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Sleep and waking behaviors change significantly during the adolescent years. The objective of this study was to describe the relation between adolescents' sleep/wake habits, characteristics of students (age, sex, school), and daytime functioning (mood, school performance, and behavior). A Sleep Habits Survey was administered in homeroom classes to 3,120 high school students at 4 public high schools from 3 Rhode Island school districts. Self-reported total sleep times (school and weekend nights) decreased by 40–50 min across ages 13–19, $ps < .001$. The sleep loss was due to increasingly later bedtimes, whereas rise times were more consistent across ages. Students who described themselves as struggling or failing school (C's, D's/F's) reported that on school nights they obtain about 25 min less sleep and go to bed an average of 40 min later than A and B students, $ps < .001$. In addition, students with worse grades reported greater weekend delays of sleep schedule than did those with better grades. Furthermore, this study examined a priori defined *adequate* sleep habit groups versus *less than adequate* sleep habit groups on their daytime functioning. Students in the short school-night total sleep group (<6 hr 45 min) and/or large weekend bedtime delay group (>120 min) reported increased daytime sleepiness, depressive mood, and sleep/wake behavior problems, $ps < .05$, versus those sleeping longer than 8 hr 15 min with less than 60 min weekend delay. Altogether, most of the adolescents' surveyed do not get enough sleep, and their sleep loss interferes with daytime functioning.

INTRODUCTION

Adolescence is a time of important physical, cognitive, emotional, and social change when the behaviors in one developmental stage are constantly challenged by new abilities, insights, and expectations of the next stage. Sleep is a primary aspect of adolescent development. The way adolescents sleep critically influences their ability to think, behave, and feel during daytime hours. Likewise, daytime activities, changes in the environment, and individual factors can have significant effects on adolescents' sleeping patterns. Over the last 2 decades, researchers, teachers, parents, and adolescents themselves, have consistently reported that they are not getting enough sleep (Carskadon, 1990a; Carskadon, Harvey, Duke, Anders, & Dement, 1980; Price, Coates, Thoresen, & Grinstead, 1978; Strauch & Meier, 1988).

Although laboratory data demonstrate that adolescents probably do not have a decreased need for sleep during puberty (Carskadon, 1990a; Carskadon et al., 1980; Carskadon, Orav, & Dement, 1983), survey and field studies show that teenagers usually obtain much less sleep than school-age children, from 10 hr during middle childhood to less than 7.5–8 hours by age 16 (Allen, 1992; Carskadon, 1982, 1990a; Williams, Karacan, & Hursch, 1974). Although sleeping less than when younger, over 54% of high school students in a Swiss study (Strauch & Meier, 1988) endorsed a *wish for more sleep.*

A consistent finding in studies of adolescent sleep patterns is that they tend to stay up late. Price et al. (1978), for example, found that 60% of the eleventh and twelfth graders whom they surveyed stated that they "enjoyed staying up late." Another large survey study found that 45% of tenth to twelfth graders go to bed after midnight on school nights, and 90% retire later than midnight on weekends (Carskadon & Mancuso, 1988). Another consistent report (Bearpark & Michie, 1987; Petta, Carskadon, & Dement, 1984; Strauch & Meier, 1988) is that weekend total sleep times average 30–60 min more than school-night sleep times in 10- to 13/14-year-olds, and this difference increases to over 2 hr by age 18. Such data are usually interpreted as indicating that teenagers do not get enough sleep on school nights and then extend sleep on weekend nights to pay back a sleep debt. The most obvious explanation for the adolescent sleep debt appears to be a pattern of insufficient school-night sleep resulting from a combination of early school start times, late afternoon/evening jobs and activities, academic and social pressures, and a physiological sleep requirement that does not decrease with puberty (Carskadon, 1990b; Manber et al., 1995; Wolfson et al., 1995).

Many factors contribute to or are affected by increased daytime sleepiness and inconsistent sleep

schedules during the junior high and senior high school years. In the sections below, we review several key issues.

Puberty: Sleep Need, Daytime Sleepiness, and Circadian Phase Delay

Several important changes directly affecting sleep patterns occur during the pubertal years. One feature that seems not to change or to change in an unexpected direction is sleep need. A 6-year longitudinal summer sleep laboratory study of Carskadon and colleagues (1980) held the opportunity for sleep constant at 10 hr in children who were 10, 11, or 12 years old at their first 3 night assessment. The research hypothesis was that with age, the youngsters would sleep less, reaching a normal adult sleep length of 7.5 or 8 hr by the late teens. In fact, the sleep quantity remained consistent at approximately 9.2 hours across all pubertal stages. Thus, these data clarified that sleep need is not reduced during adolescence. The longitudinal study of Carskadon and colleagues (1980) simultaneously demonstrated that daytime sleep tendency was increased at midpuberty. In other words, even though the amount of nocturnal sleep consumed by the adolescents did not decline during puberty, their midday sleepiness increased significantly at midpuberty and remained at that level (Carskadon et al., 1980, 1983). This finding was based on physician assessment of puberty using Tanner staging (Tanner, 1962) and a sensitive laboratory measure of sleepiness, the Multiple Sleep Latency Test (MSLT; Carskadon et al., 1986).

A significant change in the timing of behavior across adolescent development is a tendency to stay up later at night and to sleep in later in the morning than preadolescents, that is, to delay the phase of sleep (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 above, as children reached puberty, they were less likely to wake up on their own, and laboratory staff needed to wake them up (Carskadon et al., 1980). In fact, they likely would have slept more than 9 hr if undisturbed.

Carskadon and her colleagues have shown that this adolescent tendency to phase delay may be augmented by a biological process accompanying puberty. An association between self-reported puberty scores (Carskadon & Acebo, 1993) and phase preference (morningness/eveningness) scores of over 400 pre- and early pubertal sixth graders showed a delay of phase preference correlated with maturation stage (Carskadon et al., 1993). Morningness/eveningness is a construct developed to estimate phase tendencies from self-descriptions. Morning persons tend to arise early in the morning and have difficulty staying up late whereas night persons have difficulty getting up early in the morning and prefer staying up late. Whereas most people are somewhere between these extremes, the cohort value shifts during adolescence (Andrade, Benedito-Silva, & Domenice, 1993; Ishihara, Honma, & Miyake, 1990). A recent study examined the circadian timing system more directly in early adolescents by measuring the timing of melatonin secretion, for the first time demonstrating a biological phase delay in association with puberty and in the absence of psychosocial factors (Carskadon, Acebo, Richardson, Tate, & Seifer, 1997).

Environmental Constraint: School Start Time

Many U.S. school districts start school earlier at academic transitions, for example, elementary to junior high school and junior high school to senior high school. Earlier high school start time is a major externally imposed constraint on teenagers' sleep-wake schedules; for most teens waking up to go to school is neither spontaneous nor negotiable. Early morning school demands often significantly constrict the hours available for sleep. For example, Szymczak, Jasinska, Pawlak, and Swierzykowska (1993) followed Polish students aged 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 awakening 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 (Allen, 1991; Allen & Mirabile, 1989; Carskadon & Mancuso, 1988).

In a preliminary laboratory/field study, we evaluated the impact of a 65 min advance in school start time on 15 ninth graders across the transition to tenth grade (Carskadon, Wolfson, Tzischinsky, & Acebo, 1995; Wolfson et al., 1995). The initial findings demonstrated that students slept an average of 40 min less in tenth grade compared with ninth grade due to earlier rise times, and they displayed an increase

in MSLT measured daytime sleepiness. In addition, evening type students had more difficulty adjusting to the earlier start time than did morning types, and higher scores on the 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).

Daytime Behaviors

Very little research has assessed the relation 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 relation is not clear. Clinical experience shows that adolescents who have trouble adapting to new school schedules and other changes (e.g., new bedtimes 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 and stress. For example, a number of studies have found that sleep-disturbed elementary school-age children experience a greater number of stresses (e.g., maternal absence due to work/school; family illness/accident; maternal depressed mood) than non-sleep-disturbed children (Kataria, Swanson, & Trevathan, 1987). Likewise, sleepy elementary 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).

Academic Performance

Sleepy adolescents—that is, those with inadequate sleep—may also encounter more academic difficulties. Several surveys of sample sizes ranging from 50 to 200 high school students reported that more total sleep, earlier bedtimes, and later weekday rise times are associated with better grades in school (Allen, 1992; Link & Ancoli-Israel, 1995; Manber et al., 1995). Epstein, Chillag, 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 (Quine, 1992). Studies of excessive sleepiness in adolescents due to narcolepsy or sleep apnea have also reported negative effects on learning, school performance, and behavior (Dahl, Holttum, & Trubnick, 1994; Guilleminault, Winkle, & Korobkin, 1982).

Summary of Factors Imposing on Adolescents' Sleep/Wake Patterns

The interplay among sleep/wake schedules, circadian rhythms, 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 preadolescents, parents are more likely to set bedtimes, school begins later in the morning, and societal expectations favor long sleep. Prepubescent children are thus more likely to have earlier bedtimes and to wake up before the school day begins (Petta et al., 1984). In contrast, due to behavioral factors (social, academic, work-related), environmental constraints (school schedule), and circadian variables (pubertal phase delay), teenagers have later bedtimes, earlier rise times, and therefore, decreased time available to sleep (Carskadon, 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.

Unfortunately, previous studies of adolescents' lifestyles (e.g., Hendry, Glendinning, Shucksmith, Love, & Scott, 1994) have failed to factor in these important developmental changes in sleep/wake patterns, and unanswered questions remain regarding the developmental changes in adolescent sleep/wake habits, the impact of adolescents' sleep habits on their daytime functioning (e.g., school performance), and the influence of the environment (e.g., school schedules) on teenagers' sleep. The present study examines more closely adolescents' sleep/wake habits and their association with several daytime behaviors using data from a large-scale survey. Such data are useful to assess generalizability of findings; furthermore, a large sample provides an opportunity to accentuate meaningful findings by setting the effect size (Cohen, 1988) and by examining extreme groups from the larger sample (Kagan, Resnick, & Gibbons, 1989).

The chief goal of this study is to document the association between adolescents' sleep/wake habits and daytime sleepiness, high school grades, depressed mood, and other daytime behaviors. Our study has three objectives: (1) to describe age, sex, and school differences in sleep/wake patterns; (2) to characterize the relation between self-reported high school grades and sleep/wake schedules; and (3) to

compare daytime functioning in students on schedules we define a priori as *adequate* versus those adopting *less than adequate* schedules.

METHOD

Measures

In the fall of 1994, an eight page School Sleep Habits Survey was administered in homeroom classes to high school students at four public high schools from three Rhode Island school districts. School start times ranged from 7:10 A.M. to 7:30 A.M. All students who wanted to complete the survey did so unless their parent/guardian refused consent. The survey items queried students about usual sleeping and waking behaviors over the past 2 weeks. Chief variables include school-night and weekend night total sleep time (TST), bedtime, and rise time. To assess *sleep schedule regularity,* two additional sleep variables were derived: *weekend delay* is the difference between weekend bedtime and school-night bedtime, and *weekend oversleep* is the difference between weekend total sleep time and school-night total sleep time.

The survey also covered school performance (self-reported grades in school) and scales assessing daytime sleepiness, sleep/wake behavior problems (Carskadon, Seifer, & Acebo, 1991), and depressive mood (Kandel & Davies, 1982). School performance was assessed by asking students, "Are your grades mostly A's, A's and B's, B's, B's and C's, C's, C's and D's, D's, or D's and F's?" These data were collapsed into four categories (mostly A's or A's/B's; mostly B's or B's/C's; mostly C's or C's/D's; mostly D's/F's).

The sleepiness scale consisted of total responses to items asking whether the respondent had struggled to stay awake (fought sleep) or fallen asleep in 10 different situations in the last 2 weeks, such as in conversation, while studying, in class at school, and so on (Carskadon et al., 1991). The respondent was asked to rate his or her answer on a scale of 1 to 4 (1 = no to 4 = both struggled to stay awake and fallen asleep). Scores on the sleepiness scale range from 10 to 40 and coefficient alpha was .70.

The sleep/wake behavior problems scale included 10 items asking frequency of indicators of erratic sleep/wake behaviors over the course of the last 2 weeks (e.g., arrived late to class because you overslept, stayed up past 3:00 A.M., needed more than one reminder to get up in the A.M., had an extremely hard time falling asleep, and so on; Carskadon et al., 1991). High school students were asked to rate the frequency of the particular behavior on a 5 point scale from everyday/night to never (5 = everyday, 1 = never). Scores range from 10 to 50, and coefficient alpha for the sleep/wake behaviors scale was .75.

The depressive mood scale (Kandel & Davies, 1982) queried the high school students as to how often they were bothered or troubled by certain situations in the last 2 weeks. It consists of six items (e.g., feeling unhappy, sad, or depressed; feeling hopeless about the future), and three response categories were provided, ranging from not at all to somewhat too much (e.g., scored 1 to 3, respectively). The index of depressive mood was based on a total score and has high internal reliability (coefficient alpha was .79 for this sample and .79 in the original study; Kandel & Davies, 1982). The Pearson correlation between the Kandel and Davies six item, depressive mood scale and the SCL-90 scale is .72, and prior studies demonstrated that the scale has high test-retest reliability with adolescent samples (r = .76) over 5–6 month intervals (Kandel & Davies, 1982).

Participants

The survey was completed anonymously by 3,120 students, 395 students at School A (rural), 1,077 at School B (urban), 745 at School C (suburban), and 903 at School D (suburban) (48% boys, 52% girls). The sample in Schools B and C comprised grades 10–12, whereas Schools A and D had ninth to twelfth graders. Approximately 8% of the students from schools A, C, and D and 17% from School B were eligible for free or reduced price lunches (State of Rhode Island Department of Education, 1994). Overall, the response rate was 88%. The students' ages ranged from 13 to 19 years (age 13–14, n = 336, age 15, n = 858, age 16, n = 919, age 17–19, n = 988). Over 91% of the students from Schools A, C, D reported that they were European American, whereas School B was more diverse (75% European American, 25% multiracial). On average, 81% of the students from all four schools reported that they live with both parents; 46% have older siblings, and 63% have younger siblings living in their homes. Eighty-six percent of their mothers *and* fathers were employed.

Statistical Methods

The findings are presented in three sections: (1) changes in sleep/wake habits according to age, sex, and school; (2) relation between high school grades and sleep/wake habits; and (3) an analysis of the differences in daytime functioning for students in extreme groups on several sleep parameters: short versus long school-night total sleep time, short ver-

sus long weekend oversleep, and small versus large weekend delay.

In the first two sections, multivariate analyses of variance (MANOVA) were used to examine age, sex, school, and grades in relation to the sleep/wake variables: total sleep time, bedtime, rise time, weekend delay, and weekend oversleep. Three multivariate analyses were computed: (1) school-night sleep variables, (2) weekend sleep variables, and (3) weekend delay and weekend oversleep. When significant multivariate effects were found, univariate effects were then examined using Bonferroni tests to determine significant group mean differences.

The large sample size in this study raises the possibility of finding many *statistically* significant results that have very small effect sizes, thus running the risk of overinterpreting inconsequential relations. To address this potential problem, we use an effect size criterion in addition to a statistical significance criterion for discussion and interpretation of those results most likely to prove meaningful in the long run. In the results section that follows, we restrict our discussion to those significant findings that also have effect sizes between what Cohen (1988) characterizes as small and medium. Specifically, a correlation of .20 is the effect size criterion, which is slightly smaller than the midpoint of Cohen's small (r = .10) and medium (r = .30) effects in terms of variance explained. For analysis of group differences, effects where two groups differ by more than one-third of the sample standard deviation are considered. Again, this is slightly lower than the midpoint between small (d = .20) and medium (d = .50) effect sizes (Cohen, 1988). (Note that we do not calculate exact effect sizes for our more complex analyses but simply wish to have a reasonable criterion for further consideration of effects most likely to have generalizable implications.) All *statistically* significant results, regardless of effect size, are noted in the tables that accompany the text.

RESULTS

Sleep/Wake Patterns Change across High School Age Groups

Our analysis of age-related affects grouped data by four age ranges; Table 1 presents means, standard deviations, and F values for the sleep variables according to age. All school-night sleep variables were affected by age, multivariate $F(9, 6571) = 22.49$, $p < .001$. Specifically, average total sleep time decreased by approximately 40 min across the four age groups, $p < .001$, average school-night bedtimes were about 45 min later, $p < .001$, and average rise times about 10 min later, $p < .001$. Reported weekend sleep habits also showed age-related changes, multivariate $F(9, 6327) = 21.28$, $p < .001$. Average weekend total sleep time declined by about 50 min across the age groups, $p < .001$, as weekend night bedtimes shifted increasingly later, $p < .001$, differing by about 1 hr between

Table 1 Means and Standard Deviations for School-Night and Weekend Sleep Variables by Age

Sleep/Wake Variable	13–14 Years (n = 336)	15 Years (n = 858)	16 Years (n = 919)	17–19 Years (n = 988)	F Value	Bonferroni
School-night TST	462 (67)	449 (66)	435 (68)	424 (66)	24.13***	14, 15 > 16 > 17
School-night bedtime	10:05 P.M. (49)	10:20 P.M. (55)	10:37 P.M. (58)	10:51 P.M. (58)	53.54***	14 < 15 < 16 < 17
School-night rise time	5:59 A.M. (24)	6:00 A.M. (25)	6:05 A.M. (29)	6:10 A.M. (31)	19.47***	14, 15 < 16 < 17
Weekend TST	567 (100)	564 (104)	549 (108)	518 (114)	32.53***	14, 15 > 16 > 17
Weekend bedtime	11:54 P.M. (94)	12:06 A.M. (83)	12:30 A.M. (82)	12:49 A.M. (80)	42.33***	14, 15 < 16 < 17
Weekend rise time	9:22 A.M. (85)	9:40 A.M. (104)	9:46 A.M. (107)	9:32 A.M. (107)	*ns*	...
Weekend oversleep	104 (102)	115 (112)	112 (116)	95 (114)	5.80**+	...
Weekend delay	89 (71)	88 (66)	92 (65)	95 (68)	*ns*	...

Note: TST refers to total sleep time (minutes). Weekend oversleep is the difference between weekend and school-night total sleep times and weekend delay is the difference between weekend and school-night bedtimes. Standard deviations, in parentheses, are in minutes; TST, weekend oversleep, and weekend delay are in minutes as well.
** $p < .01$; *** $p < .001$; + does not meet effect size criterion (e.g., effects where two groups differ by more than one-third of the sample standard deviation).

the youngest and oldest teenagers. Weekend rise times did not change with age. Overall, weekend delay and weekend oversleep changed between ages 13 and 19, multivariate $F(6, 5060) = 3.93$, $p < .01$. Although this multivariate F is statistically significant, age group differences for weekend delay and weekend oversleep were too small (on the order of .1 *SD*) to meet our effect size criterion.

Although all four high schools had similarly early school start times (between 7:10 A.M. and 7:30 A.M.), students' school-night sleep habits varied among the schools, multivariate $F(9, 6571) = 12.76$, $p < .001$, due to differences in rise times, $p < .001$. In particular, students who attended the school with the earliest school start time (7:10) reported earlier rise times than students at the other schools (School A: M = 5:53 versus Schools B, C, D: Ms = 6:04–6:09, ps < .01). Although school differences occurred in reported average total sleep times and bedtimes, these group differences did not meet effect size criterion. Weekend sleep also varied among schools, multivariate $F(9, 6327) = 4.74$, $p < .001$; however, univariate differences for total sleep time, bedtime, and rise time did not meet our effect size criterion. Additionally, small differences among the schools on weekend delay and weekend oversleep were not meaningful based on the effect size criterion.

Few sex differences were identified. Female students reported different school-night sleep habits than their male peers, multivariate $F(3, 2700) = 41.36$, $p < .001$, due to female students reporting waking up earlier than males: females, M = 5:58 versus males, M = 6:10, $F(1, 2702) = 100.81$, $p < .001$. Boys and girls did not differ on reported school-night bedtimes, nor total sleep times. Overall, female students had greater weekend delays and weekend oversleeps than the male students, multivariate $F(2, 2530)$ = 6.67, $p < .001$; however, univariate differences did not meet the effect size criterion. Female and male high school students did not report significant differences in weekend total sleep times, bedtimes, or rise times. The overall sample distributions of sleep patterns are displayed in Figure 1.

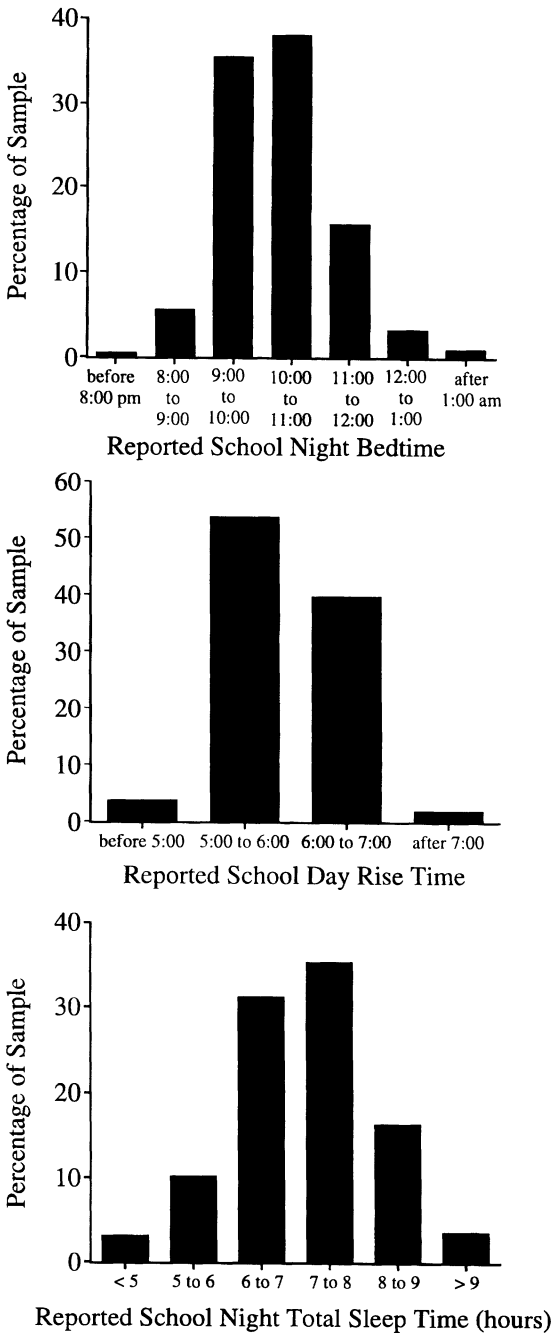

Figure 1 Sample distributions of sleep patterns

Academic Performance and Sleep Habits

Table 2 presents the analyses of sleep habits based on self-reported academic performance. In general, students with higher grades reported longer and more regular sleep, multivariate $F(9, 6571) = 8.91$, $p < .001$. Specifically, they reported more total sleep, $p < .001$, and earlier bedtimes, $p < .001$, on school nights than did students with lower grades. Post hoc analysis showed that these differences distinguished students reporting C's and worse from those reporting mostly B's or better. Students' weekend sleep habits also differed according to self-reported grades, multivariate $F(9, 6327) = 18.79$, $p < .001$. Specifically, A and B students reported earlier bedtimes and earlier rise times than did C and D/F students, ps < .001; however, self-reported grades did not distinguish the students on reported weekend total sleep. Finally, students with worse grades reported greater week-

Table 2 Means and Standard Deviations for School-Night and Weekend Sleep Variables by Grades

Sleep/Wake Variables	Self-Reported Grades: Mostly A's or A's/B's (n = 1,238)	Mostly B's or B's/C's (n = 1,371)	Mostly C's or C's/D's (n = 390)	Mostly D's/F's (n = 61)	F Value	Bonferroni
School-night TST	442 (62)	441 (66)	424 (74)	408 (94)	16.66***	A, B > C, D/F
School-night bedtime	10:27 P.M. (53)	10:32 P.M. (56)	10:52 P.M. (65)	11:22 P.M. (81)	24.58***	A, B < C, D/F
School-night rise time	6:02 A.M. (25)	6:05 A.M. (29)	6:10 A.M. (34)	6:09 A.M. (31)	*ns*	...
Weekend TST	547 (100)	547 (109)	534 (124)	549 (137)	*ns*	...
Weekend bedtime	12:06 A.M. (78)	12:29 A.M. (82)	1:09 A.M. (97)	1:33 A.M. (93)	51.32***	A < B < C, D/F
Weekend rise time	9:21 A.M. (97)	9:43 A.M. (103)	9:59 A.M. (113)	10:33 A.M. (160)	24.10***	A < B < C, D/F
Weekend oversleep	105 (101)	108 (114)	109 (130)	137 (159)	3.32*+	A, B, C < D/F
Weekend delay	99 (68)	117 (72)	137 (77)	133 (80)	26.53***	A < B < C, D/F

Note: TST refers to total sleep time (minutes). Weekend oversleep is the difference between weekend and school-night total sleep times, and weekend delay is the difference between weekend and school-night bedtimes. Standard deviations, in parentheses, are in minutes; TST, weekend oversleep, and weekend delay are in minutes as well.

* $p < .05$; ** $p < .01$; *** $p < .001$; + does not meet effect size criterion (e.g., effects where two groups differ by more than one-third of the sample standard deviation).

end delays of sleep schedule than did those with better grades, multivariate $F(6, 5060) = 18.22$, $p < .001$. Thus, C and D/F students reported going to bed on average about 2.3 hr later on weekends than on school nights versus a difference of about 1.8 hr for the A and B students, ps $< .001$. Students with D/F's reported longer weekend oversleeps than A, B, or C students; however, these differences did not meet the effect size criterion.

Daytime Functioning of Students Who Adopt *Adequate* versus *Less Than Adequate* Sleep Habits

Data presented in the previous sections demonstrate that older high school students sleep less and have later bedtimes than younger students, and those who report a poor academic performance are more likely to sleep less, go to bed later, and have more irregular sleep/wake habits. These descriptive findings, however, do not explain whether especially short amounts of sleep and/or irregular schedules are associated with changes in daytime functioning. To describe more thoroughly the high school students who are obtaining minimal sleep and/or who have irregular sleep schedules, we examined a priori defined groups based on sleep variables that have been cited previously as having an impact on behavior, deriving our values from empirical data (Carskadon et al., 1980, 1983; Carskadon, Keenan, & Dement, 1987). Other potentially important factors (e.g., history of sleep disorders), may covary with these, but data from our survey focused on total sleep and school-night versus weekend schedule changes.

The *extreme* groups of students were defined as follows: long (≥8 hr 15 min) versus short (≤6 hr 45 min) school-night total sleep time; large (≥120 min) versus small (≤60 min) weekend delay; or high (>120 min) versus low (<60 min) weekend oversleep. High school students who had longer total sleep times, small weekend delays, or low weekend oversleeps were defined as having adopted *adequate* sleep habits, whereas students with shorter sleep times, large weekend delays or high weekend oversleeps were defined as having adopted *less than adequate* sleep habits. We compared these *extreme* groups on daytime and nighttime functioning. Table 3 displays means, standard deviations, and F values for depressive mood, sleepiness, and sleep/wake behavior problems for each of the sleep variable groups. (The demographic breakdown of these groups reflected the larger sample on age, sex, and school attendance.)

Table 3 Means, Standard Deviations, and Analysis of Variance for Daytime Behavior Scales for *Adequate* versus *Less Than Adequate* Sleepers

Daytime Functioning Variables	Weekend Delay		Weekend Oversleep		School-Night TST		*F* Values Sleep Variables					
							Delay		Oversleep		TST	
	≤60 (n = 887)	≥120 (n = 928)	<60 (n = 972)	>120 (n = 1,411)	≥495 (n = 959)	≤405 (n = 1,207)	M	F	M	F	M	F
Depressive mood	10.13 (2.94)	10.35 (2.97)	9.92 (2.85)	10.42 (2.99)	9.48 (2.76)	10.79 (3.00)	*ns*	3.89*	*ns*	*ns*	10.80***	12.94***
Sleepiness	14.63 (3.71)	15.29 (3.98)	14.76 (3.82)	15.23 (3.81)	14.03 (3.51)	15.86 (4.01)	4.37*	6.45**	*ns*	*ns*	19.79***	29.77***
Sleep/wake behavior problems	19.10 (6.61)	21.80 (7.16)	19.33 (6.83)	21.22 (7.18)	18.48 (6.63)	22.17 (7.01)	13.17***	47.20***	17.83***	7.93**	16.15***	28.70***

Note: Weekend delay small = ≤60 min, large = ≥120 min; weekend oversleep short = <60 min, long = >120 min, and school-night TST long = ≥8 hr 45 min, short = ≤6 hr 15 min. M = effect for males, F = effect for females.

* $p < .05$; ** $p < .01$; *** $p < .001$.

Separate analyses of variance were calculated for each dependent variable (depressive mood, level of sleepiness, and sleep/wake behavior problems), with school-night total sleep time, weekend delay, weekend oversleep, and sex as independent variables. Age was analyzed as a covariate in these analyses.

Overall, adolescents who were in the groups defined as *less than adequate* sleep habits reported increased behavioral difficulties in comparison to those we defined as *adequate sleepers.* Thus, students in the short total sleep group reported more sleep/wake behavior problems, such as arrived late to class because of oversleeping, tired or dragged out nearly every day, needed more than one reminder to get up, $ps < .01$, higher levels of depressive mood, $ps < .001$, and greater sleepiness, $ps < .001$, than those in the long sleep group. Similarly, adolescents in the large weekend delay group described more sleep/wake behavior problems, $ps < .01$, and greater daytime sleepiness, $ps < .05$, but no difference in depressed mood from those with small weekend delays. One exception was that the female students with large weekend delays reported increased depressive mood levels, $p < .05$. Adolescents in the high weekend oversleep group reported more sleep/wake behavior problems, $p < .001$, but no differences in depressed mood or sleepiness from those in the low oversleep group. No sex differences were found in self-reported sleep/wake behavior problems; however, females reported higher levels of depressed mood: females, $M = 11.04$, $SD = 2.91$ versus males, $M = 9.20$, $SD = 2.68$, $p < .001$, and daytime sleepiness: females, $M = 15.26$, $SD = 3.59$ versus males, $M = 14.67$, $SD = 4.16$, $p \leq .01$, than did males.

DISCUSSION

The principal aim of this research was to assess the relation between adolescents' sleep/wake habits and their daytime functioning. The relatively high response rate (88%) obtained in this school-based study allows us to consider our findings representative of adolescents enrolled in moderate to large public high schools in this geographical region. The use of a self-report questionnaire enabled us to gather timely information from a large student population.

High School Students' Sleep Loss and Irregular Sleep/Wake Schedules

In particular, this sample of over 3,000 high school students reported lower total sleep (school and weekend nights) across ages 13–19. On school nights, the mean total sleep decreased from 7 hr 42 min to 7 hr 4 min. Similarly, average weekend total sleep decreased from 9 hr 20 min to 8 hr 38 min. The sleep loss is due to increasingly later bedtimes in older teens, whereas rise times remain more consistent. The sleep habits of the students attending the four different high schools showed minimal differences, with the exception of school day rise time, which was significantly earlier for students attending the school with the earliest start time. Although the difference between 7:10 and 7:30 may appear slight, the impact on sleep patterns was meaningful.

Remarkably few differences were found between male and female high school students' sleep/wake patterns. Female adolescents reported that they woke up 12 min earlier than their male peers on school mornings, a finding consistent with an earlier survey of high school students (Carskadon, 1990b) and a study of junior high school students in Taiwan (Gau & Soong, 1995). In the Gau et al. sample, however, the junior high school girls also reported less total sleep than the boys. We speculate that adolescent girls may be getting up earlier because they require more time to prepare for school and/or for family responsibilities.

Taken together, we conclude that most of these adolescents do not get enough sleep. Our laboratory data indicate that optimal sleep length is about 9.2 hr in adolescents (Carskadon, et al., 1980). Although individual differences in sleep need are likely, we note that 87% of our sample responded that they need more sleep than they get (median self-reported sleep need = 9 hr). Forty percent of the students reported that they went to bed after 11:00 P.M. on school nights, and 91% went to bed after 11:00 P.M. (67% after midnight) on weekends. Furthermore, 26% reported that they usually sleep 6.5 hr or less, and only 15% reported sleeping 8.5 hr or more on school nights (median = 7.5 hr). Nearly 70% of the students reported weekend delays of 60 min or more; on average, they reported oversleeping on weekends by nearly 1 hr and 50 min. Ninety-one percent of these high school students rise at 6:30 A.M. or earlier on school mornings, and 72% awaken at 9:00 A.M. or later on weekends.

These high school students' reported sleep/wake schedules are consistent with the major trends in the field: (1) self-reported nocturnal sleep time declines across the adolescent years; (2) bedtimes during high school become later; and (3) teenagers show large variations between weekend and school-night sleep schedules (e.g., Carskadon, 1990a; Strauch & Meier, 1988; Szymczak et al., 1993). In comparison to data from Rhode Island high school students surveyed 8

years earlier, these students reported on average approximately 15–20 min less sleep per night on school nights, principally reflecting earlier rising times (Carskadon, 1990a). The developmental and secular trends raise concerns about patterns that may have negative effects on teenagers' waking behavior.

Not assessed in this survey is the impact of family factors on sleep patterns. In the past, we have shown that parents tend to relinquish control of bedtime while increasing involvement with rising time as youngsters pass into adolescence (Carskadon, 1990a). In this particular sample, only 5.1% of students reported that parents set bedtimes on school nights; thus, the great majority of these youngsters set their own bedtime agenda. Over 80% of youngsters in this survey come from two-parent households in which both parents are employed, and we saw no differences between this cohort and those from single-parent homes on the major sleep variables. We propose that the biological and psychosocial processes favoring sleep delay in teens collides with early rising times mandated by schools and that even in the most well-regulated families the capacity for adequate adjustments may be limited.

Sleep/Wake Habits and School Performance

Our data support and extend findings from Kowalski and Allen (1995) and Link and Ancoli-Israel (1995) that students who described themselves as struggling or failing school (i.e., obtaining C's, D's/F's) report that they obtain less sleep, have later bedtimes, and have more irregular sleep/wake schedules than students who report better grades (i.e., A's, B's). In the Link and Ancoli-Israel survey of 150 high school students, students with self-reported higher grade point averages (GPA) slept more at night and reported less daytime sleepiness than students with lower GPAs. One explanation for these results is that students who get more sleep and maintain more consistent school/weekend sleep schedules obtain better grades because of their ability to be more alert and to pay greater attention in class and on homework. In contrast, Gau et al. (1995) found that younger students (junior high school age) on a highly competitive academic track reported shorter school and weekend night total sleep times, later bedtimes, and decreased daytime alertness than students in an alternative, less competitive program. Our data do not show a one-to-one relation between sleep patterns and grades. Certainly some students are able to function in school quite well with short amounts of sleep but may pay a price in other ways. Many students, however, may be too impaired by insufficient sleep to cope optimally with school demands. A major limitation of all of these studies is that they involve self-report; additional laboratory and field research are needed to clarify the direction of the relations among sleep loss, irregular sleep schedules, and academic performance and to assess other moderating and mediating variables, such as coping strategies, family rules, class schedules, and type of academic work.

Additional Consequences of Poor Sleep/Wake Habits

We have attempted to describe more thoroughly certain consequences of insufficient sleep and irregular sleep/wake schedules on adolescents' functioning by comparing extreme groups of students who reported patterns we defined as *adequate* versus *less than adequate* sleep/wake patterns. Students with short school-night sleep reported increased levels of depressed mood, daytime sleepiness, and problematic sleep behaviors in comparison to longer sleepers. Likewise, students with more irregular sleep schedules had more behavior problems. These data suggest that high school students with inadequate total sleep and/or irregular school-night to weekend sleep/wake schedules may struggle with daytime behavior problems. We interpret these findings to indicate that poor sleep habits influence behavior and mood, acknowledging that in certain youngsters the cause-effect arrow may go in the opposite direction.

Researchers are just beginning to compile evidence relating emotional well-being to sleep patterns. Our findings showing that teenagers with very short and irregular sleep/wake patterns have more daytime difficulties support the work of Morrison, McGee, and Stanton (1992), who 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. These investigators found that adolescents in the sleep-problem groups were more anxious, had higher levels of depression, and had lower social competence than those in the no-sleep-problem group. Similarly, Carskadon et al. (1991) found that a pattern of short sleep in college-bound high school seniors was associated with reports of sleepiness and sleep problems in males and females, and with anxiety and depression in females. Moreover, in a study calling for ninth to twelfth graders to reduce their habitual sleep by 2 hr over 5 consecutive nights, dysphoric mood changes occurred during the reduced sleep period on both daily and weekly depressive mood scales (Carskadon et al., 1989).

We hypothesize that if adolescents had the opportunity to obtain more sleep each night, they would experience fewer fluctuations in daily mood and fewer behavioral difficulties. In essence, we propose that adolescent moodiness may be in part a repercussion of insufficient sleep. The tendency for some adolescents to have reduced nocturnal sleep times and irregular schedules may have consequences that extend beyond daytime sleepiness to feelings of depression. On the other hand, depressed adolescents may be more inclined toward insufficient sleep and irregular schedules (Dahl et al., 1996). Additional in-depth laboratory and field assessment studies to probe the interplay between context, sleep/wake patterns, and daytime functioning of adolescents may enable us to tease apart some of these factors.

Caveats and Implications

We are very concerned about the important information that we have obtained from this large sample of high school students; however, certain caveats pertain. First, it is difficult to evaluate how representative the sample was, although the congruence between our findings and those from prior research (e.g., Carskadon, 1990a; Strauch & Meier, 1988) strongly suggest that the sample was quite typical. Whether our results hold for adolescents drawn from a wider socioeconomic and cultural background is an important issue for future studies. Second, the results of this study are based entirely on the adolescents' self-reports and suffer limitations because data are retrospective, based only on the last 2 weeks, and subjective. Multiple sources of measurement such as parent and teacher ratings, school record data, standardized test batteries, and sleep laboratory recordings would provide a more comprehensive and possibly more reliable assessment than the current study. Our previous experience in laboratory studies indicate that such self-report data are well correlated with data obtained from daily sleep diaries or continuous activity monitoring, although we have not made a formal comparison. On the other hand, in a study of tenth grade students that included 2 weeks of diaries and activity monitoring followed by a laboratory assessment, we found an average sleep length on school nights of 6 hr, 53 min (SD = 39), very similar to self-report (Carskadon, Acebo, Wolfson, Tzischinsky, & Darley, 1997).

Third, because the survey was conducted in one geographic area, some caution should be taken in generalizing the findings. Fourth, because the study design was cross-sectional, no conclusions about long-term development and ramifications of inadequate sleep can be drawn. Future investigations should gather several weeks of sleep and behavioral data and consider following high school students over several years. Finally, because the data are cross-sectional it is difficult to demonstrate causal direction. Models that include parameters different than those included in the present study (e.g., home structure, parenting styles, school schedules, and so forth) could also account for variation in grades and/or sleep/wake schedules. Nevertheless, the present study extends the research on adolescent sleep in several ways: (1) to a large population of public, high school students; (2) to a broader understanding of the association between sleep/wake habits, emotional well-being, and school performance in high school students from ages 13 to 19; and (3) to a clearer conceptualization of the risks for adolescents who obtain short amounts of sleep and/or experience erratic weekday-weekend sleep schedules on their daytime performance and mood.

Although self-report surveys have clear limitations, the implications of these data seem undeniable. First, schools need to take an active role and to examine sleep in the context of academic grades, test scores, truancy, behavioral difficulties, and other aspects of daytime functioning and adolescent development. Second, investigators in other fields who are concerned with adolescent development and well-being need to add the insights regarding adolescents' sleep into their studies and clinical work. Third, researchers, practitioners, and educators need to take interdisciplinary approaches to understanding and promoting the academic, health, and behavioral well-being of adolescents.

Adolescents confront a multitude of vulnerabilities, uncertainties, and changes. This developmental period is extremely eventful in terms of physiological, cognitive, and psychosocial development. Undoubtedly, most adolescents require more than 7 hr, 20 min (sample mean) of sleep to cope optimally with academic demands, social pressures, driving, and job responsibilities. Although adolescents may be differentially affected by pubertal changes in sleep/wake patterns, school start times, and academic responsibilities, the excessive sleepiness consequent to insufficient, erratic sleep is a potentially serious factor for adolescent development and behavioral well-being. The magnitude of the problem has been unrecognized because adolescent sleepiness is so widespread that it almost seems normal (Carskadon, 1990a). Steinberg and Darling (1994), Petersen, Silbereisen, and Soerensen (1993) and others have emphasized the importance of studying the context of adolescent development. The development of adolescent sleep-

ing patterns cannot be understood without taking into account school schedules and other contexts; likewise, adolescent development (psychosocial, cognitive, emotional) cannot be fully examined without considering sleep/wake factors.

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REFERENCES

Achenbach, T. (1991). *Manual for the Youth Self-Report and 1991 profile.* Burlington: University of Vermont Department of Psychiatry.

Allen, R. (1991). School-week sleep lag: Sleep problems with earlier starting of senior high schools. *Sleep Research, 20,* 198.

Allen, R. (1992). Social factors associated with the amount of school week sleep lag for seniors in an early starting suburban high school. *Sleep Research, 21,* 114.

Allen, R., & Mirabile, J. (1989). Self-reported sleep-wake patterns for students during the school year from two different senior high schools. *Sleep Research, 18,* 132.

Andrade, M. M., Benedito-Silva, E. E., & Domenice, S. (1993). Sleep characteristics of adolescents: A longitudinal study. *Journal of Adolescent Health, 14,* 401–406.

Bearpark, H. M., & Michie, P. T. (1987). Prevalence of sleep/wake disturbances in Sydney adolescents. *Sleep Research, 16,* 304.

Brown, C., Tzischinsky, O., Wolfson, A., Acebo, C., Wicks, J., Darley, C., & Carskadon, M. A. (1995). Circadian phase preference and adjustment to the high school transition. *Sleep Research, 24,* 90.

Carskadon, M. A. (1982). The second decade. In C. Guilleminault (Ed.), *Sleeping and waking disorders: Indications and techniques.* Menlo Park: Addison-Wesley.

Carskadon, M. A. (1990a). Patterns of sleep and sleepiness in adolescents. *Pediatrician, 17,* 5–12.

Carskadon, M. A. (1990b). Adolescent sleepiness: Increased risk in a high-risk population. *Alcohol, Drugs, and Driving, 5/6,* 317–328.

Carskadon, M. A. (1995). Sleep's place in teenagers' lives. *Proceedings of the Biennial Meeting of the Society for Research in Child Development,* p. 32 (abstract).

Carskadon, M. A., & Acebo, C. (1993). A self-administered rating scale for pubertal development. *Journal of Adolescent Health Care, 14,* 190–195.

Carskadon, M. A., Acebo, C., Richardson, G. S., Tate, B. A., & Seifer, R. (1997). Long nights protocol: Access to circadian parameters in adolescents. *Journal of Biological Rhythms, 12,* 278–289.

Carskadon, M. A., Acebo, C., Wolfson, A., Tzischinsky, O., & Darley, C. (1997). REM sleep on MSLTS in high school students is related to circadian phase. *Sleep Research, 26,* 705.

Carskadon, M. A., Dement, W. C., Mitler, M. M., Roth, T., Westbrook, P. R., & Keenan, S. (1986). Guidelines for the Multiple Sleep Latency Test (MSLT): A standard measure of sleepiness. *Sleep, 9,* 519–524.

Carskadon, M. A., Harvey, K., Duke, P., Anders, T. F., & Dement, W. C. (1980). Pubertal changes in daytime sleepiness. *Sleep, 2,* 453–460.

Carskadon, M. A., Keenan, S., & Dement, W. C. (1987). Nighttime sleep and daytime sleep tendency in preadolescents. In C. Guilleminault (Ed.), *Sleep and its disorders in children.* New York: Raven Press.

Carskadon, M. A., & Mancuso, J. (1988). Sleep habits in high school adolescents: Boarding versus day students. *Sleep Research, 17,* 74.

Carskadon, M. A., Orav, E. J., & Dement, W. C. (1983). Evolution of sleep and daytime sleepiness in adolescents. In C. Guilleminault & E. Lugaresi (Eds.), *Sleep/wake disorders: Natural history, epidemiology, and long-term evolution* (pp. 201–216). New York: Raven Press.

Carskadon, M. A., Rosekind, M. R., Galli, J., Sohn, J., Herman, K. B., & Davis, S. S. (1989). Adolescent sleepiness during sleep restriction in the natural environment. *Sleep Research, 18,* 115.

Carskadon, M. A., Seifer, R., & Acebo, C. (1991). Reliability of six scales in a sleep questionnaire for adolescents. *Sleep Research, 20,* 421.

Carskadon, M. A., Vieira, C., & Acebo, C., (1993). Association between puberty and delayed phase preference. *Sleep, 16,* 258–262.

Carskadon, M. A., Wolfson, A., Tzischinsky, O., & Acebo, C. (1995). Early school schedules modify adolescent sleepiness. *Sleep Research, 24,* 92.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences.* Hillsdale, NJ: Erlbaum.

Dahl, R. E., & Carskadon, M. A. (1995). Sleep in its disorders in adolescence. In R. Ferber & M. Kryger (Eds.), *Principles and practice of sleep medicine in the child.* Philadelphia: WB Saunders.

Dahl, R. E., Holttum, J., & Trubnick, L. (1994). A clinical picture of childhood and adolescent narcolepsy. *Journal of the American Academy of Child and Adolescent Psychiatry, 33,* 834–841.

Dahl, R. E., Ryan, N. D., Matty, M. K., Birmaher, B., Alshabbout, M., Williamson, D. E., & Kupfer, D. J. (1996). Sleep

onset abnormalities in depressed adolescents. *Biological Psychiatry, 39,* 400–410.

Epstein, R., Chillag, N., & Lavie, P. (1995). Sleep habits of children and adolescents in Israel: The influence of starting time of school. *Sleep Research, 24a,* 432.

Fisher, B. E., & Rinehart, S. (1990). Stress, arousal, psychopathology and temperament: A multidimensional approach to sleep disturbance in children. *Personality and Individual Differences, 11,* 431–438.

Gau, S-F., & Soong, W-T. (1995). Sleep problems of junior high school students in Taipei. *Sleep, 18,* 667–673.

Guilleminault, C., Winkle, R., & Korobkin, R. (1982). Children and nocturnal snoring: Evaluation of the effects of sleep related respiratory resistive load and daytime functioning. *European Journal of Pediatrics, 139,* 165–171.

Hendry, L. B., Glendinning, A., Shucksmith, J., Love, J., & Scott, J. (1994). The developmental context of adolescent life-styles. In R. K. Silbereisen & T. Eberhard (Eds.), *Adolescence in context: The interplay of family, school, peers, and work in adjustment* (pp. 66–81). New York: Springer-Verlag.

Ishihara, K., Honma, Y., & Miyake, S. (1990). Investigation of the children's version of the morningness-eveningness questionnaire with primary and junior high school pupils in Japan. *Perceptual and Motor Skills, 71,* 1353–1354.

Kagan, J., Resnick, J. S., & Gibbons, J. (1989). Inhibited and uninhibited types of children. *Child Development, 60,* 838–845.

Kandel, D. B., & Davies, M. (1982). Epidemiology of depressive mood in adolescents. *Archives of General Psychiatry, 39,* 1205–1212.

Kataria, S., Swanson, M. S., & Trevathan, G. E. (1987). Persistence of sleep disturbances in preschool children. *Pediatrics, 110,* 642–646.

Kowalski, N., & Allen, R. (1995). School sleep lag is less but persists with a very late starting high school. *Sleep Research, 24,* 124.

Link, S. C., & Ancoli-Israel, S. (1995). Sleep and the teenager. *Sleep Research, 24a,* 184.

Manber, R., Pardee, R. E., Bootzin, R. R., Kuo, T., Rider, A. M., Rider, S. P., & Bergstrom, L. (1995). Changing sleep patterns in adolescence. *Sleep Research, 24,* 106.

Morrison, D. N., McGee, R., & Stanton, W. R. (1992). Sleep problems in adolescence. *Journal of the American Academy of Child and Adolescent Psychiatry, 31,* 94–99.

Peterson, A. C., Silbereisen, R. K., & Soerensen, S. (1993). Adolescent development: A global perspective. In W. Meeus, M. de Goede, W. Kox, & K. Hurrelmann (Eds.), *Adolescence, careers and cultures* (pp. 1–34). New York: De Gruyter.

Petta, D., Carskadon, M. A., & Dement, W. C. (1984). Sleep habits in children aged 7–13 years. *Sleep Research, 13,* 86.

Price, V. A., Coates, T. J., Thoresen, C. E., & Grinstead, O. A. (1978). Prevalence and correlates of poor sleep among adolescents. *American Journal of Diseases of Children, 132,* 583–586.

Quine, L. (1992). Severity of sleep problems in children with severe learning difficulties: Description and correlates. *Journal of Community and Applied Social Psychology, 2,* 247–268.

State of Rhode Island Department of Education. (1994). *Rhode Island Public Schools 1994 District Profiles.* Providence: Rhode Island Department of Elementary and Secondary Education.

Steinberg, L., & Darling, N. (1994). The broader context of social influence in adolescence. In R. K. Silbereisen & T. Eberhard (Eds.), *Adolescence in context: The interplay of family, school, peers, and work in adjustment* (pp. 25–45). New York: Springer-Verlag.

Strauch, I., & Meier, B. (1988). Sleep need in adolescents: A longitudinal approach. *Sleep, 11,* 378–386.

Szymczak, J. T., Jasinska, M., Pawlak, E., & Swierzykowska, M. (1993). Annual and weekly changes in the sleep-wake rhythm of school children. *Sleep, 16,* 433–435.

Tanner, J. M. (1962). *Growth in adolescence.* Oxford: Blackwell.

Williams, R., Karacan, I., & Hursch, C. (1974). *EEG of human sleep.* New York: Wiley & Sons.

Wolfson, A. R., Tzischinsky, O., Brown, C., Darley, C., Acebo, C., & Carskadon, M. (1995). Sleep, behavior, and stress at the transition to senior high school. *Sleep Research, 24,* 115.