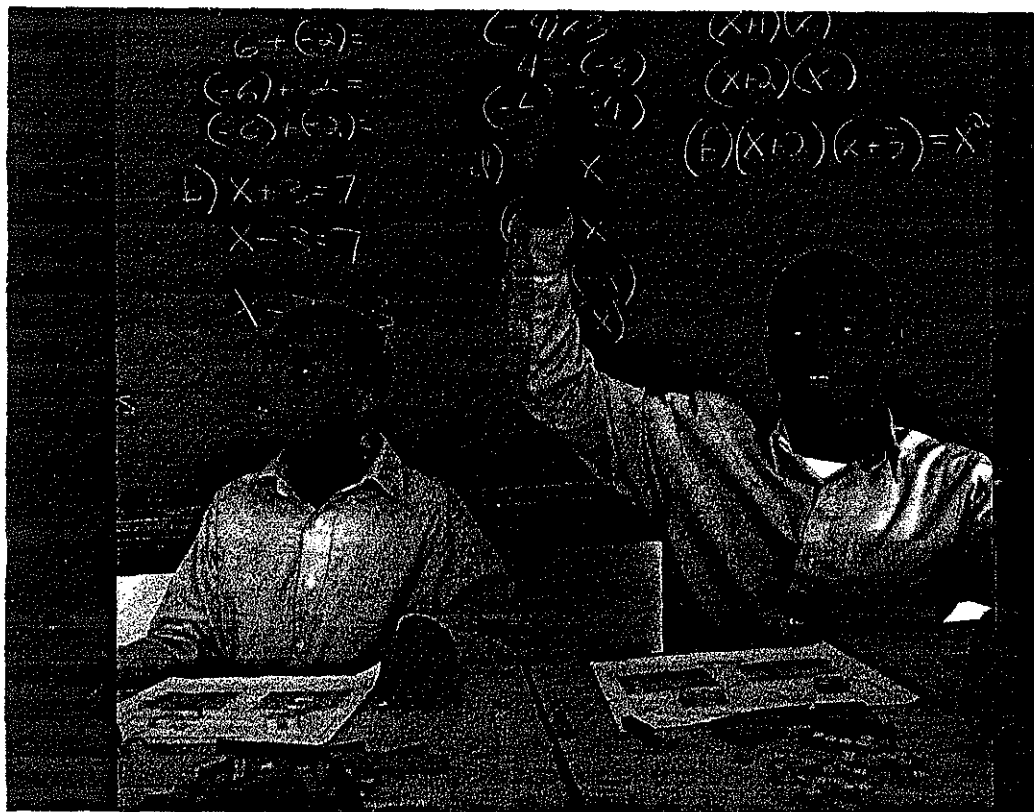


Bulletin

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- Block Scheduling and Mathematics Achievement
- High School Start Times
- Effects of Homework Prescriptions on Middle Level Students

A Survey of Factors Influencing High School Start Times

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The present study surveyed high school personnel regarding high school start times, factors influencing school start times, and decision making around school schedules. Surveys were analyzed from 345 secondary schools selected at random from the National Center for Educational Statistics database. Factors affecting reported start times included economic background of the students, number of bus tiers, and school size. Most schools had not contemplated changing or changed their school start times. Of those schools in which changes were contemplated, 32% noted concerns about teenagers' sleep needs and about 50% of the respondents endorsed possible positive outcomes, such as lower tardiness and absenteeism rates. Perceived barriers to changing school schedules commonly endorsed included sports practices, after-school activities, and the transportation system. Approximately 50% of respondents indicated that sleep is included in their district's high school health or biology course offerings.

The First Bell Survey: Factors Influencing High School Start Times

The study of adolescent sleep has begun to establish a clear understanding of adolescents' sleep needs, patterns, and underlying bioregulatory processes (Carskadon & Acebo, 2002; Carskadon, Acebo, & Jenni, 2004). With regard to perceived sleep needs, reports of teachers, parents, and adolescents have consistently indicated that teens do not get enough sleep (Price, Coates, Thoresen, & Grinstead, 1978; Strauch & Meier, 1988; Wolfson & Carskadon, 1998). Furthermore, laboratory and field studies indicate that the biological need for sleep (about 9 hours per night) does not change from ages 10 to 17. Indeed, older adolescents sleep more than younger adolescents when given the opportunity in a laboratory setting or on weekends, summers, and vacations (e.g., Andrade, Benedito-Silva, Domenice, Arnhold, & Menna-Barreto, 1993; Carskadon, 1990; Carskadon & Acebo, 2002; Park et

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al., 2001). Numerous studies across a variety of geographic and cultural settings point out, however, that middle level and high school adolescents in the "real world" typically obtain less sleep than younger, elementary school-aged children. Thus, for example, fourth graders report sleeping about 10 hours each night, middle level students about 8 hours, and teenagers average less than 7 hours per school night by the end of high school (Carskadon, 1982; Carskadon, 1990; Wolfson & Carskadon, 1998; Fukuda & Ishihara, 2001; Thorleifsdottir, Bjornsson, Benediktsson, Gislason, & Kristbjarnarson, 2002; Strauch & Meier, 1988; Wolfson, Carskadon, et al., 2002; Wolfson, Acebo, Fallone, & Carskadon, 2003).

Another general trend is that the timing of sleep gets later as children enter and pass through adolescence, staying up later at night and sleeping in later in the morning. This delay of the sleep period is most obvious on weekend nights, whereas the timing of sleep is largely determined on school days by school start time schedules (Carskadon, Wolfson, Acebo, Tzischinsky, & Seifer, 1998; Epstein, Chillag, & Lavie, 1998; Szymczak, Jasinska, Pawlak, & Swierzykowska, 1993).

In one study attempting to investigate the association of sleep patterns and school start time, Carskadon, Wolfson, et al. (1998) evaluated the effect of a 65-minute advance (earlier) of school start time for approximately 40 students across the transition from grade 9 (8:25 a.m.) to grade 10 (7:20 a.m.). Objectively documented sleep records demonstrated that only 62% of the students in 9th grade, and fewer than half the students in 10th grade obtained an average of 7 hours or more of sleep on school nights. As expected, students woke significantly earlier on school days in 10th grade than in 9th grade. In 10th grade, students also displayed atypical sleep patterns on a laboratory nap test of sleepiness (i.e., the Multiple Sleep Latency Test, or MSLT). They fell asleep faster in 10th than in 9th grade (particularly an assessment at 8:30 a.m.), and 48% of 10th-grade participants' experienced at least one REM sleep episode on the MSLT. This unusual pattern is disturbing because it mimics the clinical findings of patients with a major sleep disorder—narcolepsy (Guilleminault & Anagnos, 2000). These findings were attributed to a combination of too little sleep occurring at a time mismatched to internal circadian rhythms. Survey results consistently indicate that middle level and high school students who start school at 7:15 a.m. or earlier obtain less total sleep on school nights due to earlier rise times in comparison to students at later-starting schools (Allen, 1992; Baroni et al., 2004; Carskadon et al., 1998; Carskadon & Wolfson, 1998; Epstein et al., 1998). Imposition of early school start times for adolescents appears to require teenagers to have bedtimes that are impractical and/or infeasible. The result is insufficient time for sleeping.

Cognitive function and psychomotor skills are closely related to sleep, and numerous studies have correlated sleep loss with significant decreases in

children's and adolescents' performance (Fallone, Owens, & Deane, 2002; Sadeh, Gruber, & Raviv, 2002). Wolfson and Carskadon (2003) reviewed and critiqued studies that examined the association of sleep patterns, sleep quality, and school performance for adolescents attending middle level or high school or college. Findings from the majority of these studies indicated that shortened total sleep time, erratic sleep/wake schedules, late bed and rise times, and poor sleep quality are negatively associated with academic performance for adolescents from the middle level through the college years. Specifically, studies of middle level and high school students reported that more sleep, earlier bedtimes, later weekday rise times, and less daytime sleepiness were associated with better grades in school and greater motivation to do one's best in school (Epstein et al., 1998; Horn & Dollinger, 1989; Kahn et al., 1989; Meijer, Habekoth, & Van Den Wittenboer, 2000; Wolfson & Carskadon, 1998).

Undoubtedly, high school students have an extremely difficult task to obtain an optimal (~9.2 hours) or adequate (~8.5 hours) amount of sleep on school nights when schools start very early in the morning. Many teenagers are behaviorally and physiologically not ready to fall asleep until 11:00 p.m. or later and are biologically programmed to be asleep when school begins. As a consequence, many students fall asleep in early morning classes, and they may also fall asleep behind the wheel driving to school. Sleepiness-related crashes are most common in drivers age 16 to 25, particularly boys (Pack et al., 1995). Overall, many adolescents confront a major challenge if schools begin earlier than 8:30 a.m.; many schools start too early in the morning for adolescents to get adequate sleep, whether in the United States or in other countries such as Canada, Israel, Brazil, or Italy (Andrade & Menna-Barreto, 2002; Carskadon & Acebo, 1997; Epstein et al., 1998; Giannotti & Cortesi, 2002). One factor contributing to schedules for U.S. school districts is a three- or four-bell schedule, where high schools open first, followed by middle level or junior high schools, and then elementary schools (Nudel, 1993).

In a small pilot study of school schedules, start times dating back to 1975 were analyzed for 59 high schools by comparing start-time trends for early-starting schools (before 8:00 a.m.) in 1996 versus late (8:00 a.m. or later) starting schools (Carskadon & Acebo, 1997). Results showed that early-starting schools had become increasingly early across time. Another study examined 40 high school schedules posted on the Internet for the 1996-97 academic year: 48% started at 7:30 a.m. or earlier and 12% started between 8:15-8:55 a.m. (Wolfson, 2002). Another Internet assessment in 2001-02 showed that nearly 50% of 50 schools started between 7:31-8:14 a.m., 35% earlier than 7:30 a.m., and 16% between 8:15-8:55 a.m. (Acebo & Wolfson, in press).

A number of school districts have responded to research reports regarding the prevalence of inadequate sleep among middle level and high school

students by delaying their starting times; other districts have debated the question. Wahlstrom (2002a; 2002b) compared over 18,000 high school students in the Minneapolis School District before and after the district's school start time changed from 7:15 a.m. in the 1996–97 school year to 8:40 a.m. beginning with the 1997–98 school year. The researchers compared attendance, enrollment, grades obtained from official school records, and sleep patterns acquired from a self-report survey. They reported several statistically significant results:

- Attendance rates for students in grades 9 through 11 improved
- Percentage of high school students continuously enrolled in the district or the same school also increased
- Grades showed a slight but not statistically significant improvement
- Minneapolis high school students reported bedtimes similar to students in schools that did not change start times, obtaining nearly a hour more sleep on school nights during the 1999–2000 school year.

Similar findings were reported for middle level students in an urban, New England school district. Seventh and eighth graders at a later starting middle level school (8:37 a.m.) reported less tardiness, less daytime sleepiness, better academic performance, more school-night total sleep, and later rise times in comparison to middle level students at an earlier starting school (7:15 a.m.) (Baroni et al., 2004). More data are needed to confirm that delayed school openings will have a favorable effect on students; however, these studies (Baroni et al., 2004; Wahlstrom, 2002a, 2002b) indicate that delayed sleep schedules and early school start times are associated with daytime sleepiness, dozing in class, attention difficulties, and poorer academic performance.

Research on the sleep needs of adolescents and the influence of sleep on learning and behavior captured the interest of school districts across the United States and in other countries, and school administrators are being urged to acknowledge the evidence and to adjust school schedules accordingly (e.g., delay high school start times). One assumption underlying these discussions is that high schools have started increasingly earlier over the last few decades, an assumption that has not been thoroughly investigated.

The issue of scheduling has not entirely escaped the notice of the educational research community. In contrast to the sleep research community's approach, however, educational researchers have evaluated educational outcomes by focusing more on the effect of internal class scheduling (e.g., block schedules versus traditional high school class schedules). For example, Carroll (1994) found that schools using block scheduling had an overall increase in completed course credits, equal or better mastery and retention of material,

and a reduction in suspension and dropout rates. Likewise, Canady and Rettig (1995) noted that block scheduling allows students to enroll in a greater number and variety of elective courses, offers more opportunities for acceleration, and teachers have fewer students to keep records and grades for each semester. More recently, Hackmann and Waters (1998) found several additional positive outcomes as a result of block scheduling, including a broader array of courses selected by students, report of fewer disciplinary referrals, improved class attendance, and increased numbers of students completing AP courses. None of these evaluations, however, assessed whether the timing of the school day as an influence on these measures.

In sum, although sleep researchers have demonstrated that high school students benefit from later school start times, and some secondary school personnel have begun to delay high school start times, little is known regarding historical school start time trends and the factors that influence bell schedules. Presented here are the results of a pilot survey of school personnel regarding high school start times, factors influencing school start times, and decision making around school schedules.

Method

Procedures

Approximately 10% of the schools ($N = 4,116$) serving high school students from the National Center for Education Statistics (2001) Web site database of public schools in the United States were randomly selected to participate in the first bell survey. Specifically, the database was organized alphabetically by state and every 10th school was selected. In January 2002, school administrators from the 4,116 schools were sent an invitation letter requesting that they complete and return an enclosed First Bell Information Form (see Appendix) or fill out an online version. The form was designed a priori with the goal of collecting relevant information in a compact, two-page format to increase the likelihood of a high response rate. This brief questionnaire asked the school administrator to provide information regarding the pattern of school schedules over the past 35 years, current views and perceived barriers to make a change to the school schedule, and other questions regarding school size, bus tiers, socioeconomic background of the majority of the students, living environment of the students, whether the curriculum includes courses about sleep, and so forth.

Participants

Eight hundred and nine schools (approximately 20%) completed the form, with 8% responded via the Web, 10% by fax, and 81% by mail. However, 159 surveys were not included in the data set because the schools no longer

existed, did not include high school students at all, or were special education schools. In addition, 305 schools were not included in these analyses because they were not public schools, served special populations (e.g., learning disabled students only, returning evening students), or included elementary or middle level school-age students in addition to high school students. The final data set, therefore, includes 345 surveys from "regular" public schools serving grades 9–12 for which data at least back to the 1986–87 school year were included.

Seventy-three percent of the forms were completed by a school administrator and the remainder was completed by school secretaries/administrative assistants, school committee members, or school counselors. With the exception of Washington, DC, and Hawaii, all U.S. states and Puerto Rico are represented in the sample. The majority of the states had 1 to 10 schools, with 25 schools from New York, 23 from Ohio, 23 from California, 21 from Texas, 19 from Illinois, and 15 each from New Jersey and Michigan. All schools included grades 11 and 12, 341 also included grade 10, and 325 schools served grades 9–12. Forty-nine percent of respondents noted that the students in their school came from a "comfortable" (i.e., middle class) socioeconomic background, whereas 34% were "struggling" (i.e., low income) or impoverished. The remaining schools (nearly 13%) noted that most of the students in their school were from well off, or affluent, families. The schools in the sample ranged in size, with 29% having 500 or fewer students, 29% having 500–1,000, and 41% having over 1,000 students. Respondents noted that the living environment for at least one-third of their students was as follows: inner city/urban (12%), suburban (52%), and rural (33%). Thirty-eight percent of the schools reported that their district had at least one bus tier, 40% had two or three tiers, and 5% had no buses.

Results

School Start and End Times

Although the survey requested school schedule information as far back as 1966–67, too few (only 28%) returned forms that included information earlier than 1986–87 for the earlier years to be included in the analyses. Figure 1 displays the distribution of current (2001–02) reported bell times. As shown in Table 1, the overall average school start and end times did not change across the 15-year span from 1986–87 to 2001–02, where $p > .13$, start time $M = 7:55$ a.m. ($SD = 22$ minutes) and end time $M = 2:46$ p.m. ($SD = 33$ minutes).

In an analysis similar to Carskadon and Acebo (1997), schools were divided into two groups based upon the current (2001–02) reported start times: those earlier than 8:00 a.m. and those later than 8:00 a.m.. The earlier group included 179 schools and the later group included 165 schools. Start times were evaluated using a two-group (earlier vs. later) repeated measures analysis of variance to examine for trends across time. Figure 2

Figure 1. High school start times, 2001–02.

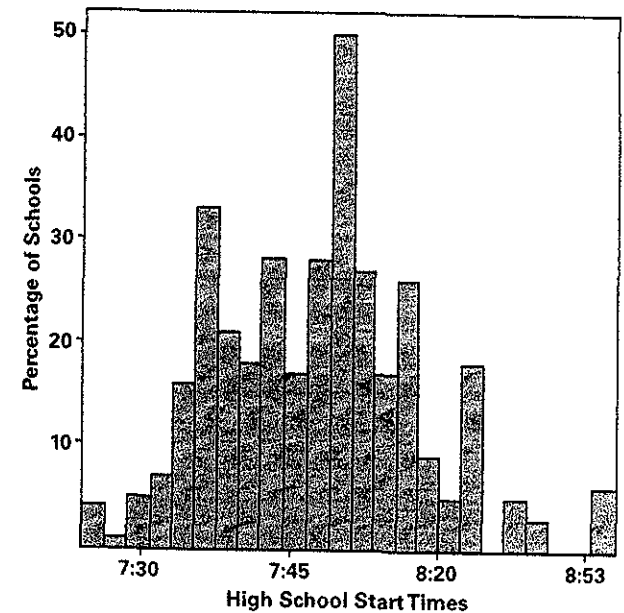


Table 1. School Start and End Times, 1986–2001

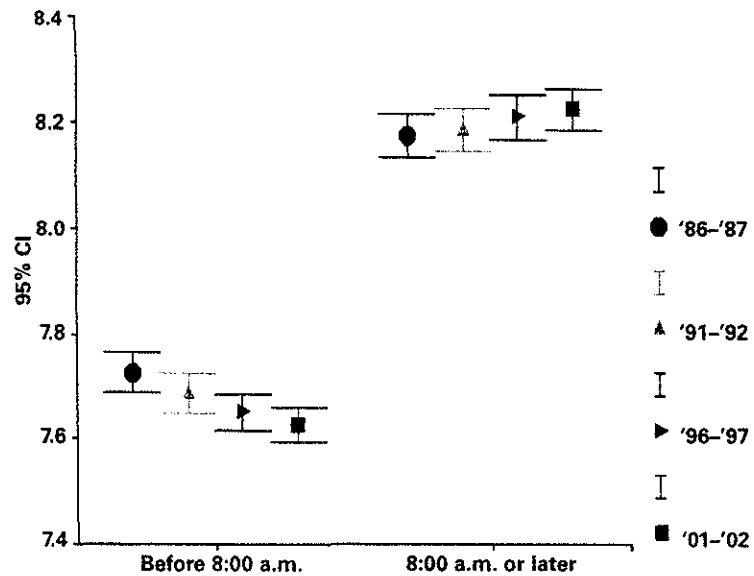
	Start Time		End Time	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
1986–87	7:56	:20	2:47	:32
1991–92	7:56	:22	2:46	:32
1996–97	7:55	:22	2:46	:35
2001–02	7:54	:23	2:47	:35

illustrates the trends for school start times showing a significant interaction of start-time group by time ($F[1,339] = 27.12, p < .001$). Post-hoc analyses demonstrated a significant linear trend in the earlier group for earlier starting times across the years ($F[1,176] = 32.06, p < .001$), whereas schools in the later group had a significant linear across time trend for later starting times ($F[1,163] = 4.83, p < .05$).

Factors Influencing School Start Times

Factors influencing high school start and end times were examined only for the 2001–02 academic year, and several emerged as significant (see Table 2). Thus, reported school start time was earlier for schools with larger enrollments ($F[3,342] = 12.42, p < .001$). In particular, schools with 1,000 or more students

Figure 2. Start time in 2001–02.



started about 15 minutes earlier than smaller schools. Reported socioeconomic backgrounds of the majority of the students also influenced school start times. For schools where most students were reported as “well off-to-affluent,” reported start time averaged about 12 minutes earlier than for schools with students from economically “comfortable” families, or schools with students whose families were “struggling” or “impoverished” ($F[2,323] = 5.89, p < .01$). Schools in rural areas were reported to start about 12 minutes later on average than schools in suburban or urban/inner city environments ($F[2,331] = 12.30, p < .001$). Finally, the number of bus tiers in the school district had a significant effect on the reported 2001–02 school start times ($F[2,294] = 27.05, p < .001$): schools in districts with two or three bus tiers had significantly earlier reported start times than schools with no buses or one tier only.

Changes or Contemplated Changes in School Schedules

One question on the form asked respondents to report whether “your district changed or considered changing the schedule for high school in the last 3 years.” (The survey did not distinguish between a changed or contemplated change in their district’s high school schedule.) Overall, 60% of reports indicated no change or no contemplated change of schedule for high schools. The reports noting that a schedule change had occurred or had been considered included 12% for an earlier start time, 17% for a later start time, 4% for

Table 2. High School Start Time and School Demographics

School Demographic	Start Time	
	M	SD
School Size**		
≤ 500 (n = 101)	8:04	19 min
501–1,000 (n = 99)	8:00	22 min
1,101–1,500 (n = 70)	7:47	22 min
>1,500 (n = 73)	7:46	25 min
Socioeconomic Status*		
Well-off to affluent (n = 43)	7:44	22 min
Comfortable (n = 167)	7:55	22 min
Impoverished to Struggling (n = 116)	7:58	23 min
Bus Tiers**		
No Buses or 1 Tier (n = 148)	8:03	18 min
2 Tiers (n = 80)	7:48	23 min
3 Tiers (n = 67)	7:43	23 min
Setting**		
Urban (n = 40)	7:52	26 min
Suburban (n = 177)	7:50	23 min
Rural (n = 115)	8:03	18 min

* $p \leq .01$, ** $p \leq .001$

an earlier end time, and 12% for a later end time. Of those schools, 32% endorsed as a principle reason concerns about adolescent sleep. Other reasons included a state-mandated increase in annual instructional hours (15%), changes in after-school activities schedules (6%), or a change in the bus fleet (6%). The schools that changed or contemplated a high school schedule change reported a number of barriers to changing school start and end times. Although many barriers were indicated (respondents could check more than one response), 55% of the sample endorsed athletic practices as a major barrier. Other barriers endorsed by respondents included after-school activities (26%), teachers’ concerns (32%), parents’ concerns (28%), the expense of

changing the transportation system (30%), and childcare before (16%) or after school (20%).

The respondents who reported a change or contemplated schedule change for high schools in their district were also asked to indicate potential positive or negative outcomes that could result from delaying school, checking as many as applied from a list. Approximately 50% endorsed each of the following positive outcomes: improved attendance, lower tardiness rates, and happier students. Other outcomes endorsed were better grades (30%) and increased teacher satisfaction (25%). Few items were endorsed as possible negative outcomes of delaying school start: endorsed decreased teacher satisfaction (13%), poorer athletic performance (4%), lower grades (4%), moodier students (2%), increased tardiness (3%), more absenteeism (3%), and reduced parental involvement (1%).

Curricular Issues

Finally, it is noteworthy that 53% of the respondents identified that sleep biology or healthy sleep patterns were part of the district's curricular offerings, principally in the high school years (9th = 30%, 10th = 29%, 11th = 15%, 12th = 12%).

Discussion

High School Start and Closing Times

Although the initial aim of this pilot survey was to examine whether school starting times had become earlier since the 1960s, we were only able to examine a 15-year interval from 1986 to 2001. Our findings indicate that high school schedules have not changed significantly on average over this period.

The majority of respondents reported that the administrators in their district had neither changed nor contemplated a change in the high school schedule over the last 3 years. For the schools that had changed or considered changing to an earlier or later school start time, the most frequently endorsed reason for the change was due to concerns about teen sleep. Correspondingly, nearly one-half of the respondents that changed or contemplated a change acknowledged possible or actual positive outcomes, such as improved attendance, lowered tardiness, and more content students, as a result of later high school start times, similar to Wahlstrom's findings (2002a, 2002b) in the Minneapolis test case. Very few schools identified possible or actual negative outcomes. We were struck that many respondents from the few schools that had changed or contemplated delaying start times acknowledged the academic and sleep benefits.

To change school start times, however, numerous obstacles, myths, and constituents are involved (Wahlstrom, 2002a; Wolfson, 2002). At this juncture,

it is recommended that adolescent health and development researchers collaborate with school administrators, parents, teachers, and teenagers to help guarantee that adolescents obtain more sleep so they can remain engaged in school. School administrators, teachers, and researchers should consider creative solutions that will allow for sleep and quality education and cocurricular activity time for high school students. Recommendations for school administrators include the following:

- Educate the community (students, parents, teachers, school nurses, guidance counselors, school board members) on sleep, sleep disorders, and biological rhythms
- Initiate a districtwide stakeholder assessment on school start times (see Wahlstrom, 2002b)
- Consider a variety of school schedule options that will benefit adolescents' sleep and daytime functioning needs
- Develop a system for evaluating students for sleep disorders or poor sleep habits when they consistently fall asleep in class, are routinely late or absent from school, or are doing poorly academically, particularly without a known or previously diagnosed learning disorder or health problem
- Institute a sleep curriculum into the middle level and high school health, biology, or other relevant courses
- Decrease nightly homework hours
- Buffer early start times by setting limits on evening activities at school as well as early morning and late evening athletic practices
- Counsel students and families to plan activities around an agenda that has adequate sleep at its core
- Work with community organizations and employers to decrease adolescents' employment hours
- Set an example for making sleep a positive priority.

Factors Influencing Start Times

This pilot study also looked at a range of factors that might contribute to high school start times such as enrollment, socioeconomic background of the students, students' living environment, and bus tiers. The number of bus tiers had a significant effect on the 2001–02 high school start times. Not surprisingly, reported start times were earlier for high schools in districts with two to three bus tiers as compared to districts with only one tier or no buses at all. In all

likelihood, high schools with several bus tiers are located in larger districts that rely on a three- or four-bell schedule with high schools opening first, followed by middle level or junior high schools, and then elementary schools (Nudel, 1993). It is unclear why, historically, high schools have opened before schools serving younger students. A number of researchers, administrators, and policy-makers have evaluated and written extensively on school bus safety, transportation costs, legal issues, and energy efficiency (e.g., Humphries & Vincent, 1981; Mawdsley, 1996; Miller, 1988; Transportation Research Board, 1989). Few analyses, however, have focused on alternative bus schedules, increasing buses so that more students start school later in the morning, bus tiers, schedules, and school start times. Additionally, although educators have written about school bus safety, no discussion has addressed the risks (e.g., driver fatigue) of having children and adolescents transported during the early morning hours when bus drivers themselves may not be alert. Moreover, high schools with larger enrollments started earlier on average than smaller schools.

Sleep Curriculum

Although large-scale, systematic countermeasures such as changing school start times have an effect on high school students' sleep/wake schedules and, ultimately, their daytime lives (e.g., academic performance, mood), individual-focused strategies may be important and beneficial to adolescents as well. One approach is to develop sleep education programs that can be implemented in health and science classes at the middle and high school levels (or even younger). Just over 50% of the respondents to the current survey acknowledged that their district's curriculum teaches students about sleep biology or healthy sleep patterns, mostly in either 9th or 10th grade. Unfortunately, however, our pilot survey did not query respondents about any of the details of their schools' curricula, so the extent of such coursework is not known.

Several groups are developing both sleep biology and sleep hygiene curricula for both middle level and high school-age adolescents. For example, the National Institutes of Health has developed a five-module high school sleep curriculum, *Sleep, Sleep Disorders, and Biological Rhythms* (Biological Sciences Curriculum Study, 2004). This particular curriculum focuses on helping students understand the importance of sleep to health, the consequences of lack of sleep, and conveying the importance of scientific research. In addition, in two preliminary studies, researchers (Rossi, Campbell, Vo, Marco, & Wolfson, 2002; Vo, LeChasseur, Wolfson, & Marco, 2003) found that a sleep hygiene education program was successful at improving middle level students' sleep habits (e.g., weekday/weekend schedule regularity, total sleep time) and their sense of competence in being able to maintain a consistent sleep schedule.

Caveats, Implications, and Conclusions

We are concerned about the implications of data obtained from this sample of high schools regarding early start times; however, certain caveats pertain. First, this pilot study relied on survey techniques and not archival data. Second, most of the respondents were school administrators; however, over one-quarter were administrative assistants, school committee members, or counselors. As a result, their access to information likely varied considerably. Future studies of high school start and end times might fare better relying on school department archives, particularly to glean historical trends. Third, this pilot First Bell Survey focused on high schools. Additional assessments of school start times for elementary and middle level schools can provide a more complete assessment of the role of the first bell at all levels.

Teenagers are often described as sleepy and dragged out. They struggle with getting up in the morning, fall asleep in classes, and fall asleep while driving. Teens are often assessed blame for these behaviors because they stay up too late. Our data indicate that at least as far back as 1986, the majority of the high schools started too early in the morning for most adolescents' sleep needs and schedule, as well as daytime functioning. Many high school and middle level students cannot get to sleep early due to a combination of biological and psychosocial factors, such as homework hours, after-school activities, and family schedules. In addition, starting school early in the morning interferes with learning, particularly during the first few classes of the day. School administrators note that many factors prevent adjusting start times later for adolescents, putting the onus for coping with the start time entirely on the students and their families. Reorganizing school start and end time schedules, bus tiers, etc. is a major undertaking for many school districts. Perhaps other countermeasures can help students while the structural barriers are identified and surmounted. Several recommendations for school administrators were outlined previously, taking into consideration large-scale countermeasures such as delaying middle level and high school start times. Likewise, interventions at the individual level, such as adapting a curriculum on sleep, have been presented.

An extensive amount of well-researched information is available on adolescents' sleep-wake schedules, disorders, daytime sleepiness, academic performance, and overall functioning; however, important questions remain. Additional research is needed in the application of this research knowledge to creating programs and new policies that will increase the time available for teenagers to sleep and engage in school. Large-scale outcome studies need to evaluate and compare the effects of school schedule changes and sleep hygiene education programs. Equally important, dialogues and exchanges of research findings and innovative ideas between sleep researchers, educators,

parents, and adolescents themselves, may help reverse the current early school start time and increased sleep loss trends.

Furthermore, we come to the issue of school schedules, not as secondary school educators, but as scientists with knowledge based in research aimed at understanding adolescent sleep patterns and the consequences of inadequate sleep in young people. We find ourselves in the position of asking educators who hear our message, who have seen their slack-jawed, dejected, and exhausted students—those, in other words, who have seen the very tangible effects of insufficient sleep—to place youngsters' sleep closer to the top of issues taken into account in all aspects of academic scheduling. We ask you to engage your creative energies in identifying ways to work toward solutions. Start time may be one of the keys, but so are times of practices, meets, concerts, and homework. We do not have the solutions; we cannot identify all the complex factors confronting secondary school educators and administrators. We only hope that the young people in your schools can find a better solution to navigate adolescence with your help. ✎

References

- Acebo, C., & Wolfson, A. R. (in press). Inadequate sleep in children and adolescents. In C. A. Kushida (Ed.), *Sleep deprivation*. New York: Marcel Dekker.
- 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.
- Andrade, M. M., & Menna-Barreto, L. M. (2002). Sleep patterns of high school students living in Sao Paulo, Brazil. In M. A. Carskadon, (Ed.), *Adolescent sleep patterns: Biological, sociological, and psychological influences* (pp. 118–131). Cambridge, United Kingdom: Cambridge University Press.
- Andrade, M. M., Benedito-Silva, A. A., Domenice, E. E. S., Arnold, I. J. P., & Menna-Barreto, L. M. (1993). Sleep characteristics of adolescents: A longitudinal study. *Journal of Adolescent Health, 14*, 401–406.
- Baroni, E. M., Naku, K., Spaulding, N., Gavin, M., Finalborgo, M., LeBourgeois, M. K., & Wolfson, A. R. (2004). Sleep habits and daytime functioning in students attending early versus late starting middle schools. *Sleep* (Abstract Supplement), *27*, A396–A397.
- Biological Sciences Curriculum Study. (2004). *Sleep, sleep disorders, and biological rhythms*. Washington, DC: National Institutes of Health, Office of Science Education and National Heart, Lung, and Blood Institute.
- Canady, R. L., & Rettig, M. D. (1995). *Block scheduling: A catalyst for change in high schools*. Princeton, New Jersey: Eye on Education.

- Carroll, J. M. (1994). Organizing time to support learning. *The School Administrator, 51*(3), 26–33.
- Carskadon, M. A. (1982). The second decade. In C. Guilleminault (Ed.), *Sleeping and waking disorders: Indications and techniques* (pp. 99–125). Menlo Park, CA: Addison-Wesley.
- Carskadon, M. A. (1990). Patterns of sleep and sleepiness in adolescents. *Pediatrician, 17*, 5–12.
- Carskadon, M. A., & Acebo, C. (1997). Historical view of high school start time: preliminary results. *Sleep, 26*, 184.
- Carskadon, M. A., & Acebo, C. (2002). Regulation of sleepiness in adolescents: Update, insights, and speculation. *Sleep, 25*(6), 606–614.
- Carskadon, M. A., Acebo, C., & Jenni, O. G. (2004). Regulation of adolescent sleep: Implications for behavior. In R. Dahl & L. P. Spear (Eds.), *Annals of the New York Academy of Sciences, adolescent brain development: Vulnerabilities and opportunities* (Vol. 1021, pp. 276–291). New York: New York Academy of Sciences.
- Carskadon, M. A., Vieira, C., & Acebo, C. (1993). Association between puberty and delayed phase preference. *Sleep, 16*(3), 258–262.
- Carskadon, M., Wolfson, A., Acebo, C., Tzischinsky, O., & Seifer, R. (1998). Adolescent sleep patterns, circadian timing, and sleepiness at a transition to early school days. *Sleep, 21*(8), 871–881.
- Epstein, R., Chillag, N., & Lavie, P. (1998). Starting times of school: Effects of daytime functioning of fifth-grade children in Israel. *Sleep, 21*(3), 250–256.
- Fallone G., Owens, J. A., & Deane, J. (2002). Sleepiness in children and adolescents: Clinical implications. *Sleep Medicine Reviews, 6*, 287–306.
- Fukuda, K., & Ishihara, K. (2001). Age-related changes of sleeping pattern during adolescence. *Psychiatry and Clinical Neurosciences, 55*(3), 231–231.
- Giannotti, F., & Cortesi, F. (2002). Sleep patterns and daytime function in adolescence: An epidemiological survey of an Italian high school student sample. In M. A. Carskadon (Ed.), *Adolescent sleep patterns: Biological, sociological, and psychological influences* (pp. 132–147). Cambridge, United Kingdom: Cambridge University Press.
- Guilleminault, C., & Anagnos, A. (2000). Narcolepsy. In M. H. Kryger, T. Roth, & W. C. Dement (Eds.), *Principles and practice of sleep medicine* (pp. 676–686). Philadelphia: W. B. Saunders.
- Hackmann, D. G., & Waters, D. L. (1998). Breaking away from tradition: The Farmington High School restructuring experience. *NASSP Bulletin, 82*(596), 83–92.

- Horn, J. L., & Dollinger, S. J. (1989). Effects of test anxiety, tests, and sleep on children's performance. *Journal of School Psychology, 27*, 373-382.
- Humphres, K. W., & Vincent, R. (1981). Five tips for cutting transportation costs. *American School Board Journal, 168*(11), 25.
- Kahn, A., Van de Merckt, C., Rebuffat, E., Mozin, M. J., Sottiaux, M., Blum, D., & Hennart, P. (1989). Sleep problems in healthy preadolescents. *Pediatrics, 84*, 542-546.
- Mawdsley, R. D. (1996). *Pupil transportation and the law* (Monograph Series No. 55) (2nd ed.). Topeka, KS: National Organization on Legal Problems of Education.
- Meijer, A. M., Habekothe, H. T., & Van Den Wittenboer, G. L. (2000). Time in bed, quality of sleep and school functioning of children. *Journal of Sleep Research, 9*(2), 145-153.
- Miller, A. R. (1988). *Pupil transportation management*. Thousand Oaks, CA: Ramsburg and Roth.
- National Center for Education Statistics. (2001). *Common core of data: Information on public schools and school districts in the United States*. Washington, DC: Author. Available: <http://nces.ed.gov/ccd/search.asp>.
- Nudel, M. (1993). The schedule dilemma. *American School Board Journal, 180*(11), 37-40.
- Pack, A. I., Pack, A. M., Rodgman, E., Cucchiara, A., Dinges, D. F., & Schwab, C. W. (1995). Characteristics of crashes attributed to the driver having fallen asleep. *Accident Analysis & Prevention, 27*(6), 769-775.
- Park, Y. M., Matsumoto, K., Shinkoda, H., Nagashima, H., Kang, M. J., & Seo, Y. J. (2001). Age and gender difference in habitual sleep-wake rhythm. *Psychiatry and Clinical Neurosciences, 55*, 201-202.
- 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.
- Rossi, C. M., Campbell, A. L., Vo, O. T., Marco, C. A., & Wolfson, A. R. (2002). Middle school sleep-smart program: A pilot evaluation. *Sleep* (Abstract Supplement), 25, A279.
- Sadeh, A., Gruber, R., & Raviv, A. (2002). Sleep, neurobehavioral functioning, and behavior problems among Israeli children. *Child Development, 73*, 405-417.
- Strauch, I., & Meier, B. (1988). Sleep need in adolescents: A longitudinal approach. *Sleep, 11*(4), 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*(5), 433-435.
- Thorleifsdottir, B., Bjornsson, J. K., Benediktsdottir, B., Gislason, T., & Kristbjarnarson, H. (2002). Sleep and sleep habits from childhood to young adulthood over a 10-year period. *Journal of Psychosomatic Research, 53*, 529-537.
- Transportation Research Board. (1989). *Improving school bus safety: Special report*. Washington, DC: National Research Council.
- Vo, O. T., LeChasseur, K., Wolfson, A., & Marco, C. (2003). Sleepy pre-teens: Second pilot of sleep-smart program in 7th graders. *Sleep* (Abstract Supplement), 26, 1036.
- Wahlstrom, K. (2002a). Accommodating the sleep patterns of adolescents within current educational structures: an uncharted path. In M. A. Carskadon (Ed.), *Adolescent sleep patterns: Biological, sociological, and psychological influences* (pp. 172-197). Cambridge, United Kingdom: University Press.
- Wahlstrom, K. (2002b). Changing times: Findings from the first longitudinal study of later high school start times. *NASSP Bulletin, 86*(633), 3-21.
- Wolfson, A. (2002). Bridging the gap between research and practice: What will adolescents' sleep/wake patterns look like in the 21st century? In M. A. Carskadon (Ed.), *Adolescent sleep patterns: Biological, social, and psychological influences* (pp. 198-219). Cambridge, United Kingdom: University Press.
- Wolfson, A. R., Acebo, C., Fallone, G., & Carskadon, M. A. (2003). Actigraphically-estimated sleep patterns of middle school students. *Sleep* (Abstract Supplement), 26, 313.
- Wolfson, A. R., & Carskadon, M. A. (1998). Sleep schedules and daytime functioning in adolescents. *Child Development, 69*, 875-887.
- Wolfson, A. R., & Carskadon, M.A. (2003). Understanding adolescents' sleep patterns and school performance: A critical appraisal. *Sleep Medicine Reviews, 7*(6), 491-506.
- Wolfson, A. R., Carskadon, M. A., Acebo, C., Seifer, R., Fallone, G., Labyak, S. E., & Martin, J. L. (2003). Evidence for the validity of a sleep habits survey for adolescents. *Sleep, 26*(2), 213-216.

Appendix

First Bell Information Form

*Instructions: Please answer the questions below as accurately as you can.
This information helps us compare different schools from around the USA.*

School Name: _____

Address: _____

Congressional District (or name of Representative): _____

Type of School (check all that apply):

- Private Public Parochial Day only Boarding only
 Day & Boarding Coeducational Boys only Girls only

Size of school (check one):

- 100 or fewer 101 to 500 501 to 1,000
 1,001 to 1,500 over 1,500

Grades (check all that attend the school on a daily basis):

- K 1 2 3 4 5 6 7 8
 9 10 11 12

Living environment of students (check all that constitute at least 1/3 of students):

- Inner city City (urban) Suburban Small town
 Rural/farming

Socioeconomic background of the majority of students:

- Affluent/wealthy Well off Comfortable
 Struggling to make ends meet Impoverished

What is the annual per student expenditure on education in your school district? (optional) \$ _____

Complete the table below with as much information as you can provide accurately.

School Year	Start Time (First Bell)	End Time (Last Bell)
Current Year: 1999-2000		
Previous Years: 1994-1995		
1989-1990		
1984-1985		
1979-1980		
1974-1975		
1969-1970		
1964-1965		

Source of school schedule information:

- School administrator School secretary
 School committee (school board) State records Other

Name (optional): _____

How many tiers are in your district's transportation system?

- No buses Single tier 2 tier 3 tier
 Other: _____

If your district has changed or considered changing the schedule for high school in the last three years, has the (contemplated) change been to a schedule with:

- earlier or later start time (first bell) no change contemplated
(skip next 3 items)
 earlier or later end time (last bell)

For what principal reason has your school contemplated a new schedule in the last 3 years?

- State-mandated increase in annual instructional hours
 Change in after-school activities schedules
 Change (reduction increase) in bus fleet
 Concerns about adolescent sleep
 Other (describe briefly): _____

What barriers exist(ed) in your community to altering school schedules?

- Athletic practices After-school activities other than sports
- Teachers' concerns Parents' concerns Associated administrative costs
- Expense of changing the transportation system Child care before school
- Child care after school Others (list): _____

What results might occur (have occurred) from starting school later? (check all that apply):

- Improved attendance More absenteeism Lower tardy rate
- Increased tardy rate Lower grades Better grades
- Happier students Moodier students Decreased teacher satisfaction
- Increased teacher satisfaction Poorer athletic performance
- Better athletic performance Reduced parental involvement
- Increased parental involvement

Does your school curriculum teach students about sleep biology or healthy sleep patterns?

- no yes If yes, for what grade(s)? _____