolescence and most adolescents in the United States do not meet the federal recommendations for physical activity. Obesity rates have increased over the past 4 decades, posing a variety of health problems. Several eating disorders become more common in adolescence, including anorexia nervosa, bulimia nervosa, and binge eating disorder. Mortality also rises in adolescence, most often due to a rise in injury-related death. Ethnic differences in mortality emerge in adolescence, in both death rates and causes of fatal injuries. Adolescents' health is also influenced by their access to health care. Over the course of adolescence, young people become less likely to use health services and there are large socioeconomic disparities in health care access. Health literacy refers to the knowledge, skills, and attitudes about health and the ability to obtain, process, and understand health information to make appropriate health decisions. Health literacy holds critical implications for adolescents' health and well-being.

KEY TERMS

adolescent growth spurt, 33

adrenarche, 32

anorexia nervosa, 47

binge eating disorder, 47

body mass index (BMI), 41

bulimia nervosa, 47

delayed phase preference, 36

eating disorders, 47

endocrine system, 32

estrogen, 32

gonadarche, 32

gonadotropin-releasing hormone (GnRH), 32

gonads, 32

health literacy, 52

hormones, 32

hypothalamus, 32

hypothalamus-pituitary-gonadal axis (HPG), 32

kisspeptin, 41

leptin, 41

melatonin, 36

menarche, 34

menstruation, 34

nocturnal emissions, 35

obesity, 44

overweight, 44

pituitary gland, 32

primary sex characteristics, 34

puberty, 31

secondary sex characteristics, 34

secular trend, 42

semen, 35

spermarche, 35

testes, 35

testosterone, 32