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Impact of changing school start times on parent sleep

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ABSTRACT

Objective: To examine the impact of changing school start times on sleep in parents of students in elementary, middle, and high school.
Methods: Annual surveys were completed by parents of K-12 students (n = 8190-10,592 per year) before (pre-change) and for 2 years (post-change, follow-up) after implementation of new school start times (elementary school [ES]: 60 minutes earlier, middle school [MS]: 40-60 minutes later, high school [HS]: 70 minutes later), providing parent self-reported weekday bedtime and wake time, sleep quality, and feeling tired.
Results: Significant level-by-year interactions were found for parent bedtime, wake time, and sleep duration (all $p < .0001$). Post hoc analyses show ES parents reporting earlier bedtimes and wake times at post-change, with no change in sleep duration, while MS and HS parents reported later post-change wake times. Post-change, more MS and HS parents reported sufficient sleep duration ($p < .0001$) and good sleep quality ($p < .0001$), with fewer HS parents reporting feeling tired ($p < .0001$).
Conclusions: This is the first study to consider the impact of a policy change aimed at improving child sleep on parent sleep. Healthy school start times has a significantly positive downstream effect on secondary school parents' sleep and daytime functioning, with minimal impact reported by parents of elementary school students.

In 2014, the American Academy of Pediatrics recommended middle and high schools start no earlier than 8:30 AM, allowing adolescents the opportunity for 8.5-9.5 hours of sleep per night.[1] This recommendation followed a comprehensive review[2] of a growing literature that has shown later school start times result in increased sleep duration and decreased sleepiness,[3-9] increased attendance and graduation rates,[10,11] and fewer motor vehicle crashes.[3,12-14] In addition, most studies have shown that adolescents do not go to bed later when start times are delayed,[3,4,7,10] thus their increased sleep duration and positive outcomes result from waking later in the morning.

However, students are part of a complex socioecological system, with studies showing that child sleep is impacted by not only individual child factors, but also family routines, school schedules, neighborhood characteristics, and broader socio-cultural factors.[15,16] Further, each level in the socioecological model is connected, with complex bidirectional relationships.[17] For example, parenting behaviors (eg, set bedtimes) play a direct role in child and adolescent sleep,[18,19] while child sleep disruptions can impact parent sleep duration and continuity.[20-22] In addition, several studies have found parent sleep patterns to be moderately associated with sleep patterns in both school-aged children and adolescents.[23-26] However, no studies have considered how a policy change such as changing school start times in order to improve child sleep-wake patterns may also impact parent sleep-wake patterns.

The Changing Start Times: Longitudinal Effects Study (CaSTLES) is the first large mixed-methods study designed to provide a comprehensive evaluation of the impact of changing school start times before and for 2 years after a change in school start times, including quantitative surveys and qualitative focus groups with students, parents, and teachers/staff, as well as school district and community level data.[27] In August 2017, the Cherry Creek School District (CCSD), a diverse suburban district of ~55,000 students near Denver, Colorado, changed school start times across the district: high schools (grades 9-12) started 70 minutes later (8:20 AM), middle schools (grades 6-8) started 40-60 minutes later (8:50 AM), and elementary schools (grades K-5) started 60 minutes earlier (8:00 AM).[27] With these changes in start times, middle school students reported waking 37 minutes later and high school students reported waking 60 minutes later, while elementary school students reported waking 23 minutes earlier.[28] Because parents are often involved in waking students in the morning and helping get them off to school, it is likely

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that parent sleep-wake schedules were also impacted by the implementation of this policy. Thus, the aim of this paper is to examine the impact of changing school start times on parent sleep.

Methods

Study design and participants

All parents or legal guardians (referred to as "parents" going forward) of students enrolled in the CCSD were invited to complete an online survey in spring 2017 ("pre-change," ~4 months before start times changed), spring 2018 ("post-change," ~6 months postchange), and spring 2019 ("follow-up," ~18 months postchange). Pre-change surveys included parents of students in Kindergarten [K] through 11th grade, and both the post-change and follow-up surveys included parents of students in K through 12th grade. There were no exclusion criteria. Study surveys and procedures were approved by the CCSD Research Review Committee, and all applicable ethical standards were followed. Parents were informed of the upcoming survey through multiple email and phone notifications from CCSD in their preferred language (i.e., English, Amharic, Arabic, Chinese, Korean, Russian, Spanish, and Vietnamese). Parent surveys were sent via e-mail (in the parent's preferred language), with multiple email and phone reminders to complete the survey. Survey data were collected with SurveyGizmo (Boulder, CO).

Parents annually register their student in the CCSD, self-identifying a primary parent/caregiver who receives all communications, and a secondary parent/caregiver who receives selected communications. Surveys were sent to both primary and secondary parents. Although some families had 2 parents complete surveys, only the data from the primary caregiver survey is included in this paper. Based on previous experiences with surveys sent by the district, collecting additional parent demographic information (gender, age, relationship to student(s)) tended to decrease the parent response rate. Therefore, those data were not collected in order to increase the response rate for the anonymous survey. However, parents provided information about whether they were currently employed for pay full-time, part-time, or not currently employed for pay. Student demographic information was provided by the school district, including race and free or reduced lunch status (FRL), with the latter a proxy schools often use for poverty.

Outcome measures

Sleep timing and duration. Surveys asked about the parent's typical bedtime and wake time on weekdays. Times were selected from drop down menus in 5-minute increments, providing information for the following outcomes: (1) bedtime; (2) wake time; and (3) sleep duration (hours between bedtime and wake time). Sleep duration for parents was also categorized into sufficient (at least 7 hours) and insufficient (less than 7 hours).[29]

Sleep quality and feeling tired. Sleep quality was assessed 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."[30] Feeling tired was assessed using an item from the PROMIS Sleep-Related Impairment item bank (*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."[30]

Data analysis

As many parents had more than 1 student, with students at different educational levels, a 7-category variable ("level") was created in order to more clearly parse out the effect of the student(s) wake time on the parent: elementary school only [ES only], middle school only [MS only], high school only [HS only], elementary and middle school [ES/MS], elementary and high school [ES/HS], middle and high school [ES/HS], and all 3 levels [ES/MS/HS].

It was not possible to link the full sample of parents across years as this was an anonymous survey. Thus, we averaged data within level, 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. Models were also run with parent employment status and family FRL status, with no change in outcomes (data not presented).

Chi-square analysis with Cramer's V effect size (small = 0.07, medium = 0.21, large = 0.35)[31] was used to compare the proportion of parents who obtained sufficient sleep, good sleep quality, and feeling tired across years. Proportions for all response choices, separated by outcome and year, are provided in the Supplement.

Results

Sample characteristics

Table 1 provides the number of parents who participated in the survey each year, as well as demographic characteristics of their

Table 1
Demographic characteristics of students whose parents completed the survey

	Pre-change	Post-change	Follow-up
Total parent N	10,592	8,200	8,190
% More than 1 child	53.2	54.1	53.6
Responding parent employment status			
% Not currently employed	19.1	19.1	19.3
% Employed part-time	15.2	16.9	15.4
% Employed full-time	65.7	63.9	65.3
Total student N	16,224	12,633	12,576
% Female	47.8	47.9	47.8
% FRL	17.6	16.5	13.5
Student grade %			
K	8.1	7.6	7.8
1st	8.8	8.8	8.7
2nd	9.0	8.6	8.5
3rd	8.7	8.7	7.8
4th	8.3	8.4	7.9
5th	8.2	7.7	7.4
6th	8.7	8.2	7.5
7th	8.4	8.1	8.2
8th	8.3	7.4	7.9
9th	8.9	7.7	8.1
10th	8.1	7.7	7.9
11th	6.6	6.7	7.3
12th	0.0	4.5	4.9
Level of student(s) %			
ES only	37.4	36.2	35.5
MS only	7.2	8.5	8.3
HS only	13.8	16.0	17.0
ES and MS	17.1	17.1	15.4
ES and HS	5.7	5.6	5.9
MS and HS	11.0	11.7	13.0
ES, MS, and HS	4.9	4.9	4.9
Student race/ethnicity %			
White	64.0	64.7	64.3
Black	6.3	5.0	5.0
Hispanic	14.0	14.0	15.0
Asian	8.2	8.4	8.4
MR/AIAN/NHOPI	7.5	7.9	7.3

FRL: free or reduced lunch status; ES: elementary school; MS: middle school; HS: high school; MR/AIAN/NHOPI: mixed race/American Indian or Alaskan Native/Native Hawaiian or Other Pacific Islander.

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Table 2
F-statistics and *p* values for linear mixed models for sleep outcomes

	F	*p*
Bedtime		
Year	1.18	.306
Level	3.43	.003
Year x level	5.64	<.0001
Wake time		
Year	12.57	<.0001
Level	4.56	<.0001
Year x level	36.62	<.0001
Sleep duration		
Year	18.72	<.0001
Level	16.84	<.0001
Year x level	14.04	<.0001

students. Parent response rate was 45% pre-change, 32% post-change, and 27% at follow-up. Although the response rate decreased over time, it remained similar (or higher) to previously administered district surveys.[27] Parent employment status was consistent across study years and there was a relatively even distribution of student grade across years. Compared to overall student enrollment, the sample was similar to CCSD enrollment in terms of gender, Asian students, and students of mixed race/American Indian or Alaskan Native/Native Hawaiian or Other Pacific Islander (MR/AIAN/NHOPI). However, the sample was overrepresented of White students (~64% vs. district average 51%) and less representative of students who qualify for FRL (~14%-18% vs. district average 29%), Hispanic students (14%-15% vs. district average 20%), and Black students (~5%-6% vs. district average 11%).

Sleep timing and duration

Models for the 3 sleep outcomes are found in Table 2, with level-by-year least square means found in Table 3. For parent bedtime, there was a significant interaction for level-by-year, suggesting that changes in parent bedtime over the 3 years differed by student level(s). Post hoc analyses indicate significantly earlier bedtimes for ES-only parents from pre-change to post-change (9 minutes earlier, $p < .0001$), with no significant difference in bedtime from post-change to follow-up. Bedtimes remained relatively consistent across years for parents of students in all other levels.

A significant level-by-year interaction was also found for parent wake time, with changes in parent wake times over the 3 study years differing by student level(s). Post hoc analyses indicate significantly earlier wake times from pre-change to post-change for ES-only parents (14 minutes) and significantly later wake times from pre-change to post-change for MS-only parents (9 minutes), HS-only parents (23 minutes), and MS/HS parents (25 minutes, all $p < .0001$). There were no significant changes in parent wake times from post-change to follow-up for parents of students at any level(s).

For parent sleep duration, a significant level-by-year interaction was found, with changes in parent sleep duration over the 3 years differing by student level(s). Post hoc analyses indicate significant increases in sleep duration for MS-only parents (12 minutes, $p < .0001$), HS-only parents (20 minutes, $p < .0001$), ES/MS parents (10 minutes, $p = .005$), and MS/HS parents (20 minutes, $p < .0001$). There were no significant changes in parent sleep duration from post-change to follow-up for parents of students at any level(s).

Sufficient sleep duration, sleep quality, and tired outcomes

An increase in the percent of parents reporting sufficient sleep duration was found for all levels (Table 4, all $p < .0001$, small effect sizes), except ES-only (where there was no change). From pre-change to post-change, the increase ranged from 4.0% to 12.1%, with greater increases in the proportion of parents with sufficient sleep duration for parents who had at least 1 student in HS. From post-change to follow-up, the proportion of parents reporting sufficient sleep duration was similar across groups.

The percent of parents who reported *very good/good* sleep quality increased for MS-only parents ($p < .0001$, small effect size), HS-only parents ($p < .0001$, small effect size), ES/HS ($p = .01$, small effect size), and MS/HS parents ($p = .001$). As seen in Table 4, the most notable changes were from pre-change to post-change, with an increase of 4.8%-9.3% of parents reporting *very good/good* sleep quality, with an additional 6.6% increase for parents of ES/HS students from post-change to follow-up.

Table 3
Least square means (95% CIs) and differences for parent sleep outcome variables across years by level of students in the home

	ES only	MS only	HS only	ES/MS	ES/HS	MS/HS	ES/MS/HS
Bedtime[a]							
Pre-change	22:24 (22:22-22:26)	22:21 (22:17-22:25)	22:17 (22:14-22:21)	22:26 (22:21-22:30)	22:27 (22:17-22:36)	22:21 (22:16-22:26)	22:32 (22:16-22:47)
Post-change	22:15 (22:12-22:17)	22:17 (22:12-22:23)	22:19 (22:15-22:23)	22:21 (22:16-22:27)	22:21 (22:10-22:33)	22:26 (22:20-22:32)	22:30 (22:09-22:51)
Follow-up	22:13 (22:10-22:15)	22:19 (22:14-22:24)	22:20 (22:16-22:24)	22:21 (22:15-22:27)	22:21 (22:10-22:32)	22:22 (22:16-22:27)	22:29 (22:07-22:51)
Wake time[a]							
Pre-change	6:18 (6:16-6:21)	5:58 (5:54-6:02)	5:43 (5:39-5:47)	6:03 (5:58-6:08)	5:58 (5:48-6:08)	5:44 (5:39-5:50)	5:49 (5:32-6:06)
Post-change	6:04 (6:01-6:07)	6:07 (6:01-6:12)	6:06 (6:02-6:10)	6:09 (6:03-6:15)	6:07 (5:55-6:19)	6:09 (6:03-6:15)	6:05 (5:43-6:27)
Follow-up	6:04 (6:01-6:07)	6:12 (6:06-6:18)	6:05 (6:01-6:09)	6:05 (5:58-6:11)	6:06 (5:54-6:18)	6:08 (6:02-6:14)	6:04 (5:40-6:27)
Duration[a]							
Pre-change	7.90 hr (7.86-7.94)	7.62 hr (7.56-7.68)	7.44 hr (7.39-7.48)	7.62 hr (7.55-7.70)	7.52 hr (7.35-7.69)	7.39 hr (7.30-7.47)	7.29 hr (7.00-7.57)
Post-change	7.83 hr (7.78-7.88)	7.83 hr (7.74-7.92)	7.78 hr (7.73-7.82)	7.80 hr (7.70-7.90)	7.76 hr (7.55-7.97)	7.72 hr (7.63-7.82)	7.58 hr (7.20-7.97)
Follow-up	7.86 hr (7.81-7.90)	7.89 hr (7.80-7.98)	7.75 hr (7.71-7.80)	7.74 hr (7.63-7.84)	7.75 hr (7.55-7.95)	7.76 hr (7.68-7.85)	7.57 hr (7.16-7.98)

Hr: hours; min: minutes; ES: elementary school; MS: middle school; HS: high school.
[a] Data are presented as mean (95% CI), with military time used for bedtimes and wake times.

Table 4
Parent perception of sleep quality and feeling tired by level and year

	Pre-change	Post-change	Follow-up	*X*2	*p*	Cramer's V[a]
Sufficient sleep duration (% at least 7 hours)[b]						
ES only	86.7	86.2	86.8	0.57	.750	0.007
MS only	80.1	85.1	86.5	18.34	<.0001	0.08
HS only	74.4	84.2	84.3	74.86	<.0001	0.12
ES/MS	81.2	87.2	85.4	15.66	<.0001	0.07
ES/HS	75.9	80.9	84.6	8.93	.011	0.09
MS/HS	73.3	85.4	86.6	57.40	<.0001	0.16
ES/MS/HS	69.6	80.0	81.5	10.54	.005	0.13
Sleep quality (% very good/good)[c]						
ES only	41.9	41.8	44.4	6.59	.159	0.02
MS only	44.3	53.6	50.8	33.40	<.0001	0.07
HS only	43.2	52.5	53.8	53.10	<.0001	0.07
ES/MS	43.9	45.5	47.0	4.49	.344	0.03
ES/HS	37.3	42.1	48.7	13.08	.011	0.08
MS/HS	44.9	53.9	52.4	19.19	.001	0.06
ES/MS/HS	40.0	49.0	43.1	3.68	.451	0.05
Tired (% quite a bit/very much)[c]						
ES only	28.8	29.0	28.0	2.01	.733	0.01
MS only	24.1	20.8	21.1	4.98	.289	0.03
HS only	24.0	17.7	16.8	43.34	<.0001	0.07
ES/MS	27.2	27.7	25.1	2.02	.732	0.02
ES/HS	27.7	26.3	28.3	5.37	.251	0.05
MS/HS	29.7	21.2	19.3	34.01	<.0001	0.09
ES/MS/HS	35.0	28.2	29.0	3.06	.547	0.05

[a] Cramer's V effect size: small = 0.07, medium = 0.21, large = 0.35.
[b] Chi-square degrees of freedom = 2.
[c] Chi-square degrees of freedom = 4.

The percent of parents who reported feeling *quite a bit/very much* tired decreased for HS-only parents ($p < .0001$, small effect size) and MS/HS parents ($p < .0001$, small effect size). As seen in Table 4, for HS-only parents and MS/HS parents there was a decrease from pre-change to post-change in parents reporting feeling *quite a bit/very much* tired (6.3% decrease for HS-only parents, 8.5% decrease for MS/HS parents). Minimal changes were found from post-change to follow-up.

Discussion

This study is the first to consider the impact of changing school start times on parent sleep. Similar to changes in student sleep-wake patterns following changes in school start times, parent sleep-wake patterns also changed with the implementation of earlier elementary school start times and later middle and high school start times. Changes in school start times were also associated with changes in the percent of parents obtaining sufficient sleep duration, as well as parental self-report of sleep quality and feeling tired.

For parents who only had children in elementary school, bedtimes and wake times were earlier at post-change, with no additional difference noted at follow-up. This is consistent with findings from student data.[28] However, unlike elementary school students, there was no change in sleep duration for elementary parents. In addition, there were no changes in the percent of elementary parents obtaining sufficient sleep duration, and no changes in parental self-reported sleep quality or feeling tired. Together these findings suggest that, in response to an earlier school start time, parents may adapt their own sleep schedules to ensure they continued to obtain sufficient sleep duration, with the new sleep-wake patterns maintained for 2 years after the implementation of earlier start times.

Parents of middle and high school students, and in some cases parents of students in multiple levels, reported minimal changes in their bedtimes, later wake times, and longer sleep duration, with changes maintained 2 years after the implementation of later start times. This pattern was again similar to that seen in middle and high school students' self-reports.[28] Changes in sleep-wake patterns were greatest for parents of high school students, where parents had an average increase in sleep duration of 20 minutes per night. Over the course of a school year, this adds up to 60 extra hours of sleep for parents. Notably, parent bedtimes reported in this study were similar to student self-reported bedtimes in a previous report.[28] However, as data were anonymous, it is not clear that parents and students within the same family provided these reports. As high school students, in particular, may have later bedtimes than parents, future studies should continue to examine the relationship between parent and child sleep-wake patterns.

At post-change, more parents with at least one secondary student reported obtaining greater sleep duration with the later school start times, and at follow-up, 82%-87% of CCSD secondary parents continued to report sufficient sleep duration. The percent increase in parents obtaining sufficient sleep duration represents approximately 5000 parents when considered across a school district with thousands of students and families. Notably, according to data from the 2018 County Health Rankings and Roadmaps (University of Wisconsin Population Health Institute), only 64%-74% of adults across Colorado were obtaining sufficient sleep.[32]

With the increase in sleep duration and sufficient sleep, it is not surprising that more parents of secondary school students reported good sleep quality and fewer parents reported feeling tired. At follow-up, reports of "feeling tired quite a bit/very much" decreased by over 10% for MS/HS parents, and by over 7% for parents with a high school student. Reports of "feeling tired" neither increased nor decreased for elementary school parents over the course of the study.

The study has many strengths, but several limitations should be noted. First, although this is the first study of school start times that has directly considered parent sleep, these data were self-reported without an objective assessment (eg, actigraphy). Second, as surveys were collected once per school year, in the spring, it is possible that outcomes may have differed if surveys were conducted at a different time of the year (eg, fall, winter). Third, despite the large sample of parents, an anonymous survey was used, similar to previous research on school start times. Thus, thus individual data could not be linked year-to-year, and limited demographic data were available. Finally,

the parent sample was not fully representative of the district's diversity in terms of race/ethnicity and economic status, and it is noted that CCSD is a suburban district. Thus, results may not be generalizable to parents of students in urban inner city school districts or rural school districts. Nevertheless, prior analysis of the student data[24] found that, while there were some differences in sleep across race and social economic status, the change in start times did not appear to impact racial and economic groups differently.

Conclusion

Findings from this first-ever study of school start time changes and parent sleep outcomes show how a policy aimed at improving student sleep has, in fact, a downstream impact on parent sleep. Across the many prior studies on outcomes for students with later school start times, none have examined the outcomes associated with parent sleep duration, sleep quality, and parents' feelings of tiredness. Many of the previous studies of start times have included a call for greater parent education about the importance of sleep duration and routines for their children[9,33]; however, this study reveals that the caretakers of the students realize sleep benefits as well. Linking the findings for students to the wellness of their parent(s) is an even stronger argument for instituting the policy of later school start times for secondary students. This study provides an excellent expansion of what we know about the timing of school start times, now also examining its effect on the family as a whole.

Declaration of conflict of interest

The authors have declared no conflicts of interest.

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Supplementary materials

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