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RESEARCH ARTICLE

Impact of Changing School Start Times on Teacher Sleep Health and Daytime Functioning

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ABSTRACT

BACKGROUND: The benefits of delaying school start times for secondary students are well-established. However, no previous study has considered how changing school start times impacts sleep and daytime functioning for K-12 teachers.

METHODS: Teachers in a large suburban school district completed 3 annual surveys (pre-change n = 1687, post-change n = 1857, follow-up n = 1812) assessing sleep and daytime functioning.

RESULTS: With delayed start times, high school teachers had later rise times (high school [HS]: 28 minutes, middle school [MS]: 14 minutes), increased sleep duration (HS: 22 minutes, MS: 13 minutes), and improved daytime functioning. Improvements for middle school teachers were noted but were not statistically significant. With earlier start times, elementary teachers reported earlier bedtimes (9 minutes) and wake times (9 minutes), with no changes in sleep duration or daytime functioning.

IMPLICATIONS FOR SCHOOL HEALTH POLICY, PRACTICE, AND EQUITY: Today's school health policies often focus on wellness. Findings from this study reveal that the policy of healthy school start times can have a significant, positive impact on adults who teach in later-starting secondary schools. Later school start times for secondary teachers provide greater parity with their elementary colleagues in terms of sleep opportunity.

CONCLUSIONS: This study extends previous findings on how the policy of later secondary school start times improves the health and well-being of adolescents, highlighting that healthy start times contribute to increased sleep opportunity for MS and HS teachers and improved daytime functioning for HS teachers, with changed start times having no significant negative effect on elementary school teachers.

Keywords: school start time; teacher health; school health policies; elementary teacher sleep; adolescent health; sleep equity.

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Sleep is a critical health asset and is necessary for positive physical health, mental health, cognitive functioning, and well-being.[1] Early school start times are a significant and modifiable factor associated with insufficient sleep duration for secondary school students,[2] with multiple studies demonstrating the benefits of delaying middle and high school start times for students.[3-9] Although a growing number of schools and districts across the United States have changed their start time policy to meet the

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2014 recommendation of the American Academy of Pediatrics,[10] the majority of schools and districts in the United States continue to have secondary school start times before 8:00 AM.[11] While the significant benefits of healthy start times are clear for students, teachers are also directly impacted by this policy change. Yet no studies have specifically examined the impact of changing school start times on the sleep and daytime functioning of teachers.

Although small in number, studies that have considered teacher sleep around the world have consistently shown that teachers average 6.5 to 6.8 hours of sleep per night,[12-15] which is less than the recommended 7 hours of sleep per night for adults,[16] and is considered chronic partial sleep deprivation. In the United States, one study found that 43% of teachers were significantly sleep deprived, obtaining <6 hours of sleep per night.[12] Studies have also found that the majority of teachers have difficulty with sleeping or have poor sleep quality.[14,15,17-19] As insufficient sleep duration and poor sleep quality are known to negatively impact health and daytime functioning,[1] it is essential to ensure teachers have the opportunity for healthy sleep.

Only a limited number of studies have directly considered the negative impact of insufficient or poor-quality sleep on the daytime functioning of teachers. In the United States, one study found nearly 25% of classroom teachers reporting daily activities being impaired by signifcant sleepiness,[12] while a study in Brazil reported 46% of high school teachers were diagnosed with excessive daytime sleepiness.[14] Sleep-deprived teachers have also reported more mood swings,[12,14] with several studies suggesting an association between sleep and teachers' job stress.[13,15,19,20] Poor sleep in teachers may indirectly impact students, with studies finding that sleepy teachers are at higher risk of providing inferior instruction and insufficient supervision.[12,14]

The focus of the current investigation is to examine how the policy of changing school start times for middle and high school students, a policy aimed at improving student sleep duration, also impacts sleep duration and sleep quality for teachers across grade levels. A complicating factor for many districts seeking to implement a later start time for secondary schools is multitiered bus transportation.[21,22] These schedules typically require moving elementary school start times earlier in order to achieve delayed middle and high school start times. The study reported here is, to our knowledge, the first of its kind in 2 ways: not only does it examine the impact of a later start time for secondary school teachers' sleep and daytime functioning, but it also examines the effect of an earlier school start time on elementary teachers' sleep and daytime functioning.

METHODS

Overview

Data were drawn from the Changing Start Times: Longitudinal Effects Study (CaSTLES), a comprehensive and longitudinal examination of the impact of changing school start times in the Cherry Creek School District (CCSD). The CCSD is a suburban school district in southeast Denver, Colorado, serving more than 55,000 students. Using district classification groups, students are identified as 50.5% white, 11.4% African American, 20.9% Hispanic, and 7.7% multiracial, with 29% of students qualifying for free and reduced lunch.

The CCSD implemented new start times for the 2017-2018 school year, with high schools (grades 9-12) starting 70 minutes later (8:20 AM), middle schools (grades 6-8) starting 40-60 minutes later (8:50 AM), and elementary schools (grades K-5) starting 60 minutes earlier (8:00 AM).[23] Data were collected at 3 time points: pre-change (spring 2017, ~4 months before the start time change), post-change (spring 2018, ~6 months post-change), and at follow-up (spring 2019, ~18 months post-change).

Participants

Study participants included teachers of students in grades K-12 who were teaching in the CCSD during each of the 3 study years. As seen in Table 1, an average of 1784 teachers participated in the study across the 3 years (average participation rate 49.9% per year). With approximately half of all teachers participating each year, it is likely many teachers completed more than two survey. However, as this was an anonymous survey, data were not linked year-to-year for individual respondents.

Table 1. **Demographic Characteristics of Teachers**

	Pre-Change	Post-Change	Follow-Up
Total teacher, N	1683	1857	1812
Response rate, %	49.0	51.0	49.6
Level, %			
Elementary school	47.5	46.4	45.6
Middle school	22.5	22.6	24.9
High school	30.0	31.0	29.5
Years teaching			
% 0-5 years	13.3	12.3	11.8
% 6-10 years	17.9	16.6	17.0
% 11-20 years	43.0	44.1	43.8
% 21-30 years	22.4	24.1	23.6
% More than 30 years	3.4	2.9	3.8
Years in district			
% 0-5 years	30.6	30.0	31.0
% 6-10 years	18.8	18.2	19.4
% 11-20 years	37.9	38.8	35.2
% 21-30 years	11.2	11.9	12.9
% More than 30 years	1.5	1.1	1.5

To ensure anonymity, and based on previous experiences with surveys conducted by the district having low return rates, teacher demographic data (gender and age) was not collected due to respondents' prior hesitance to provide that data. However, as teacher experience has been associated with teacher stress,[19,24] teachers did provide information on the number of years they had been teaching, both overall and in the CCSD. Over two thirds of participants who completed the survey each year had significant teaching experience (>11 years), with 26%-28% having taught for over 20 years. Further, at least half of the teachers in each year of the study had taught for more than 11 years within the CCSD, with 13%-14% having taught within the district for over 20 years.

Instrumentation

Sleep timing and duration. Teachers were asked to report their typical weekday bedtime and wake time using a drop-down menu (time was in 5-minute increments). Consistent with other surveys, sleep duration was calculated as the number of hours between bedtime and wake time. Sleep duration was also categorized as sufficient (at least 7 hours) or insufficient (less than 7 hours).[16]

Sleep quality and daytime functioning. Teachers reported on their sleep quality using an item from the PROMIS Sleep Disturbance item bank (*In the past 7 days, my sleep quality was*...), with response choices collapsed to ''Very poor/Poor,'' ''Fair,'' and ''Good/Very good.''[25] Daytime functioning was assessed with 2 items from the PROMIS Sleep-Related Impairment item bank (*In the past 7 days, I felt alert upon waking* ... and *In the past 7 days, I felt tired* ...), with response choices collapsed to ''Not at all/A little bit,'' ''Somewhat,'' and ''Quite a bit/Very much''.[25] The PROMIS Sleep Disturbance and Sleep-Related Impairment item banks have been shown to have strong reliability (≥.90), as well as both convergent and discriminant validity.[26]

Procedure

During each of the 3 study years, all teachers in the CCSD were invited to complete an online survey. There were no exclusion criteria. Teachers were notified about the survey via their district email, with multiple reminders to complete the survey sent at each time point. An online survey platform (SurveyGizmo, Boulder, CO) was used to collect data.

Data Analysis

Due to the anonymous nature of the survey, it was not possible to link the full sample of teachers across years. Thus, data were averaged within level (elementary, middle, high), school, and year. Sleep outcomes (bedtime, wake time, sleep duration) were each fit as a function of year, level, and year-by-level using linear mixed models. This model allowed us to examine whether changes over time in mean sleep outcomes differed by level. Since some schools had more participants than others, each outcome mean was weighted by the number of subjects used in the average. Chi-square analysis with Cramer's V effect size (small = 0.07, medium = 0.21, large = 0.35)[27] was used to examine sufficient sleep duration, sleep quality, and daytime functioning.

RESULTS

Sleep Timing and Duration

For teacher bedtime, there was a significant level-by-year interaction, $F(4, 4696.11) = 5.08$, $p < .001$, suggesting that changes in teacher bedtime over the 3 years differed by level (Figure 1a). Post-hoc analyses indicate significantly earlier bedtimes for elementary school teachers from pre-change to post-change (9 minutes earlier, $p < .001$), with changes maintained (i.e., no significant difference in bedtime) from post-change to follow-up. For middle and high school teachers, no significant change in bedtimes across years was found.

For teacher wake time, there was also a significant level-by-year interaction, $F(4, 4688.29) = 40.10$, $p < .001$, with changes in teacher wake times differing by level over the 3 study years (Figure 1b). Post hoc analyses indicate significantly earlier wake times from pre-change to post-change for elementary school teachers (9 minutes, $p < .001$), with wake times 4 minutes later at follow-up compared to post-change ($p = .04$). For middle school teachers, post hoc analyses indicate significantly later wake times from pre-change to post-change (14 minutes, $p < .001$), with later wake times maintained between post-change and follow-up. High school teachers reported significantly later wake times at post-change compared to pre-change (28 minutes, $p < .001$), with no significant difference in wake times from post-change to follow-up.

A significant level-by-year interaction was found for teacher sleep duration, $F(4, 4663.67) = 9.10$, $p < .001$, with changes over the 3 years differing by level (Figure 1c). Although sleep duration for elementary school teachers did not differ between pre-change and post-change, a small increase in elementary school teacher sleep duration was found from post-change to follow-up (7 minutes, $p = .02$). For middle school teachers, a significant increase in sleep duration was found from pre-change to post-change (13 minutes, $p = .001$), with the increased sleep duration maintained between post-change and follow-up. Finally, a significant increase in sleep duration was also found for high school teachers from pre-change to post-change (22 minutes, $p < .001$), with this increase

Figure 1. **Changes in Sleep Outcomes by School Level**

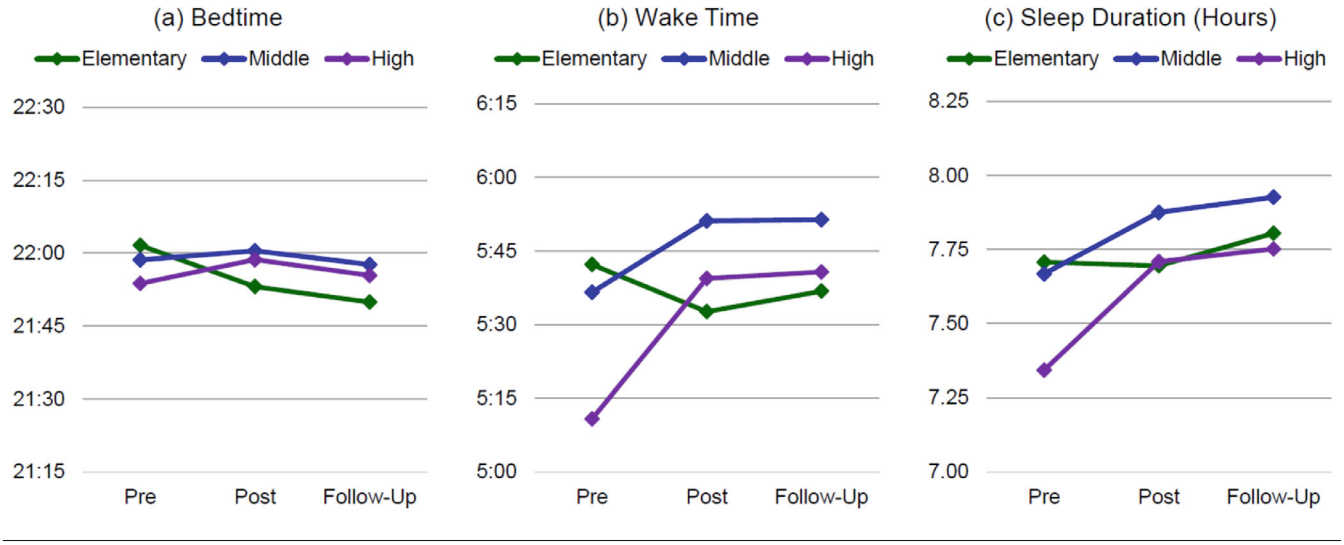

Table 2. **Additional Teacher Outcomes Related to Sleep Duration, Sleep Quality, and Daytime Functioning**

	Pre-Change	Post-Change	Follow-Up	X^2 (4)	*p*	Cramer's V*
Sufficient sleep duration (% at least 7 hours)						
Elementary	86.4	86.7	85.9	1.20	.88	.02
Middle	82.6	90.4	89.7	23.45	<.001	.10
High	71.7	87.5	86.2	59.85	<.001	.14
Sleep quality (% very good/good)						
Elementary	40.1	39.9	42.2	3.91	.42	.03
Middle	41.5	40.9	36.7	5.97	.20	.05
High	29.2	48.0	51.7	64.28	<.001	.14
Alert upon waking (% quite a bit/very much)						
Elementary	35.1	30.9	36.4	7.43	.12	.04
Middle	31.4	34.1	35.5	1.65	.80	.03
High	28.4	43.0	45.9	54.07	<.001	.13
Tired (% quite a bit/very much)						
Elementary	37.8	42.6	38.5	6.82	.15	.04
Middle	34.8	36.6	35.6	1.03	.91	.02
High	49.6	29.5	27.6	74.14	<.001	.16

*Cramer's V effect size: small = .07, medium = .21, large = .35.

in sleep duration maintained between post-change and follow-up.

Sufficient Sleep Duration, Sleep Quality, and Daytime Outcomes

The percent of teachers reporting sufficient sleep duration increased for both middle and high school teachers, with no changes observed for elementary school teachers (Table 2, $p < .001$, small effect sizes). Increases were noted between pre-change and post-change for middle school and high school teachers, with increases maintained from post-change to follow-up.

For sleep quality, the percent of teachers reporting very good/good sleep quality increased only for high school teachers (Table 2, $p < .001$, small effect sizes), going from 29.2% at pre-change to 48.0% at post-change, with this increase maintained at follow-up (51.7%). No significant changes were seen for the percent of elementary or middle school teachers reporting very good/good sleep quality.

Similarly, significant changes in both daytime variables were found for high school teachers only (Table 2, $p < .001$, small effect sizes), and were most notable between pre-change and post-change. Specifically, there was a noted increase in the percent of high school teachers reporting feeling alert upon waking (pre-change: 28.4%, post-change: 43.0%), and a significant decrease in the percent of teachers reporting feeling tired during the day (pre-change 49.6%, post-change: 29.5%), with both changes continuing to improve at follow-up.

DISCUSSION

This is the first study to consider the longitudinal impact of changing school start times on the sleep and daytime functioning of K-12 teachers. Similar to findings for secondary school students when school start times were delayed,[28] secondary school teachers reported no changes in weekday bedtimes, but significantly delayed weekday wake times, resulting in significantly increased weekday sleep duration. With the new start times (later for middle and high schools, earlier for elementary schools), 85%-90% of CCSD teachers reported obtaining sufficient sleep duration. In comparison, during this same period, only 64%-74% of adults in Colorado were obtaining sufficient sleep duration,[29] highlighting how healthy school start time policies can have a significant beneficial impact on teacher sleep. The change in the percent of secondary school teachers who obtained sufficient sleep duration (at least 7 hours) represents a 9% increase for middle school teachers and a 22% increase for high school teachers at post-change compared to pre-change. Further, the percent of high school teachers reporting good sleep quality represents a 64% increase from pre-change to post-change.

With increased sleep duration, the change in the percent of high school teachers reporting feeling alert represents a 51% increase at post-change compared to pre-change, while the change in the percent of high school teachers reporting feeling tired represents a 41% decrease at post-change compared to pre-change. Together these findings highlight the benefits of a delayed start time on teacher well-being and alertness for teaching.

Due to the tiered busing system in CCSD, elementary school start times were moved earlier. With this change, elementary school teachers reported earlier weekday bedtimes and earlier weekday wake times. However, no changes were found in terms of elementary school teacher sleep duration, the percent of elementary school teachers obtaining sufficient sleep duration, or reported daytime functioning. This finding of no negative outcomes for elementary school teachers is similar to findings in elementary school students,[28] and is important because many districts who are considering delaying secondary school start times will have to do so by moving elementary school start times earlier.[21] However, there remains a significant need to learn more about how early is too early for elementary school start times. In the CCSD the start time was 8:00 AM, but the impact of starting earlier than this remains unknown.

The novel findings from this study highlight how healthy secondary school start times may mitigate some of the negative effects that sleep deprivation has on both educational and personal consequences for teachers. In particular, other researchers have concluded that sleep deprived teachers are at a greater risk of providing inferior classroom instruction, and are less likely to provide vigilant supervision in class, during passing time, or in student gatherings.[12,14]

Study findings also highlight how a systemic change can benefit a large number of teachers at the same time, compared to previous studies that have examined individual-focused programs to improve teacher sleep. In one such study, an 11-week mindfulness intervention (that required 36 hours of instruction) resulted in an initial increase in sleep duration similar to the current study (24 minutes).[30] However, this was not maintained at the 3-month follow-up. Similarly, another study evaluated a 4-week sleep education program for teachers (that required 16 hours of participation) focused on increasing sleep knowledge and improving sleep hygiene.[31] Although 17% of teachers in the education group reported improved sleep quality, 9% of the control group also reported improved sleep quality. Further, no changes were found in teacher sleep duration or reported sleepiness following the intervention. For teachers, who already have limited time for additional training and development outside of the classroom, these individual interventions produced minimal benefits, especially when compared to the widespread benefits noted with delayed secondary school start times.

Strengths and Limitations

This study has a number of strengths, including the large sample size and the inclusion of 3 annual surveys. In addition, over two-thirds of participants were experienced teachers, which may have reduced the likelihood of the data being skewed by responses from young, novice teachers who are still adjusting to the sleep-depriving demands of being a classroom teacher. However, this study was conducted in a single school district which limits the generalizability of the findings. Also, the need to assure survey respondents of absolute anonymity limited the ability to collect demographic data that could have been used in further analyses. In addition, the anonymous nature of the survey required the use of a cohort approach to analyses, precluding the ability to link teacher data year-to-year. Finally, the teaching staff in the school district in which this study was conducted are predominantly white, even though the student population of the district has much greater diversity.

Implications for School Health Policy, Practice, and Equity

Many school districts have increased their focus on student, staff, and community wellness. Yet, efforts to improve individual wellness are not only time consuming, but often do not consider how organizational systems and structures can constrain an individual's ability to make healthy choices. This

is particularly true when school districts establish school start (and end) time policies for their schools. While most districts have local control over school start times, this policy choice can impact the sleep health of an entire community. Findings from this study reveal that healthy school start times as a policy choice can have a significant positive impact on secondary school teachers, with no negative impact on elementary school teachers. In a sense, with later school start times secondary teachers have more ''sleep opportunity parity'' with their elementary colleagues.

Study findings are also consistent with previous research on secondary students whose schools implemented later school start times. These studies have shown that later start times means a greater sleep opportunity for adolescents. With puberty, adolescent sleep duration is often constrained due to the intersection of early school start times and biological changes to their circadian rhythm,[32] making it difficult for secondary school students to fall asleep early enough to obtain sufficient sleep duration. Pre-adolescents, in comparison, do not experience this biological change to their internal sleep-wake rhythm and are able to adjust their sleep schedules more easily. Thus, later school start times for secondary school students provides a more equitable opportunity for students across grade levels to obtain sufficient sleep duration.

Finally, it is important to reiterate that health and wellness programs focused on teaching mindfulness or healthy sleep habits may be viewed as being sufficient for individual teachers. However, as previously noted, these programs are not only time consuming for teachers, but have limited impact on changing teacher sleep duration.[30,31] Instead, healthy school start time policies can promote teachers' sleep health at a systemic level, requiring little time from individual teachers who are already faced with day-to-day teaching responsibilities in and out of the classroom.

CONCLUSIONS

The shift to later secondary start times for students has been studied extensively in the past 2 decades, but this is the first study that has reported on the positive effect of healthy start times on teachers. Findings from this study reveal that high school teachers clearly benefit from the later start time of their schools. Even when elementary start times were shifted earlier due to transportation schedules, this study found that the shift did not have a detrimental effect on elementary teachers' sleep or daytime functioning. Notably, with the new start times, there were no longer differences in the percent of teachers across levels who were obtaining sufficient sleep duration. This study highlights how implementing later secondary school start times is a significant policy shift that not only improves the health and well-being of adolescents, but can also equalize healthy sleep duration for all K-12 teachers.

Human subjects approval statement

The CaSTLES study survey and procedure were approved by the Cherry Creek School District Research Review Committee. All ethical standards were followed.

Conflict of Interest

The authors have no conflicts of interest.

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