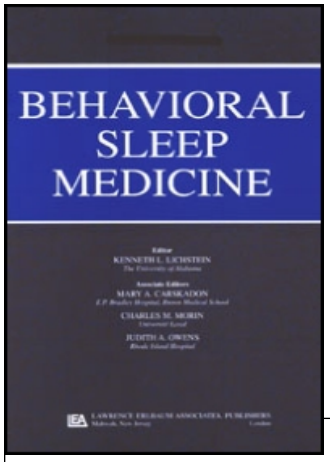

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Middle School Start Times: The Importance of a Good Night's Sleep for Young Adolescents

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Middle School Start Times: The Importance of a Good Night's Sleep for Young Adolescents

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With the onset of adolescence, teenagers require 9.2 hr of sleep and experience a delay in the timing of sleep. In the "real world" with early school start times, however, they report less sleep, striking differences between their school-weekend sleep schedules, and significant daytime sleepiness. Prior studies demonstrated that high schoolers with later school starts do not further delay bedtimes but obtain more sleep due to later wake times. This study examined sleep–wake patterns of young adolescents attending urban, public middle schools with early (7:15 a.m.)

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versus late (8:37 a.m.) start times. Students ($N = 205$) were assessed at 2 time periods. Students at the late-starting school reported waking up over 1 hr later on school mornings and obtaining 50 min more sleep each night, less sleepiness, and fewer tardies than students at the early school. All students reported similar school-night bedtimes, sleep hygiene practices, and weekend sleep schedules.

It is no surprise that adolescents often push aside their need for sleep to accommodate a vast array of social, academic, and extracurricular demands (Carskadon & Acebo, 2002; Dahl & Lewin, 2002; Wolfson, Acebo, Fallone, & Carskadon, 2003). Yet their ability to function throughout the school day is greatly impacted by the quantity, regularity, and quality of their sleep. Studies conducted in a variety of different countries with different youth cultures have consistently shown similar adolescent sleep needs and illustrated that adolescents experience a biological delay in the timing of sleep onset and awakening that is associated with pubertal status and not chronological age (Carskadon & Acebo, 2002; Carskadon, Vieira, & Acebo, 1993; Carskadon, Wolfson, Acebo, Tzischinsky, & Seifer, 1998; Gau & Soong, 1995; Iglowstein, Jenni, Molinari, & Largo, 2003; Jenni & Carskadon, 2004; Knutson, 2005; Thorleifsdottir, Bjornsson, Benediktsdottir, Gislason, & Kristbjarnarson, 2002). In the face of these sleep needs and schedules, "real-world" survey studies reveal that as early as 6th grade, adolescents report strikingly different sleep–wake patterns than do younger children. Young adolescents regularly obtain an inadequate amount of sleep, have irregular school–weekend night sleep schedules, experience increased daytime sleepiness, and have more unplanned daytime naps (Fredriksen, Rhoades, Reddy, & Way, 2004; Sadeh, Gruber, & Raviv, 2000; Wolfson, Acebo, et al., 2003; Wolfson & Carskadon, 1998; Wolfson, Carskadon, et al., 2003).

Environmental constraints such as school start times, extracurricular activities, and employment (paid or volunteer) can be detrimental to adolescents' sleep schedules and requirements (Carskadon et al., 1980; Carskadon et al., 1998; Wolfson, 2002; Wolfson & Carskadon, 1998). Adolescents tend to stay up increasingly later at night as they progress through middle school and high school, while simultaneously having to wake up even earlier for school and, as a result, get increasingly less sleep over the course of adolescence (Carskadon, 1990; Wolfson, Acebo, et al., 2003; Wolfson & Carskadon, 1998; Wolfson & Carskadon, 2005; Wolfson, Carskadon, et al., 2003). This means that adolescents obtain an inadequate amount of sleep on school nights and sleep more on weekends to catch up on lost sleep (Szymczak, Jasinska, Pawlak, & Swierzykowska, 1993; Wolfson & Carskadon, 1998). The result of this sleep debt is that a number of adolescents are frequently absent or late for school, sleepy and moody during school hours, inattentive during class time, and more likely to do poorly in school (Carskadon, 1990; Wahlstrom, 2002; Wolfson & Carskadon, 1998; Wolfson & Carskadon, 2003).

Undoubtedly, the biological delay in sleep onset and the social pressures of the teen years—staying up late to watch TV, chat on the phone with friends, socialize online (e.g., instant messenger), or do homework—when combined with the need to arise early in the morning for school, easily creates a situation in which the teenager chronically obtains inadequate sleep. Historically, schools have started early in the morning throughout the United States as well as elsewhere (Carskadon & Acebo, 1997; Wolfson & Carskadon, 2005). Wolfson and Carskadon (2005) found that overall average school start and end times did not change across the 15 years span from 1986–1987 to 2001–2002 (M = 7:55 a.m.); however, earlier starting schools reported increasingly earlier starting times over this period, whereas later starting schools reported increasingly delayed bell schedules (Wolfson & Carskadon, 2005). Many U.S. school districts use a schedule that consists of high schools beginning first, followed by middle schools, and then elementary schools with one or two starting times (Nudel, 1993). According to this traditional schedule, the students that fall asleep the latest at night are being forced to wake the earliest.

Carskadon et al. (1998) evaluated the impact of a 65-min advance of school start time across the transition from Grade 9 (8:25 a.m.) to Grade 10 (7:20 a.m.). Sleep records demonstrated that just over 60% of the 9th graders and fewer than one half the 10th graders obtained an average of 7 hr or more of sleep on school nights, and they awakened significantly earlier on school mornings in 10th than in 9th grade. In 10th grade, students also displayed atypical sleep patterns on the Multiple Sleep Latency Test (MSLT). For example, they fell asleep faster in 10th versus 9th grade, and about one half of the 10th-grade participants experienced at least one rapid eye movement sleep episode on the MSLT. These young adolescents' inadequate sleep resulted in a level of daytime sleepiness that is usually seen in patients with narcolepsy (Guilleminault & Anagnos, 2000). Similarly, survey results consistently indicate that high school students who start school at 7:15 a.m. or earlier obtain less total sleep on school nights due to earlier wake times in comparison to students at later starting schools (Allen, 1992; Wolfson & Carskadon, 1998; Carskadon et al., 1998; Epstein, Chillag, & Lavie, 1998; Wahlstrom, 2002). Imposition of early school start times for adolescents requires teenagers to have bedtimes that are impractical or infeasible. The results are insufficient time for sleeping and the ensuing consequences such as diminished academic performance (Wolfson & Carskadon, 2003). Due to this persistent sleep loss and a delay in circadian phase, students perform better later in the day than in the early morning (Hansen, Janssen, Schiff, Zee, & Dubocovich, 2005).

An increasing number of studies have demonstrated that later school start times are associated with later wake times, increased total sleep, as well as improved academic performance (Allen, 1992; Epstein, Chillag, & Lavie, 1995, 1998; Wahlstrom, 2002). Wahlstrom's study evaluated 18,000 Minneapolis high

school students after their school start time was changed from 7:15 a.m. during the 1996–1997 academic school year to 8:40 a.m. the following year. Results showed slight improvement in the student's grades, increased attendance among 9th through 11th graders, and improved high school enrollment. These high school students had similar bedtimes to students from other earlier starting schools, despite the delay in school start time. On average, students at the later starting high schools got almost 1 hr more sleep each school night (Wahlstrom, 2002).

While researchers and school districts have focused largely on the consequences of early school start times for high school students, few studies have looked at younger adolescents. This study examined the impact of early versus late school start times on middle school students. This study compared sleep patterns and academic performance for seventh and eighth graders attending two urban, New England, public, middle schools with start times that differed by over 60 min.

The purpose of this study was threefold: (a) to examine the impact of early versus late starting times for younger adolescents in middle school; (b) to compare self-reported school- and weekend-night sleep patterns, behaviors, and hygiene of seventh and eighth graders attending early- versus late-starting schools; (c) to assess attendance, tardiness, and school performance for young adolescents at early- versus late-starting schools.

METHOD

Procedures

Participants were recruited from one early-starting (School E's start time: 7:15 a.m.) and one late-starting (School L's start time: 8:37 a.m.) middle school in an urban, New England school district. Based on school department information, the schools were similar in socioeconomic status, size, and ethnic distribution of the students. During the previous summer, the school board voted to start some middle schools at 8:37 a.m. and others at 7:15 a.m. to save money in the school budget (all middle schools started close to 8:00 a.m. during the previous year). Both schools are set up with clusters within each school whereby students attend classes throughout seventh and eighth grade with the same team of students. Students are randomly assigned to these school clusters. For this study, principals at each school randomly chose one cluster (approximately 100 students per cluster, 7 clusters in each school) from each school to have the opportunity to participate in the study. Specifically, each principal placed the cluster names in a box and then had an administrative assistant pick out one cluster. Parents or guardians of the children in these two clusters were sent a letter inviting

their son or daughter to participate in a study on middle school students' sleep patterns and daytime behaviors. The College of the Holy Cross Human Subjects Committee approved the study, and written informed consent was obtained from parents and verbal assent from students. Participants completed a shortened version of the Sleep Habits Questionnaire (Wolfson & Carskadon, 1998) and the Adolescent Sleep Hygiene Scale (ASHS; Harsh, Easley, & LeBourgeois, 2002; LeBourgeois, Giannotti, Cortesi, Wolfson, & Harsh, 2005) in the fall of 2003 and again in the spring of 2004.

Participants

Seventh- and eighth-grade students ($N = 205$; 123 girls and 82 boys; 99 seventh graders and 106 eighth graders; 126 at School L and 79 at School E) participated in the study. The response rate for the two schools was as follows: School E = 80% and School L = 96%. There were no demographic differences between the two schools ($\chi^2 \leq 8.3$, $p \geq .11$). The demographics for each school are displayed in Table 1. It is noteworthy that nearly 50% of the participants were minorities, and 18% of the students were from low income homes.

Measures

The Sleep Habits Questionnaire queried students about their usual sleeping and waking behaviors over the past 2 weeks, which is a typical interval for point-

TABLE 1
Sample Demographics by School

Variable	*School L*	*School E*
Ethnic background		
White	60%	46%
Black/African American	8%	9%
Hispanic	16%	19%
Asian	6%	10%
Other	10%	16%
Parent employment		
Mother employed	79%	75%
Father employed	79%	80%
Socioeconomic status based on free lunch		
Low income status	18%	18%
School transportation		
Walk	18%	28%
Bus	26%	34%
Car	46%	33%

assessment sleep habits surveys. The questionnaire also included questions regarding the students' ethnic background, family makeup, parents' work status, and school transportation. The following sleep habits variables (school and weekend nights separately) were assessed: (a) total sleep time (TST)—: usual TST ("Figure out how long you usually sleep on a school night and fill it in here," answered as specific hours and minutes such as 7 hr, 30 min); (b) bedtime—usual bedtime ("What time do you usually go to bed on school days?," answered as one specific time such as 11:30 p.m.); and (c) wake time—usual wake time ("What time do you usually wake up on school days?," answered as one time such as 6:10 a.m.).

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 TST and school-night TST.

The questionnaire also included scales assessing daytime sleepiness and sleep–wake behavior problems (Carskadon, Seifer, & Acebo, 1991; Wolfson & Carskadon, 1998). 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, etc. (Carskadon et al., 1991). The respondent was asked to rate his or her answer on a scale ranging from 1 (*no*) to 4 (*both struggled to stay awake and fallen asleep*). Scores on the Sleepiness scale range from 10 to 40 and were similar to previous studies; coefficient alpha was .70 (Wolfson & Carskadon, 1998). 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 morning, had an extremely hard time falling asleep, etc.; Carskadon et al., 1991; Wolfson & Carskadon, 1998). Students were asked to rate the frequency of the behavior on a five-point scale ranging from 5 (*everyday/night*) to 1 (*never*). Scores range from 10 to 50 and the coefficient alpha for the Sleep–Wake Behaviors scale was .75, similar to prior reports (Wolfson & Carskadon, 1998).

The ASHS (Harsh et al., 2002; LeBourgeois et al., 2005) is a 33-item self-report instrument that assesses sleep hygiene practices in 12- to 18-year-olds. Adolescents report how often specific sleep inhibiting and sleep facilitating behaviors have occurred during the past month using a six-point scale ranging from 1 (*always*), 2 (*frequently, if not always*), 3 (*quite often*), 4 (*sometimes*), 5 (*once in awhile*), to 6 (*never*). The Sleep Hygiene scale is measured along the following seven dimensions: physiological, cognitive, emotional, sleep environment, bedtime routine, daytime sleep, and sleep stability. Subscale scores for each dimension and a total Sleep Hygiene score may be obtained with higher

scores indicative of better sleep hygiene. Coefficient alphas for the nine subscales ranged from .50 to .74, and the full scale reliability was .80 (LeBourgeois et al., 2005).

Official academic performance, attendance, and tardiness records were provided by the schools with parental consent. Grades were provided for English, science, mathematics, and social studies for the fall quarter. An average quarter grade, based on the mean of these four subject grades, was calculated. Grades were recorded on the standard 100-point scale (70s = C, 80s = B, 90s = A).

Statistical Analysis

First, multivariate analyses of variance (MANOVAs) were used to examine school, grade, and gender differences for the self-reported sleep variables: TST, bedtime, wake time, weekend delay, weekend oversleep, as well as the qualitative sleep variables (sleepiness, sleep–wake behavior problems, sleep hygiene).

Second, MANOVA was used to assess school, grade, and gender differences for the participants' school performance and behavior variables (e.g., academic grades, tardiness, and absenteeism). When significant multivariate effects were found, univariate effects were then examined using Bonferroni tests to determine significant group mean differences. Only student participants who completed the questionnaires at both times of measurement were included in the analyses.

Third, analyses were conducted separately for the fall and the spring to examine if fall trends in sleep patterns, problems, and daytime behavior were replicated later in the year after the students had been on the same school start time schedules for about 6 to 7 months.

RESULTS

Sleep–Wake Patterns

Table 2 presents means and standard deviations for fall and spring school-night sleep variables according to school and grade. Overall, seventh- and eighth-grade students at the early- versus late-starting middle schools reported different fall school-night sleep–wake patterns: multivariate $F(4, 181) = 238.01$, $p < .001$. Although students at the later starting school reported bedtimes that were 22 min later than students at the earlier starting school ($F[1, 192] = 4.98$, $p < .05$), on average, students at the later starting school reported 37 min more total sleep ($F[1, 192] = 17.26$, $p < .001$) largely due to getting up 75 min later in comparison to the other students ($F[1, 192] = 218.98$, $p < .001$). At the spring assessment, students at School L reported 65 min more sleep on school nights due entirely to later wake times in comparison to students at

TABLE 2
Means and Standard Deviations for School-Night Sleep–Wake Patterns

	School E				*School L*			
	Fall		*Spring*		*Fall*		*Spring*	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Bedtime*[a]	9:19	0:38	9:47	1:00	9:41	0:56	9:53	0:57
Wake time**[a,b]	5:44	0:25	5:53	0:22	6:59	0:33	7:00	0:39
Total sleep time (min)**[a,b]	497	75	470	78	534	78	535	76
Departure time**[a,b]	6:46	0:22	6:46	0:16	8:09	0:16	8:11	0:20

[a]Fall. [b]Spring.
* $p < .05$, school effect.
** $p < .001$, school effect.

School E: multivariate $F(4, 181) = 264.54$, $p < .001$. At both the fall and spring assessments, School L students reported that they departed for school nearly 1.5 hr later than School E students (ps $< .001$).

Figure 1 captures the distribution differences for school-night TST for students attending the early- versus late-starting middle schools. As seen in this figure, 36% of the seventh and eighth graders attending School L reported that they obtained more than 9 hr of sleep on school nights in comparison to only 18% at School E.

Furthermore, students at the two schools reported similar weekend sleep–wake patterns in the fall and again in the spring (see Table 3); however, sleep–

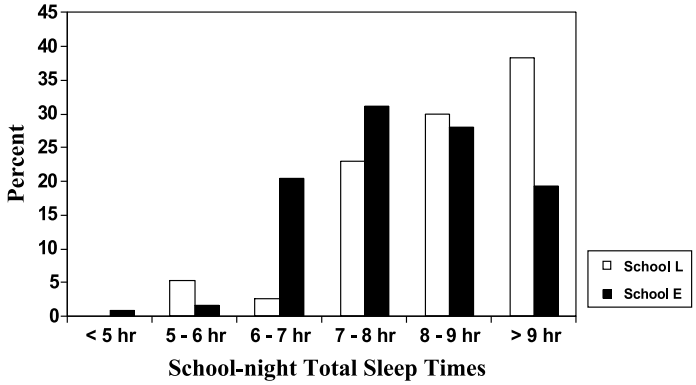

FIGURE 1 Distribution of school-night total sleep: Early- versus late-starting middle schools.

TABLE 3
Means and Standard Deviations for Weekend-Night Sleep–Wake Patterns

	School E				*School L*			
	Fall		*Spring*		*Fall*		*Spring*	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Bedtime	11:29	1:23	11:37	1:34	11:48	1:44	11:52	1:37
Wake time	9:31	1:32	9:36	1:41	9:11	1:46	9:16	1:44
Total sleep time (min)	604	104	597	110	565	108	568	123
Weekend delay	113	69	116	84	120	100	118	92
Weekend oversleep*[a]	143	87	140	98	86	64	105	82

[a]Fall.
* $p < .001$, school effect.

wake schedule variables differed between the two schools in the fall only: multivariate $F(2, 187) = 8.19$, $p < .001$, with students at the earlier starting middle school oversleeping, on average, 48 min more than the comparison students, $F(1, 196) = 16.45$, $p < .001$.

There were no significant grade or gender differences for school-night sleep–wake patterns for students attending either middle school. Yet, female versus male middle school students reported different weekend sleep–wake patterns: multivariate $F(3, 187) = 5.10$, $p < .01$. In particular, female seventh and eighth graders reported that they obtained 52 min more sleep on weekend nights than their male peers, due to later wake times (ps $< .01$). There were no significant gender or grade differences for weekend sleep delay or oversleep.

Sleep–Wake Quality

As seen in Table 4, overall middle schoolers at School L also reported better sleep–wake quality than their peers at School E at both assessments: multivariate Fs$(3, 170) > 3.53$, ps $< .05$. In the fall, the students at the two schools reported the same level of sleep–wake behavior problems and sleep hygiene practices; however, students at the later starting school reported significantly less daytime sleepiness than the students at the earlier starting school ($p < .05$). In the spring, however, the difference was due to fewer sleep–wake behavior problems as opposed to less daytime sleepiness or better sleep hygiene. In particular, students attending the later starting school reported fewer sleep–wake behavior problems than their peers ($p < .05$). There were no grade or gender differences for the sleep–wake quality variables at either time of assessment.

TABLE 4
Means and Standard Deviations for Sleep Hygiene, Daytime Sleepiness, and Sleep–Wake Behavior Problem Scales

	School E				*School L*			
	Fall		*Spring*		*Fall*		*Spring*	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Sleep hygiene	4.18	0.69	4.22	0.68	4.10	0.71	4.09	0.65
Daytime sleepiness*[a]	12.03	3.42	11.73	3.49	11.23	2.80	11.07	2.77
Sleep–wake behavior problems*[b]	18.42	5.94	19.36	6.80	17.71	7.39	16.66	5.52

[a]Fall. [b]Spring.
* $p < .05$, school effect.

School Performance and Behavior

Table 5 displays the means and standard deviations for academic performance, attendance, and tardiness variables. Academic performance was not analyzed for the spring time of measurement because the school department had a serious computer system problem, and they were not able to get us the transcript grades. Analysis of the fall quarter average grades revealed a significant School × Grade interaction: $F(1, 208) = 17.06$, $p < .001$. Specifically, there were no school differences for the seventh graders; however, eighth graders at School L had significantly higher average grades than their peers at School E: $F(1, 104) = 10.60$, $p < .01$. No gender differences were found for academic performance.

TABLE 5
Means and Standard Deviations for Fall Academic Performance, Tardiness, and Absenteeism Rates

	School E				*School L*			
	7th		*8th*		*7th*		*8th*	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Grade point average*[a]	83.16	7.16	76.85	9.45	80.46	10.11	83.79	8.80
Tardies*[b]	3.18	5.74	6.99	10.12	0.94	1.46	1.20	2.27
Absences	2.96	3.15	3.80	3.29	3.20	3.21	2.48	2.18

[a]School × Grade Effect. [b]School effect.
* $p < .001$.

In addition, fall quarter attendance and tardiness records for students at each school were examined. There were no significant differences in the number of absences for students at each school, but there was a significant difference in tardiness rates (see Table 5). Students at the earlier starting school were tardy nearly four times as often as students at the later starting school: $F(1, 113) = 8.04$, $p < .001$. The figures in Table 5 for tardiness were calculated using the entire sample population. There were, however, some outliers in terms of excessive tardiness. Those that fell outside of the normal distribution curve of tardiness were removed, and the analyses were rerun. The significant difference remained for both grades: seventh graders at School E, $M = 2.64$ ($SD = 4.49$) versus seventh graders at School L, $M = 0.94$ ($SD = 1.46$); eighth graders at School E, $M = 3.79$ ($SD = 4.30$) versus eighth graders at School L, $M = 1.20$ ($SD = 2.27$). There were no grade or gender differences for these attendance and tardiness rates.

DISCUSSION

Previous research demonstrated that high school students benefit when school start times are delayed by over 1 hr. In particular, Wahlstrom (2002) found that attendance rates improved, continuous enrollment remained the same or increased, grades showed slight improvement, and students reported bedtimes similar to students in schools that did not change start times when obtaining 1 hr more sleep on school nights. The present study adds to the field by demonstrating that middle school students are also at an advantage when school start times are delayed. Results reveal that seventh and eighth graders attending an early starting middle school are obligated to wake up earlier in the morning to attend school and are not compensating by going to bed earlier throughout the school year. As a result, these young adolescents are getting significantly less sleep than their peers at a later starting school and report more irregular weekly sleep patterns, increased daytime sleepiness, and more sleep–wake behavior problems. The seventh and eighth graders at the early starting middle school obtained about $\frac{3}{4}$ hr less sleep each night, which amounts to about 3.5 hr less sleep over a 5-night school week. Furthermore, after students had been on their school schedules for over 6 months, those at the early starting school reported more sleep–wake behavior problems, raising questions about the longer range negative implications of early start times for young adolescents. In addition to the sleep deficit, school records indicated that students at the earlier starting school were tardy four times more frequently, and eighth graders at the earlier starting school obtained significantly worse average grades than the eighth graders at the comparison, later starting school.

Not surprising, the findings also suggest that girls and eighth graders may be particularly affected by early starting middle schools. Although there were no gender differences for school-night sleep patterns, on weekend nights girls reported that they obtained more sleep and slept in later on weekend mornings in comparison to their male peers. One explanation for this is pubertal status; female middle school students' sleep patterns may be more phase-delayed than their less mature male classmates. Another plausible explanation is that young, male adolescents may be somewhat more likely to be involved in weekend athletics that may require them to awaken earlier for practices or games. Remarkably few prior studies, however, report significant gender differences in adolescents' sleep duration or bed and wake times. Researchers have found that both middle and high school-age adolescent girls are more likely to report difficulty falling asleep along with other sleep problems in comparison to boys possibly due to pubertal status (Knutson, 2005; Laberge et al., 2001). In addition, previous self-report studies have found that female high school-age teenagers wake up slightly earlier than their male peers on school mornings possibly to get dressed and groomed for school or to assist with family responsibilities (Gau & Soong, 1995; Wolfson & Carskadon, 1998). In this study of younger adolescents, females did not wake up earlier on school mornings than their male peers. Moreover, the eighth graders' behavior appeared to be more influenced by the early start time than the younger, seventh graders. Eighth graders at the early starting school had poorer average grades than eighth graders at the later starting school. Again, although not substantiated in this study of seventh and eighth graders, older adolescents may be experiencing more of a delay in the timing of their nighttime sleep and as a result unable to obtain enough sleep to function their best in school.

These findings are important because they add to the body of evidence in support of delaying school start times for both middle and high school students. Undoubtedly, later school start times serve as an effective countermeasure. Students at later starting middle and high schools obtain more sleep due to later wake times and, in turn, function more effectively in school. In addition, the data strongly suggest that young adolescent students forced to wake up early for school do not compensate for this with earlier bedtimes, nor do those that have later start times choose to stay up later. Since these children are not compensating with earlier bedtimes, they are also struggling with the early wake times, leading to increased tardiness.

Caveats, Implications, and Future Directions

Although our findings definitely add to the research on school start times and adolescents' sleep, certain caveats are relevant. For example, it is difficult to evaluate how representative the sample was, although the congruence between our findings and those of prior research (e.g., Wahlstrom, 2002) suggest that the

sample was relatively typical of other middle or high school-age teenagers. As described in the Participants' section, many of the middle schoolers in this study came from low socioeconomic status families, and over one half were minorities. This is relatively unusual for studies of adolescents' sleep–wake patterns. Future research should examine school start time, sleep, and academic performance in a larger, more heterogeneous sample of middle and high school-age adolescents.

On a related issue, although not objectively derived, the researchers observed that the early starting school had a more traditional, regimented, and disciplined environment with more emphasis on starting school on time than the later starting school. This was striking because it was the School E students who reported significantly greater tardiness. In the future, it would be helpful to objectively examine schools' disciplinary organization and structure in relation to school start times and students sleep and daytime functioning.

The results of this study are based entirely on adolescents' self-reports of their sleep habits and suffer limitations because they were retrospective and subjective. Future research should include an additional assessment such as continuous activity monitoring combined with daily diaries (Acebo, Sadeh, & Seifer, 1999; Wolfson, Carskadon, et al., 2003). Moreover, although academic performance was assessed through school transcript data, it was not available for the spring measurement period. Multiple measures of daytime functioning such as mood, behavior, and health would provide a more comprehensive assessment of the relationship between school start times, sleep patterns, and overall daytime functioning.

An experimental design would have been a more reliable and valid method for evaluating the impact of school start times on students' sleep and behavior. In the current real-world case, the school district voted to shift middle schools' starting times over the summer in an effort to tighten the transportation budget. Optimally, a study evaluating the impact of a school start time shift should involve collecting data from the same adolescents before and after a school start time change with a comparison school that kept the same start time over the same time period.

Finally, it is recommended that future research explore other countermeasures and interventions that may positively impact adolescents' sleep habits and daytime behaviors either independently or combined with school start time and schedule changes. In this study, twice as many students at the later start time middle school obtained the recommended 9 hr of sleep on school nights. Even with a delayed school start time, however, only about one third of the students obtained this standard of 9 hr. Undoubtedly, other factors that contribute to inadequate sleep in adolescents need to be assessed and targeted. School start time changes are a large-scale, environmental countermeasure. Interventions at the individual level such as sleep hygiene preventive programs and sleep education classes for adolescents, parents, and school professionals may positively affect

sleep quantity and quality (Cortesi, Giannotti, Sebastiani, Bruni, & Ottaviano, 2004; Vo, LeChasseur, Wolfson, & Marco, 2003)

In conclusion, this study strongly indicates that middle school-age adolescents attending a later starting school report more total sleep, later wake times, less daytime sleepiness, fewer sleep–wake behavior problems, and less tardiness in comparison to their peers attending schools with earlier start times. Younger adolescents, like their older contemporaries, function better when they are able to sleep in later in the morning before going to school. Future research should continue to examine the relationship between school schedules and adolescents' sleep requirements. In addition, studies need to examine school start times in relationship to preadolescents and elementary school-age youngsters (Spaulding, Butler, Daigle, Dandrow, & Wolfson, 2005). School start times continue to be an issue of debate in school districts around the country, and findings such as those discussed here should provide further support for delaying middle and high school start times.

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