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School start time changes and sleep patterns in elementary school students

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ABSTRACT

Objectives: Research finds significant sleep deprivation among adolescents with early school start times. This study surveyed sleep patterns in elementary school students before and after a district-wide change to earlier start times.

Design: Students in grades 3–5 completed a self-administered sleep survey in the spring of 2009 (third grade, $n = 216$; fourth grade, $n = 214$; fifth grade, $n = 259$; total, $n = 689$) and again in 2010 (third grade, $n = 168$; fourth grade, $n = 194$; fifth grade, $n = 263$; total, $n = 625$), after the school start time switched from 8:20 AM to 7:45 AM in the Fall of 2009. Students entering grade 3 experienced a larger shift from 9:10 AM to 7:45 AM, due to moving from the kindergarten–second-grade building to the third-to-fifth-grade building. Descriptive statistics quantified responses by grade.

Results: Prechange, wake time across all grades was similar; postchange, fourth and fifth graders woke on average 30–40 minutes earlier than children in those grades the year before, and third graders woke on average 8 minutes later. Compared to prechange, third graders reported longer average total sleep times (24 minutes); fourth and fifth graders reported average sleep times 4 and 9 minutes shorter, respectively, than students in those grades the previous year. The percentage of students in each grade reporting later weekend wake and bed times decreased postchange. Reports of sleepiness somewhat increased for fifth graders postchange.

Conclusions: School start time change did not decrease total amount of sleep. This is the first study of its kind to report on the effects of a start time change in elementary school students.

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Introduction

While the developmental process during childhood and adolescence is defined by biological change, daily life is often structured by the school schedule. Logistical and financial factors influence school start times, with many districts having their high schools start the earliest. Empirical data find that adolescents' total reported sleep time declines from 10 hours in middle childhood to less than 7.5–8 hours by age 16 years.^{1–5} Early school start times may exacerbate the challenge of adolescents obtaining the needed amount of sleep on school nights.⁴ The American Academy of Pediatrics recently recognized the importance of insufficient sleep in adolescence as an important public health issue and endorsed the scientific rationale for later school start times.^{6,7} Specifically, by 12th grade, 75% of

adolescents are not obtaining the recommended 8+ hours of sleep per night.^{6,7}

While social and environmental factors including most recently the use of technology are important contributors, biological changes also play a role in the problem of adolescent sleep deprivation. Pubertal changes alter melatonin levels, the underlying mechanism regulating sleep–wake cycles, and lead to a “delayed sleep phase” creating a biological barrier to adolescents falling asleep earlier.^{8–10}

Schools delaying start times for their adolescent students have offset the consequences of chronic sleep deprivation, including poorer cognitive functioning, disruptive sleep patterns, and alterations in physical and mental health (^{4,11–18}). Modest delays of 1 hour or less find students attaining more total sleep (29–45 minutes^{19–22}), reporting less daytime sleepiness overall and in class^{19–22} and schools reporting increased student attendance and better academic performance.¹⁹ Reduction in adolescent risky behaviors, such as drowsy driving and juvenile delinquency, has also been correlated with later start times, although these findings are based on cross-sectional study designs and warrant further prospective work to determine a causal link.^{23–25}

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Decisions to delay high school start times, however, often involve changing to earlier start time for younger students to accommodate logistics, such as tiered bus systems, leading to concerns of early start time effects on younger students. One question is whether this switch simply transfers the problem of sleep deprivation from the older students to the younger ones.

Sleep research on younger school-aged children largely focuses on sleep-related behavior problems²⁶ such as sleep walking, bed wetting,^{26,27} and nightmares²⁶—all shown to lead to shorter sleep durations and sleep deprivation.^{28–30} We lack research on the sleep needs of young children without clinical sleep issues, and these handful of studies are limited by small sample sizes and wide age ranges (eg, 5–12).^{29,30} The purpose of this study is to determine whether a switch to an earlier start time for elementary school students significantly affects their sleep patterns.

Participants and methods

Participants

Participants included third to fifth graders enrolled in a public northeastern elementary school during the 2008–2009 and 2009–2010 academic years. The superintendent granted permission to publish the findings as long as the school system's identity remained anonymous. The community from which the student population was drawn is predominantly white (97.8%), and 82.2% of housing units were owner occupied (reference excluded to retain anonymity of school). Because this was a school-initiated survey and the data were deidentified, the Boston University Institutional Review Board determined that institutional review board approval was not required.

Instruments

The measures were modified from the Sleep Habits Survey used in previous adolescent sleep studies conducted by Wolfson and Carskadon^(3,31,32). The survey included 16 questions containing open-ended, multiple choice, and Likert-scaled questions focusing on sleep-wake schedules and bedtime and wake routines. Dr Amy Wolfson advised the school on modifications of the survey for appropriateness for grades 3–5, which was also reviewed by teachers from the school.

Procedure

Deidentified surveys were administered on the same day by classroom teachers in grades 3–5. Teachers used scripted instructions during survey administration. Completed surveys were returned to the school's administrative offices and copied for data entry use.

Before the change in school start times (eg, prechange), students in grades 3–5 completed self-administered surveys that included questions on sleep duration at the end of the 2008–2009 academic year (Spring 2009) (third grade, $n = 216$; fourth grade, $n = 214$; fifth grade, $n = 259$; total, $n = 689$). In the next academic year (Fall 2009), students in third grade moved from a previous start time of 9:10 AM to 7:45 AM, whereas students in grades 4–5 switched from a start time of 8:20 AM to 7:45 AM to accommodate a switch in the start time for middle and high school students from 7:30 AM to 8:15 AM. At the end of this academic year (Spring 2010; postchange), students from grades 3–5 completed the same set of self-administered questionnaires (third grade, $n = 168$; fourth grade, $n = 194$; fifth grade, $n = 263$; total, $n = 625$). Students surveyed in grade 3 after the change had experienced a greater shift to earlier start times when they moved into the elementary school (9:10 AM

to 7:45 AM, 85-minute difference), whereas those in grades 4 and 5 had experienced a 35-minute shift in start time (8:20 AM to 7:45 AM).

Community outcry necessitated that the data collection process involved no student identifying information except grade level, preventing direct longitudinal comparison. However, more than 90% of students from each grade during the first survey administration attended the next grade in the same school system for the second survey administration. Thus, a large subset of students who took the initial prechange survey comprised the student sample that took the second postchange survey the following year.

Data analysis

Data from the survey were entered and analyzed using SPSS and rechecked for data entry accuracy. Descriptive statistics included means, bar graphs, correlations and comparisons between grades, SDs, and percentages of each question were used to quantify responses by grade level.

Results

Students were queried via a multiple-choice question as to their method of getting to school. Both before and after the change, at least 79% of students in each grade used school-provided buses as their primary transportation. Between 1.2% and 3.7% of students reported walking to school, and 8.4% to 16% reported being driven. These percentages were consistent across both presurvey and postsurvey time points.

Results from the 2 cross-sectional surveys indicated that before the change in start times, weekday wake times across grades 3–5 were relatively similar. Postchange, fourth and fifth graders woke up on average 30–40 minutes earlier than children in those grades the year before, whereas third graders woke up on average 8 minutes later. Before and after the change, mean school night bedtimes became later with increasing grade level. Postchange, students in grades 3–5 had earlier average bedtimes. When compared with prechange data, third graders reported longer total sleep times (24 minutes), whereas fourth and fifth graders exhibited sleep times 4 and 9 minutes shorter, respectively, than students in those grades the previous prechange year (Table 1).

Students were queried as to whether their bedtimes and wake times were later on weekends compared with weeknights in a multiple-choice question format. Before the change in school start times, 60.6% of third graders, 64.0% of fourth graders, and 78.4% of

Table 1
Summary of wake times, bed times, and total sleep times for students in grades 3–5 before and after the change in school start times.

Grade	2009 (prechange)	2010 (postchange)	Difference
	Average wake up time (SD, min)	Average wake up time (SD, min)	
3	6:49 (31)	6:57 (51)	+ 8 min
4	6:56 (41)	6:22 (28)	– 34 min
5	6:59 (26)	6:23 (31)	– 36 min
Grade	Average bed time (SD, min)	Average bed time (SD, min)	Difference
3	8:37 (42)	8:22 (53)	+ 15 min
4	8:52 (43)	8:22 (41)	+ 30 min
5	9:10 (37)	8:43 (40)	+ 27 min
Grade	Average total sleep time (SD, min)	Average total sleep time (SD, min)	Difference
3	10:11 (45)	10:35 (68)	+ 24 min
4	10:03 (52)	9:59 (49)	– 4 min
5	9:49 (41)	9:40 (45)	– 9 min

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