

## 12. Bridging the Gap between Research and Practice: What Will Adolescents' Sleep-Wake Patterns Look Like in the 21st Century?

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According to psychologists, sociologists, and educators, as well as anecdotal reports and stories from parents and teachers, adolescents growing up in the United States are portrayed as stormy, moody, persistent, entitled, self-centered, independent, and emotional. Sleep researchers, parents, and teachers have added that adolescents are frequently sleepy and exhausted. This intense developmental stage is marked by physiological, cognitive, emotional, and psychosocial changes. Among the host of changes that accompany adolescence are alterations in sleeping and waking patterns. During adolescence, quality, quantity, and timing of sleep are influenced by changing academic demands, new social pressures, altered parent-child relationships, and increased time spent in part-time jobs, extracurricular activities, and sports. Likewise, the way adolescents sleep critically influences their ability to think, behave, and feel throughout adolescence. Researchers have documented that adolescents growing up in the late 1990s and early part of this decade are not getting enough sleep; however, countermeasures have not been developed to reverse this trend.

Although sleep consumes approximately one-third of our lives (50% at early school age), it is often ignored by developmental psychologists,

pediatricians, educators, and others who devote their lives to working with children and adolescents. For example, sleep is rarely mentioned in textbooks on adolescent development, child-adolescent sleep topics are infrequently presented at the Society for Research on Child Development meetings (3% of presentations at the 1995 biennial SRCDD meeting), and pediatricians get very little training in sleep medicine. This chapter examines current knowledge of the factors that influence adolescents' sleep-wake patterns and discusses how adolescent sleep researchers, school administrators, health care providers, and policy makers must bridge the research-practice gap so that adolescents can be alert (not sleep-deprived) and successful in school.

Philosophers, psychologists, and other theorists throughout history, such as Aristotle, John Locke, G. Stanley Hall, and Carol Gilligan (Brown & Gilligan, 1992), have viewed the transition or crossroads from childhood to adulthood as a time of vulnerability as well as an opportunity for developing a life-style that promotes health, physical and psychological well-being, and empathy. They argued that special attention should be given to helping and supporting adolescents through this period so that they can become healthy and successful adults. Unfortunately, over the past several decades adolescents have been viewed with disrespect, disregard, and antagonism. More than 30 years ago, U.S. teenagers were seen as idealistic. In contrast, currently they are viewed as one of the main roots of our nation's social ills (e.g., drug abuse, juvenile crime, teen pregnancy, gangs, violence). This chapter argues that one explanation for adolescents' academic difficulties, behavior problems, and disengagement from school relates to society's reinforcement of irregular and short sleep-wake schedules through early morning school start times and pressure to work long hours after school. Data suggest that adolescents are starting school at increasingly earlier times, working increasingly longer hours after school, and sleeping fewer hours than in the past. If this trend continues, teenagers will have difficulty successfully negotiating the transition into adulthood. We must focus on how to make things more manageable for adolescents as opposed to setting up systems that are likely to promote failure.

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Throughout this chapter I refer to a large-scale survey study that my colleagues and I (Acebo, Wolfson, & Carskadon, 1997; Wolfson & Carskadon, 1998) conducted in the fall of 1994. Some of the findings have been reported in other papers (Acebo et al., 1997; Wolfson et al., 1998), whereas some of the data discussed here has not been presented

previously. Specifically, an eight-page sleep habits survey was administered to 9th–12th grade students in four public high schools from three districts in the Providence metropolitan area with a response rate of 88%. The four schools had start times between 7:10 and 7:20 A.M. The survey was completed anonymously by 3,120 (48% boys, 52% girls). The students' ages ranged from 13 to 19. More than 91% of the students from schools A, C, and D noted that they were Caucasian, whereas school B was more diverse (75% Caucasian, 25% multiracial). Students from all four schools reported that 81% to 85% of their mothers and fathers were employed. The survey items queried students about usual sleeping and waking behaviors over the past two weeks (e.g., total sleep, bedtimes and rise times, work, sports and study hours, depressed mood, daytime sleepiness, academic performance, and substance use).

### Developmental Changes in Adolescents' Sleep

As described earlier in this book (Carskadon, Chapter 2 in this volume), there are striking changes in sleep-wake schedules, sleep quality and to total sleep times during adolescence. In the United States, parents, school administrators, and teenagers themselves have assumed that adolescents do not really need as much sleep as preadolescents. A myriad of surveys and field studies have shown that teenagers usually obtain much less sleep than school-age children, from 10 hours during middle childhood to less than 7 hours by age 17 (Williams, Karacan, & Hursch, 1974; Carskadon, 1982; Carskadon, 1990a; Allen, 1992; Wolfson & Carskadon, 1998). Furthermore, numerous studies have observed that adolescents tend to stay up increasingly later over the high school years, get up extremely early for school, and, as a result, get increasingly less sleep over the course of adolescence. For example, the 3,120 high school students surveyed in Rhode Island were getting only 7 hours, 20 minutes total sleep on school nights, and school-night and weekend total sleep decreased linearly across ages 13 to 19 by 40 to 50 minutes (Wolfson & Carskadon, 1998).

Although surveys document that teenagers are getting increasingly less sleep over the high school years, laboratory studies show that adolescents do not have a decreased need for sleep across puberty (Carskadon, Harvey, Duke, Anders, & Dement, 1980; Carskadon, Orav, & Dement, 1983; Carskadon, 1990a). In fact, Carskadon et al. (1980) clearly demonstrated that sleep quantity remained constant at approximately 9.2 hours across all pubertal stages.

### Sleep-Wake Patterns in the 21st Century

In addition, adolescents tend to delay their phase of sleep by staying up later at night and sleeping in later in the morning than preadolescents (Carskadon, Vieira, & Acebo, 1993; Dahl & Carskadon, 1995). One manifestation of this process is that adolescents' sleep patterns on weekends show a considerable delay (as well as lengthening) versus weekdays, with sleep onset and offset both occurring significantly later. This sleep phase shift is attributed to psychosocial factors and to biological changes that take place during puberty. For example, in the longitudinal study described earlier, as children reached puberty, they were less likely to wake up on their own and lab staff needed to wake them up (Carskadon et al., 1980). Carskadon et al. (1980) noted that they probably would have slept more than 9 hours if undisturbed.

Carskadon and her colleagues have shown that this adolescent tendency to phase delay may be augmented by a biological process accompanying puberty. Their group examined self-reported puberty scores (Carskadon & Acebo, 1993) and phase preference (morningness-eveningness) scores of over 400 pre- and early pubertal 6th graders (Carskadon, Vieira, & Acebo, 1993). These data documented that morning types reported going to bed earlier, rising earlier, and waking up spontaneously more often than evening types. In contrast, evening types were more likely to report staying up past 3:00 A.M. and sleeping past noon. Furthermore, pubertal 6th grade girls were more evening type than prepubertal 6th graders (Carskadon et al., 1993). Andrade, Benedicto-Silva, and Domenice (1993) and Ishihara, Homma, and Miyake (1990) also reported an adolescent delay of sleep phase in Brazilian and Japanese teenagers, respectively. A recent study examined the circadian timing system more directly in early adolescents by measuring the timing of melatonin secretion. Findings from this study led to the hypothesis that a developmental delay of circadian phase may occur in young humans (Carskadon, Richardson, Tate, & Acebo, 1997).

The changes from childhood to adolescence in sleep need, sleep-wake schedules, and circadian timing of sleep have several ramifications for the teenagers themselves, and for the context in which they live, attend school, work, and interact with their families. Although research suggests that the circadian phase delay and sleep needs of adolescents are similar across cultures, environmental constraints, such as school schedules, leisure time activities, and employment demands are highly culturally determined. In the next few sections, the relationship between sleep-wake patterns, school start times, and work schedule demands for U.S. teenagers are explored.

## Environmental Constraints That Affect Sleep-Wake Patterns

### *School Start Times*

Researchers of adolescent development have focused mainly on the ways in which adolescents' backgrounds and personal characteristics help or hinder them as they progress through the junior and senior high school years. In contrast, the social ecology approach emphasizes how social demography (e.g., single-sex schools, minority enrollment) and organizational characteristics (e.g., schedules, tracking, number of grades in the school) of the school influence adolescent behavior and development. Historically, schools have started early in the morning throughout the United States. Additionally, many U.S. school districts use a three- or four-bell schedule where high schools open first, followed by middle or junior high schools, and then elementary schools with one or two starting times (Nudel, 1993). In a preliminary survey of 40 high school schedules posted on the Internet from throughout the United States, 48% started at 7:30 A.M. or earlier, whereas only 12% started between 8:15 and 8:55 A.M. School districts claim that they have developed these schedules for a variety of reasons, such as bus schedules, parent work schedules, ideal learning times, and pressure from high school student employers. This early high school start time is a significant, externally imposed constraint on teenagers' sleep-wake schedules, for most teens waking up to go to school is neither spontaneous nor negotiable. In combination with factors such as late night activities or jobs, early morning school demands often significantly constrict the hours available for sleep. Szymczak, Jasinska, Pawlak, and Zwierzykowska (1993) followed Polish students ages 10 and 14 years for over a year and found that all slept longer on weekends and during vacations as a result of waking up later. These investigators concluded that the school duty schedule was the predominant determinant of waking times for these students. Similarly, several surveys of high school students found that students who start school at 7:30 A.M. or earlier obtain less total sleep on school nights due to earlier rise times (Carskadon & Mancuso, 1987; Allen & Mirabile, 1989; Allen, 1991; Wolfson & Carskadon, 1998). In a laboratory and field study, Carskadon and her colleagues evaluated the impact of a 65-minute advance in school start time on 25 9th graders across the transition to 10th grade (Carskadon, Wolfson, Tzischinsky, & Acebo, 1995; Wolfson, Tzischinsky, Brown, Darley, Acebo, & Carskadon, 1995). Specifically, junior high school started at 8:25 A.M. and high school started at 7:20 A.M. in this large urban school

district. The initial findings demonstrated that students slept an average of 40 minutes less in 10th grade compared with 9th grade due to earlier rise times, and they displayed an increase in the multiple sleep latency test (MSLT)-measured daytime sleepiness (laboratory measure of sleepiness described in Chapter 2; Carskadon, Dement, Mitter, Roth, Westbrook, & Keenan, 1986). In addition, evening-type students had more difficulty adjusting to the earlier start time than did morning types, and higher scores on an externalizing behavior problems scale (Youth Self-Report, Achenbach, 1991) were associated with less total sleep and later bedtimes (Brown et al., 1995; Wolfson et al., 1995).

### *Work Hours and Other After-School Activities*

Adolescents spend a significant portion of their time engaged in leisure activities and an even more substantial amount of time in the part-time labor force. In studying adolescence, social scientists have given primary attention to the family, school, and peer group as central contexts for development. Today, however, high school education and employment are simultaneous activities. In fact, the tendency for teenagers to work in the paid labor force has increased substantially in the past 20 years. According to the U.S. Department of Labor (1996), nearly 43% of 16- to 19-year-olds who are enrolled in school are also employed throughout the year. Although some high school students work only in the summer, nearly 90% of 11th and 12th graders in the National Survey of Families and Households who worked for pay worked for at least part of the academic year (Manning, 1990). Greenberger and Steinberg (1986) and Steinberg, Brown, and Dornbusch (1996) argued that high school students' employment is distinctly an American phenomenon. Moreover, middle-class high school students are more likely to work than students from economically disadvantaged homes (Greenberger & Steinberg, 1986).

Researchers looked at the short-term and long-term effects of working part-time while attending high school. A number of studies concluded that increased hours of work are correlated with lowered grade point averages (GPA), lowered sense of well-being and self-image, increased absenteeism, lateness, cutting classes, cheating, and the use of cigarettes, marijuana, and alcohol (Greenberger & Steinberg, 1986; Yamoor & Mortimer, 1990). Specifically, researchers demonstrated that students with lower GPAs are more likely to work and, therefore, have less time available for schoolwork (Wirtz, Rohrbeck, Channer, & Fraser, 1988). In contrast, Greenberger and Steinberg's (1986) survey of workers

in four California high schools pointed out that employment was associated with punctuality, dependability, and personal responsibility. Their study suggested that employed students maintain grades, even while working long hours, by manipulating their schedules to avoid courses that require a heavy time investment (e.g., math, science, foreign language). Similarly, D'Amico (1984) reported that students who work less than 20 hours per week are less likely to drop out of high school, and that long work hours depress grades for 10th and 11th graders but not 12th graders. Unfortunately, these studies did not assess the relationship between high school work hours and sleep-wake schedules. Teenagers who work more than 20 hours per week may avoid academically demanding courses, obtain poor grades, miss school, and exhibit other negative behaviors because they are exhausted from not getting enough sleep.

Adolescents are also not getting enough sleep because of after-school commitments to athletic teams and other activities. School schedules demand increasingly earlier rise times. At the same time, academic pressures, extracurricular activities, and work hours require later and later bedtimes. In an analysis of the 3,120 high school students from the Wolfson and Carskadon study (1998), it is clear that adolescents spend a large percentage of their time working for pay as opposed to studying, playing sports, participating in other extracurricular activities, or sleeping. Over the high school years, total work hours increased linearly across ages 13 to 19 from 11 hours to 22 hours, whereas participation in sports, extracurricular activities, and study hours changed minimally (see Figure 12.1). Steinberg et al. (1996) would argue that high school students are increasingly more disengaged from school and school-related activities.

Especially in 11th and 12th grade, work hours occupy a significant amount of the adolescent's time. Fifty-two percent of the 1,712 Rhode Island students in 11th and 12th grades reported that they hold part-time jobs, and 56% of those who work do so for 20 hours or more per week ( $M = 21.1$ ,  $SD = 10.0$ ). On average, males reported that they work 2 more hours than their female peers (21 vs. 19 hours). In comparison to this intense involvement in after school work hours, only 29% reported participating in sports ( $M = 9.2$ ,  $SD = 6.8$ ) and 28% were involved in extracurricular activities ( $M = 5.9$ ,  $SD = 5.8$ ). While 66% of the 11th and 12th graders reported that they spend time on homework and studying, the mean number of hours spent studying was only 7 hours, 8 minutes per week. In addition, 37% of these 11th and 12th graders are working 2 to 5 weekdays after school in the afternoon and/or evening hours.

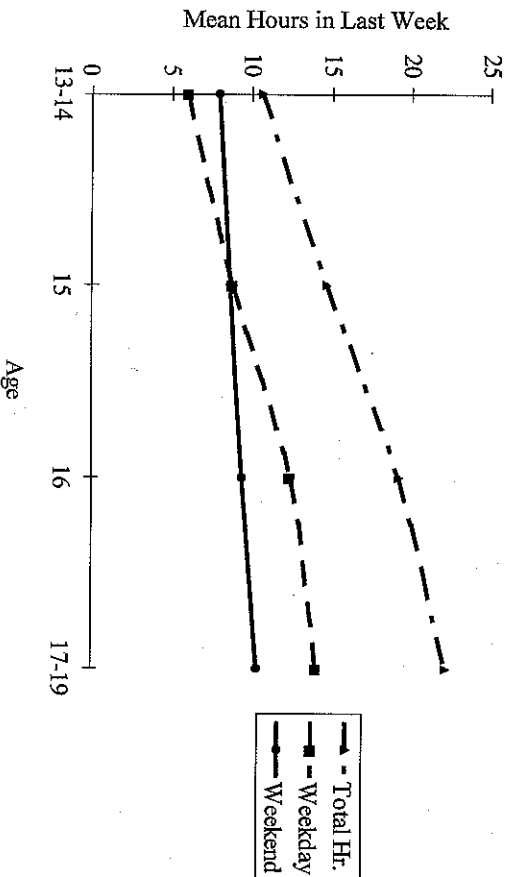


Figure 12.1. Hours spent working.

Obviously, outside of school hours, these juniors and seniors are spending their time in the work force. Hours working after school compete with time for doing homework and time for sleeping. Based on data from several studies (Carskadon, 1990b; Steinberg et al., 1996; Wolfson & Carskadon, 1998), an average 11th or 12th grader's weekday schedule would be similar to the schedule displayed here:

- 11:00 P.M. Bedtime
- 6:10 A.M. Rise time
- 7:00 A.M. Leaving home for school
- 7:30 A.M. School start time
- 2:30 P.M. School closing time
- 3:00 P.M. After school sports
- 5:00 P.M. Part-time job
- 9:30 P.M. Homework, socializing, television
- 11:00 P.M. Bedtime.

Carskadon (1990b) previously documented a relationship between hours spent at jobs, sleep patterns, and daytime sleepiness. These new data demonstrate that the 11th and 12th grade students who work 20 hours or more have more problematic sleep-wake habits than students who work less than 20 hours or who do not work at all. Specifically, the high-work group reported significantly less total sleep and later bedtimes on school nights (e.g., total median sleep time 6 hours, 57 minutes vs. 7 hours, 17 minutes). In addition, students working more

than one evening per week reported less school-night total sleep than students working during the day or not at all. The high-work group in the more recent sample as well as from the survey conducted in the late 1980s (Carskadon, 1990b) reported more symptoms of daytime sleepiness, such as more difficulty staying awake in classes or while studying; increased sleep-wake behaviors (e.g., arriving late to class due to oversleeping or feeling tired, dragged out, or sleepy during the day); and reported greater use of caffeine, alcohol or drugs, and tobacco. Figure 12.2 depicts the significant relationship between work status and scores on the sleep-wake behaviors scale (Carskadon, Seifer, & Acebo, 1991).

In both surveys, the high school students also reported being sleepy while driving a car (Carskadon, 1990b). In the 1994 data, 10% of the 11th and 12th graders who were spending 20+ hours per week versus 8% of those working less than 20 hours per week admitted to struggling to stay awake and/or having fallen asleep at the wheel. Adolescents who work more than 20 hours a week and/or have other time-consuming demands on their schedule are likely to develop a sleep-wake pattern of minimal sleep, excessive sleepiness, decreased alertness, and increased risk-taking behaviors (e.g., substance abuse, driving while tired).

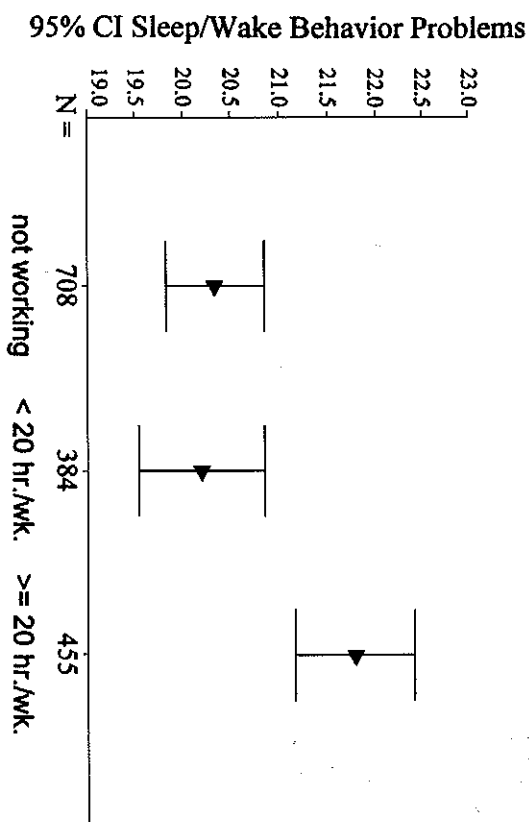


Figure 12.2. Sleep-wake behavior problems according to work status.

## Impact of Sleep-Wake Patterns on Adolescents' Quality of Life

### Academic Performance

When the United States is contrasted with other industrial nations, it has the lowest economic support for education, the lowest rate of parental involvement in schools, the poorest performance on high school achievement tests, and the lowest number of hours spent in school (Ravitch, 1995). Furthermore, sleepy adolescents – that is, those with inadequate sleep – seem to encounter increased academic difficulties. Wolfson and Carskadon's study of over 3,000 high school students (1998) found that high schoolers who described themselves as struggling or failing in school (i.e., obtaining Cs, Ds, and Fs) reported that they obtain less sleep, have later bedtimes, and more irregular weekday-weekend sleep schedules than students who report better grades (i.e., As, Bs). Other surveys of high school students reported that more total sleep, earlier bedtimes, and later weekday rise times were associated with better grades in school (Allen, 1992; Link & Ancoli-Israel, 1995; Manber et al., 1995). Epstein, Chlilag, and Lavie (1995) surveyed Israeli elementary, junior high, and senior high school students and reported that less total sleep time was associated with daytime fatigue, inability to concentrate in school, and a tendency to doze off in class. Persistent sleep problems have also been associated with learning difficulties throughout the school years (elementary through high school grades) (Quine, 1992). Studies of excessive sleepiness in children and adolescents due to delay phase sleep disorder, narcolepsy, or sleep apnea have also reported negative effects on learning, school performance, and behavior (Gullemineault, Winkle, & Korobkin, 1982; Dahl, Holttum, & Trubnick, 1994; Dahl & Carskadon, 1995). One explanation for these results is that students who get more sleep and maintain more consistent school and weekend sleep schedules obtain better grades because of their ability to be more alert and to pay greater attention in class and on homework.

### Emotional and Behavioral Well-Being

Research is in the early stages of investigating the complex relationship between adolescents' sleep patterns and their daytime behaviors. Although studies have concluded that associations between sleep-wake patterns and daytime functioning exist, the direction of this relationship is not clear. In addition, several of the studies have looked at younger children as opposed to adolescents. Inferences and conclusions



about sleep and daytime functioning in younger children may or may not apply to adolescents. Clinical experience shows that adolescents who have trouble adapting to new school schedules and other changes (e.g., new bed and rise times, increased activities during the day, increased academic demands) may develop problematic sleeping behaviors leading to chronic sleepiness. Several studies indicate an association between sleep, stress and emotional well-being. For example, studies have found that sleep-disturbed elementary school-age children experience a greater number of stresses (e.g., maternal absence due to work or school; family illness or accident; maternal depressed mood) than non-sleep-disturbed children (Kataria, Swanson, & Trevathan, 1987). Likewise, sleepy school-age children may have poorer coping behaviors (e.g., more difficulty recognizing, appraising, and adapting to stressful situations) and display more behavior problems at home and in school (Fisher & Rinehart, 1990; Wolfson et al., 1995).

In the Rhode Island survey of over 3,000 high school students, many of the teenagers complained about feeling depressed, fatigued, and falling asleep in classes and noted that they used a variety of mood-altering substances. Specifically, 51% of the 9th through 12th graders reported that they feel tired or dragged out nearly every day, 30% rarely had a good night's sleep in recent weeks, 27% admitted that they fell asleep and/or struggled to stay awake while in class, and 34% reported that they use 2-4 substances (e.g., caffeine, alcohol, cigarettes) at least once a day.

Wolfson and Carskadon (1998) examined a priori defined groups of high school students based on their sleep times and schedules. The extreme groups of students were defined as follows: long ( $\geq 8$  hours 15 minutes) versus short ( $\leq 6$  hours 45 minutes) school-night total sleep time; large ( $\geq 120$  minutes) versus small ( $\leq 60$  minutes) weekend delay; and high ( $\geq 120$  minutes) versus low ( $\leq 60$  minutes) weekend oversleep. High school students who had longer total sleep times, small weekend delays, and low weekend oversleeps were defined as having adopted adequate sleep habits, whereas students with shorter sleep times, large weekend delays, and high weekend oversleeps were defined as having adopted less than adequate sleep habits. Students with short school-night sleep reported increased levels of depressed mood, daytime sleepiness, and problematic sleep behaviors in comparison with longer sleepers. Likewise, students with more irregular sleep schedules had more behavior problems and increased substance abuse (e.g., cigarettes and marijuana).

Analogous findings were reported by researchers in New Zealand, France, and Canada. Morrison, McGee, and Stanton (1992) compared four groups of 13- and 15-year-olds in New Zealand: those with no sleep problems, those indicating they needed more sleep only, those reporting difficulties falling asleep or maintaining sleep, and those with multiple sleep problems. They concluded that adolescents in the sleep-problem groups were more anxious, had higher levels of depression, and lower social competence than those in the no-sleep-problem group. Similarly, in a sample of over 500 French and French-Canadian high school students, suicidal ideation and self-reported depression were associated with tiredness, less total sleep, and more sleep disturbances (Choquet, Kovess, & Poutignat, 1993). These studies all strongly suggest that adolescents with inadequate total sleep, irregular school-night to weekend sleep-wake schedules, and/or sleep disturbances struggle with behavior problems, academic difficulties, and substance abuse.

#### **Implications of the Factors Imposing on Adolescents' Sleep-Wake Patterns**

The interplay among sleep-wake schedules, circadian rhythms, environmental constraints, and behavior during adolescence results in an increasing pressure on the nocturnal sleep period, producing insufficient sleep in many teenagers and ultimately changes in daytime functioning (Carskadon, 1995). For children and preadolescents, society structures time for nighttime sleep, parents are more likely to set bedtimes, and school begins later in the morning. Prepubescent children are thus more likely to have earlier bedtimes and to wake up before the school day begins (Petta, Carskadon, & Dement, 1984). In contrast, due to behavioral factors (social, academic, and work-related, as well as environmental constraints such as school schedule and job hours), and circadian variables (pubertal phase delay), teenagers have later bedtimes, earlier rise times, and therefore, decreased time available to sleep (Carskadon et al., 1995). As a result, adolescents get to bed late, have difficulty waking up in the morning, and struggle to stay alert and to function successfully during the daytime.

#### *The Next Generation of Students*

Clearly, a number of variables impact the American high school student. High school students are influenced by society's values toward

education. Educators and social scientists have pointed out that two trends reveal educational values: the devaluing or trivializing of education; and the competing interests of media, consumerism, and employment upon studying (Prather, 1996). The studies presented in this chapter demonstrate a third trend – the devaluing of emotional and physical health, particularly sleep. With increasingly earlier high school start times, increasingly more time spent in after school employment, increasing consumerism, diminished time for sleep, and possibly increased illness and injury rates (Acebo et al., 1997), what will high school students' sleep-wake patterns will look like in the 21st century?

In light of the growing number of hours students are spending in the work force relative to all of their other activities (which do not appear to change over these years), I examined the impact of increasing work hours on total sleep in high school students. Among the nearly 40% of high school students who work an average of 19.5 hours/week (SD = 10.7 hours), for every 10 hours that they work, 14 minutes of sleep is lost per night (see Figure 12.3). On a weekly basis, the typical student who works approximately 20 hours per

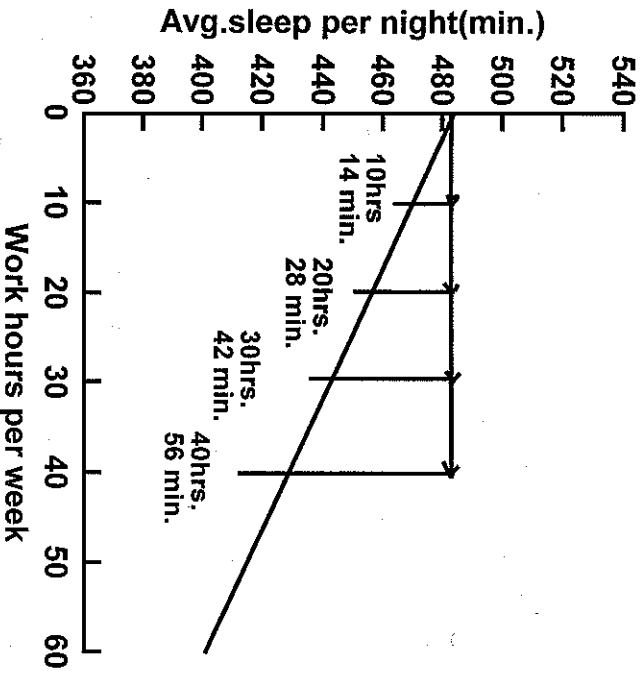


Figure 12.3. Work and lost sleep. For every 10 hours of work, 14 minutes of sleep is lost per night.

**Table 12.1. Characteristics of the 21st-Century High School Student's Sleep-Wake Habits**

School-night total sleep time less than 7 hours
School-night bedtime later than 11:00 P.M.
School-morning rise time prior to 6:00 A.M.
School start times earlier than 7:00 A.M.
More than 25 after-school work hours
Increased disengagement from school
Weekend sleep-wake schedule delayed by 2 or more hours
Decreased academic performance and less than 45 minutes per night study time
Increased emotional and behavioral difficulties
Increased sleepy-driver automobile accidents and other injuries

week will lose 3 hours, 20 minutes of sleep per week. At the extreme, the 5% of students who are working full-time and attending school are losing approximately 1 hour of sleep per night or 7 hours of sleep per week. If these data hold true, we are faced with an increasing sleep debt for adolescents in the United States with academic, emotional, and health consequences. Table 12.1 illustrates the typical adolescent's sleep-wake patterns in the next century if the trends of the 1990s continue.

#### *Countermeasures: Bridging the Gap between Research and Practice*

At this juncture, how can sleep and adolescent development researchers work with school administrators, parents, and teachers to guarantee that adolescents obtain more sleep and engage more in school in the next decade? In recent years sleep researchers have suggested that public schools delay high school start times from, for example, 7:30 to 9:00 A.M. to increase the likelihood that teenagers will sleep more. School principals and superintendents, however, have been reluctant to start high schools at later morning times. For example, last spring, in a suburban school district in Connecticut, more than 620 students and parents signed a petition urging the district to reject a plan to start high school at 7:30 A.M., 10 minutes earlier than the previous year (Stansbury, 1996; Dunne, 1996). One of the student leaders presented the petition along with relevant information from research studies conducted by Carskadon, Wolfson, and others to the board of education. However, the school superintendent, high school principals, and other board members and administrators stuck with their plan to move the start time to

7:30 A.M. to lengthen the school day. Dunne (1996) reported that the administrators emphasized that the regulation of school hours are the responsibility of the administration; however, the board has plans to evaluate the consequences of the earlier start time. Although this is a case example and not a large-scale study of researcher-school administrator relations, many school districts are reluctant to rethink the timing of the school day, which may result in large-scale systemic changes. Wahlstrom describes the Minneapolis-St. Paul experience of delaying start times in Chapter 11 of this volume.

A number of barriers interfere with establishing working relationships between sleep researchers and educators. Sleep researchers are reluctant to collaborate with school administrators because they fear that they will have to compromise on experimental design. Likewise, school administrators argue that the researchers do not understand the economic constraints of running a public school system (e.g., bus schedules, time for after-school sports before dark, parent work schedules). Researchers, educators, and parents must be able to speak each other's languages and to understand and respect each other's expertise to combine their talents to improve adolescents' sleep-wake patterns and their engagement with school.

Three requirements for productive connections are interdisciplinary communication skills, experiences that develop mutual respect and enthusiastic support from the field of sleep research and sleep medicine. First of all, sleep researchers who want to work actively with school systems must publish, present, and discuss their findings at conferences and in journals and other publications that are subscribed to by educators and child development specialists. Second, educators are much more likely to consider sleep clinicians and researchers' recommendations when they come out of a collaborative process. For example, school districts may be more likely to change school start times as a part of a pilot project that involves students' input, parents' concerns, school transportation departments' goals, and teachers' pedagogical questions. Finally, the sleep field needs to increase professional training in child and adolescent sleep development at the undergraduate level in medical and nursing schools, and in masters and doctoral programs in education and psychology. These components should strengthen the discipline and increase the likelihood that schools will take adolescents' sleep needs seriously in designing curriculums, schedules and school reforms.

Over the past decade, sleep and circadian rhythm researchers have worked with industry, highway safety organizations, the National

Aeronautics and Space Administration, hospitals, and other organizations that rely on 24-hour operations. Increasingly more programs have been developed and implemented on the individual and systemic level to promote performance, productivity, and safety in 24-hour operations (Rosekind et al., 1995; Monk, 2000). However, few interventions, countermeasures, and/or systemic changes have been implemented for the high school setting to promote academic performance, motivation, engagement, and health and safety for adolescents. Systemic and individual countermeasures may potentially stop the increasing adolescent sleep debt and improve adolescents' sleep hygiene and daytime functioning in school. Similar strategies have been developed for pilots, truck drivers, and shift workers (Rosekind et al., 1995).

#### *School and Community Countermeasures and Systemic Changes*

School systems and sleep researchers should continue to evaluate the benefits of later school start times for junior and senior high school students. Although research has not definitively proved an ideal school start time, the data strongly indicate that many current school start times are too early. For example, students with later school start times report the same average bedtimes as students with earlier school start times, but they have later rise times (Carskadon et al., 1995). One argument for increasingly earlier school start times has been to lengthen the school day; however, school reform studies have concluded that extending the quantity of time in school does not necessarily improve academic performance (Adelman, 1996). In addition to changing school start times, it is also important to evaluate school schedules. Are there certain times of day that adolescents perform better, feel more motivated, and are more likely to engage in their education? Data suggest that junior and senior high school students are more owl-like than elementary school-age children (Carskadon & Acebo, 1993). Therefore, high school students may be more involved and obtain better grades in late morning and afternoon classes in comparison to elementary school children.

The goal of countermeasures is to improve school performance and alertness. Because it may be difficult to change class schedules and school start times to an hour that meets everyone's needs (e.g., students, administrators, teachers), active learning that involves more social interaction may be a useful strategy for fighting sleepiness in junior and senior high schools. Although the usefulness of napping for high school students is not well researched, napping is one of the countermeasures



that has been tested for adults and college students (Gorin, Kelly, Wolfson, 1994; Rosekind et al., 1995). Rosekind et al.'s study demonstrated that a planned 40-minute nap improved reaction time and vigilance performance and alertness for long-haul crew members. Similarly, first-year college students who took planned, early afternoon naps reported more effective coping strategies than students who took no naps or erratic, spontaneous naps (Gorin et al., 1994). Future studies should evaluate the effectiveness of scheduled naps (e.g., nap rooms) as a way to improve alertness and performance for high school students.

The studies reviewed in this chapter also indicate that high school students are employed in after-school jobs for far too many hours and that work hours further decrease time for sleep. Ideally, if high schools started later and, therefore, ended later, teenagers would have less time to work. Over the past 2 decades schools have started increasingly earlier, and during the same period high school students have increased their hours in the paid labor force. For working adolescents, child labor laws should be adequate not only to protect them from occupational risks but also to insure that they have time to sleep and that their ability to learn in school is not adversely affected. Communities must begin to limit high school students' time in after-school jobs. Presently, 29 states have no limits at all on the numbers of hours that students may work each week during the academic year and 13 states allow 40 or more hours of employment per week. Eight states have some restrictions on weekly hours of employment during the school year; however, only 2 states actually limit employment to 20 hours per week or less (Steinberg et al., 1996). In addition to limiting teenagers' time in after-school jobs, employers should pay more attention to their adolescent employees' school performance and health (e.g., sleep requirements).

#### *Countermeasures for Sleepiness: Student Strategies*

Although the large-scale, systemic countermeasures discussed in the previous section are crucial, they take a long time to develop, are difficult to implement, and may be costly. In comparison, individual-focused strategies may be important in the short-run and may be efficacious for many adolescents. The following six preventive strategies or sleep hygiene guidelines are recommended for adolescents:

1. Minimize sleep loss by keeping consistent, regular bedtimes and rise times throughout the week.

2. As emphasized in the previous section, planned 25- to 45-minute naps can improve alertness and performance. Prior studies have shown that *prophylactic napping* is helpful for adults who must work for prolonged hours to prevent sleepiness from increasing to a level that impairs one's ability to function (Dinges & Broughton, 1989).
3. A presleep routine is helpful for adolescents so that they unwind and relax before going to bed. During evening hours, high school students tend to socialize on the phone with friends, watch television, play video games, and/or log on to the Internet or pursue other computer activities. An established sleep routine breaks the connection between the psychological stressors and stimulating activities of the day and the sleep period (Rosekind et al., 1995).
4. Circadian strategies are particularly relevant to adolescents. Because adolescents experience a phase delay and are sleepy later in the evening, it is helpful to reduce the amount of light that teenagers are exposed to in the evening, including the light from television(s) and computer(s), to prevent a further delay of bedtime and augment morning light.
5. Avoid alcohol, caffeine, nicotine, and other drugs as they have well-documented disruptive effects on sleep (see reviews by Rosekind et al., 1995; Zarcone, 2000). Steinberg et al. (1996) reported that students who work long hours use drugs and alcohol about 33 percent more often than students who do not work. Similarly, in the 1994 survey of high school students in the Providence area, the 11th and 12th graders working more than 20 hours per week reported greater substance use than those working fewer hours. Moreover, students with more irregular sleep-wake habits and less total weekly sleep used more substances. Clearly, some adolescents are further aggravating their sleep debt through their use of caffeine, nicotine, and alcohol.
6. Regular exercise may be helpful for adolescents' sleep hygiene. Morning exercise advances the circadian clock, whereas exercise in the late evening may delay the phase of sleep. However, additional research is needed to elucidate the relationship between the different types and quantity of exercise, sleep, and circadian rhythms, especially for adolescents. These adolescent-focused countermeasures combined with more systematic changes may help to improve the quantity and quality of adolescents' sleep and, as a result, school engagement and daytime functioning.

## Conclusions

Although a tremendous amount of well-researched information is available on adolescents' sleep-wake patterns, sleepiness, school and job schedules, and daytime functioning, research in these areas is still in its youth. This is particularly true in the application of this research knowledge to creating programs and new policies that will increase the time available for adolescents to sleep and reengage in school. Outcome studies need to evaluate and compare the effects of school schedule changes, revisions in adolescent labor regulations, and sleep hygiene education programs. The development of countermeasures, continued research, and ongoing dialogues between sleep researchers, educators, parents, and adolescents themselves will help reverse the early school start time, increased work hours, and increased sleep loss trends that face the teenager at the turn of the 21st century.

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