In the following report, Hanover Research reviews the empirical research on the impact of school start times and sleep on adolescents and examines key considerations for implementing changes to school start times.
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EXECUTIVE SUMMARY

INTRODUCTION

National surveys indicate that over 70 percent of adolescents receive less than eight hours of sleep per school night, which is the minimum recommended amount for this age group.\(^1\) As research finds that adolescents struggle to fall asleep before 11:00 p.m. due to hormonal changes affecting their natural sleep cycle, professional associations such as the American Academy of Pediatrics (AAP) recommend that secondary schools start no earlier than 8:30 a.m.\(^2\) However, school districts often encounter challenges when changing school start times, and must consider the impact on factors including transportation, athletics and extracurricular activities, and schedules of community stakeholders.

To support Mountain View Los Altos High School District (MVLA) in their evaluation of school start times, Hanover Research (Hanover) reviews professional recommendations and peer-reviewed research studies related to the effects of school start times on secondary school students. Additionally, Hanover presents findings from the experiences of districts that have implemented changes to their school start times to reveal critical implementation considerations. The report includes the following two sections:

- **Section I: The Impact of School Start Times on Student Outcomes** presents an overview of recommendations regarding nightly sleep and school start times for adolescents and examines research on the effects of school start times on secondary school students.

- **Section II: Considerations for Changing School Start Times** discusses district- and school-level strategies for managing challenges associated with implementing changes to school start times, including considerations related to transportation; athletics, extracurricular activities, and student employment; and family schedules and community support.

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KEY FINDINGS

THE IMPACT OF SCHOOL START TIMES ON ADOLESCENTS

- An increasing number of professional associations support delaying middle and high school start times to 8:30 a.m. or later. The American Academy of Pediatrics (AAP) notes that “a substantial body of research has now demonstrated that delaying school start times is an effective countermeasure to chronic sleep loss and has a wide range of potential benefits to students with regard to physical and mental health, safety, and academic achievement.” Consequently, the AAP, American Medical Association, and American Academy of Sleep Medicine all endorse a start time of 8:30 a.m. or later for secondary students.

- Supporting these recommendations, research indicates that later school start times allow adolescents to sleep longer. Multiple studies find that students gain an additional minute or more of sleep per night for every two-minute delay in school start times. Students with a later start time may fall asleep later in the evening but still tend to sleep longer than their earlier starting peers. In addition, students with a later start time also typically report less sleepiness during the school day.

- A limited research base additionally suggests that later start times have a positive effect (or at worst, a negligible effect) on academic, behavioral, and other outcomes for secondary students. More specifically, U.S.-based studies generally find that a delay in school start times corresponds with either no significant change or an improvement in student achievement. Several studies also suggest that a delay in school start times reduces the percentage of teenage drivers in accidents, improves students’ mental health, and raises attendance and/or graduation rates. The few studies examining the effect of school start times on extracurricular participation suggest that a delay in start time does not affect participation rates.

CONSIDERATIONS FOR CHANGING SCHOOL START TIMES

- Districts may encounter a variety of challenges when implementing school start time changes, and should consider factors relating to:
  - Transportation, including increased traffic congestion, public transportation capacity and availability, and potentially longer commuting times for students, staff, and families;
  - Athletics, Extracurricular Activities, and Student Employment, including reduced time after school for extracurricular activities and student jobs, as well as competition for athletic facilities; and
  - Family Schedules and Community Support, including inconveniences to families who drop their students off at school on their way to work and the importance of general support from students, staff, parents, and other community members.

---

- **Districts may combat increased traffic congestion around schools by developing alternative traffic patterns and encouraging parents and students to reduce the number of cars entering school grounds.** For schools with a large volume of parents providing students with transportation to and from school, districts may opt to incorporate multiple designated curbside drop-off zones to disperse drop-off and pick-up traffic among various locations within school proximity. To reduce on-campus traffic, districts may also encourage students to carpool and/or use alternative transportation methods such as public transportation, walking, and biking.

- **Districts can incorporate field lights and/or develop partnerships with community organizations and institutions with lighted athletic facilities to ensure that all athletics teams have sufficient practice and game time.** As delaying school start times also typically delays school dismissal times, districts commonly add lights to fields and courts to account for the reduced after-school daylight hours. Districts may also collaborate with community organizations to utilize nearby facilities that already have lights.

- **Supervised morning time for quiet study and/or breakfast on school grounds allows families with inflexible schedules to drop off students before the start of the delayed school day.** Similarly, some schools with delayed school start times have implemented a flexible period before classes begin; students can use open school facilities similar to a study hall period. These unstructured but supervised flexible times before classes begin give students an opportunity to maintain a consistent schedule that aligns with parent work schedules.
SECTION I: THE IMPACT OF SCHOOL START TIMES ON ADOLESCENTS

This section presents an overview of recommendations regarding nightly sleep and school start times for adolescents and discusses research on the effects of school start times on secondary school students.

SLEEP AND SCHOOL START TIME RECOMMENDATIONS

Consensus statements published by both the American Academy of Sleep Medicine (AASM) and the National Sleep Foundation recommend that adolescents sleep from eight to 10 hours per night. However, the 2017 Youth Risk Behavior Survey (YRBS), a national survey of U.S. high school students conducted biannually by the Centers for Disease Control and Prevention (CDC), indicates that less than 25 percent of adolescents sleep eight or more hours on an average school night. Data from preceding YRBS administrations suggest that the percentage of adolescents receiving adequate sleep (i.e., eight hours or more) has decreased over the past decade, falling from 31 percent in 2007. Figure 1.1 below presents findings on school night sleep duration from the 2017 YBRS, segmented by gender and grade level.

Figure 1.1: Average School Night Sleep Duration of High School Students

<table>
<thead>
<tr>
<th></th>
<th>8 or more hours of sleep</th>
<th>Less than 8 hours of sleep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Students</td>
<td>25%</td>
<td>75%</td>
</tr>
<tr>
<td>Female Students</td>
<td>25%</td>
<td>75%</td>
</tr>
<tr>
<td>Male Students</td>
<td>26%</td>
<td>74%</td>
</tr>
<tr>
<td>Grade 12 Students</td>
<td>18%</td>
<td>82%</td>
</tr>
<tr>
<td>Grade 11 Students</td>
<td>21%</td>
<td>79%</td>
</tr>
<tr>
<td>Grade 10 Students</td>
<td>27%</td>
<td>73%</td>
</tr>
<tr>
<td>Grade 9 Students</td>
<td>35%</td>
<td>65%</td>
</tr>
</tbody>
</table>

Source: Centers for Disease Control


Notably, research commonly associates insufficient sleep with a variety of negative health outcomes that can impact academic achievement. For example, the AASM identifies the following benefits and risks associated with adolescent sleeping patterns:

- **Sleeping the number of recommended hours on a regular basis** is associated with better health outcomes including: improved attention, behavior, learning, memory, emotional regulation, quality of life, and mental and physical health.

- **Regularly sleeping fewer than the number of recommended hours** is associated with attention, behavior, and learning problems. Insufficient sleep also increases the risk of accidents, injuries, hypertension, obesity, diabetes, and depression. Insufficient sleep in teenagers is associated with increased risk of self-harm, suicidal thoughts, and suicide attempts.

**Delaying Secondary School Start Times**

Advocates for delayed school start times argue that traditional middle and high school schedules fail to accommodate adolescents’ biologically-determined sleep patterns. According to a research brief published by the Education Commission of the States (ECS), the onset of puberty causes adolescents to fall asleep and wake later because of a natural shift in the circadian rhythm, which regulates the sleep cycle through controlling the production of the sleep-inducing hormone melatonin. Research finds that this “biologically driven delay” in the natural sleep and wake patterns of teens and young adults totals nearly three hours.

Under this schedule, the adolescent body begins producing melatonin around 11:00 p.m. and reaches peak melatonin levels close to 7:00 a.m. In contrast, adult melatonin levels peak at 4:00 a.m., leading experts to equate a consistent 7:00 a.m. wake-up time for adolescents to a 4:00 a.m. wake-up time for adults. Due to this shift in the circadian rhythm and melatonin production, adolescents naturally find it difficult to fall asleep before 11:00 p.m. Since experts recommend that adolescents sleep between eight to 10 hours per night, a school start time that requires students to wake up before 8:00 a.m. is likely to cause or contribute to chronic sleep deprivation.

---

To promote healthier sleeping patterns in adolescent students, a growing number of professional associations support delaying secondary school start times to 8:30 a.m. or later. For example, in a 2014 policy statement, the American Academy of Pediatrics (AAP) notes that “a substantial body of research has now demonstrated that delaying school start times is an effective countermeasure to chronic sleep loss and has a wide range of potential benefits to students with regard to physical and mental health, safety, and academic achievement.”13 As such, the AAP recommends that districts delay school start times for adolescents in middle and high schools to 8:30 a.m. or later in order to improve students’ health, safety, and academic outcomes.14 In the years following the release of AAP’s policy statement, associations including the National Association of School Nurses, the Society of Pediatric Nurses, the American Medical Association, and the AASM have all issued similar position statements that support the AAP’s recommendation.15

However, despite (1) recommendations regarding adolescent sleep habits, (2) biological research finding that adolescents struggle to fall asleep before 11 p.m., (3) national surveys indicating that more than 70 percent of adolescents receive insufficient weeknight sleep, and (4) policy statements supporting delayed school start times, recent national data indicates that fewer than 20 percent of middle and high schools have a start time of 8:30 a.m. or later.16

OVERVIEW OF RESEARCH

Over the past two decades, a growing number of U.S. studies have assessed the effects of changes to school start times on a variety of student outcomes. Prompted in part by research indicating that children experience hormonal-driven changes in their sleep patterns, a large majority of the existing research studies focus on the effects of school start times on adolescents. For example, in a comprehensive literature review published in May 2016 in the *Journal of School Health*, Wheaton, Chapman, and Croft identified 38 U.S.- and foreign-based studies published since 1995 that consider the effects of start times on middle and high school students.17 Of these, 23 studies were conducted in U.S. public and private schools, with more than half published in 2007 or more recently.

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14 Ibid.
Studies on the effects of school start times most commonly include adolescent sleep patterns as an outcome. For instance, in their review, Wheaton, Chapman, and Croft determined that week-day sleep duration is the most common student outcome measure employed in start time research. In contrast, less than a third of the studies included in their review measure the effects of school start times on outcomes such as academic achievement, driving safety, and extracurricular participation (Figure 1.2).18

**Figure 1.2: School Start Time Research Base**

Source: Journal of School Health19

In addition to the studies included in Wheaton, Chapman, and Croft’s literature review (all published on or before July 1, 2015), Hanover also reviewed more recently published studies on school start times, as well as those included in two other 2016 literature reviews.20 However, the review by Wheaton, Chapman, and Croft is very comprehensive and includes all but two of the relevant sources included in the other two 2016 research reviews.21

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18 Ibid.
19 Figure adapted from: Ibid., pp. 375–378.
21 Two additional relevant studies included by: Morgenthaler et al., Op. cit.
When reviewing findings from studies on the effects of school start times, it is important to keep in mind the methodological limitations of the existing research. Studies on the effects of school start times typically employ either cross-sectional or longitudinal studies. Cross-sectional studies “compare different population groups at a single point in time,” while longitudinal studies compare “several observations of the same subjects over a period of time.” Although longitudinal studies are “more likely to suggest cause-and-effect relationships” when compared to cross-sectional studies, both methodological designs can only draw associations between school start times and other variables; these studies cannot establish causation. Current research also fails to evaluate whether the effects of changes in school start times are sustained over multiple years. As Morgenthaler et al. note in their 2016 literature review, studies examining the results of school start time changes over longer periods are needed “to determine whether the observed sleep increases and other outcomes are maintained.”

While studies typically control for school and student characteristics that may affect student outcomes, such controls (especially in cross-sectional studies) are imperfect. Findings from studies that rely on small sample sizes (e.g., students from a single school) or unique student populations (e.g., private boarding school students) should be interpreted with caution. Geographic location may also impact findings as the existing research does not consider the impact of school locations within a time zone on circadian rhythm or natural waking time. As Morgenthaler et al. note, “studies in states with a large distance from east to west may have children waking at a different biological time or circadian phase, such that the same school start time will result in an earlier biological time for children in the west compared with the east.”

Finally, districts also need to consider students’ daily travel time to school when interpreting research findings. As travel time is the second factor that determines student wake-up time, districts need to consider the effects of the start time and the time it takes students to travel to school.

**Summary of Research**

Hanover identified 21 U.S.-based studies published since 2007 that examine the effects of school start times on middle and high school students. These studies employ either a cross-sectional or longitudinal design and consider the effects of start times ranging from 7:00 a.m. and earlier to past 9:15 a.m. Figures 1.3, 1.4, and 1.5 on the following pages provide an overview of these studies, which are grouped based on the size of the delay in start time (or,
for cross-sectional studies, the difference between start times). Please note that positive findings indicate that students benefited from a delayed school start time.

**Figure 1.3: Studies with Delays in School Start Time of Less Than an Hour (2007-2018)**

<table>
<thead>
<tr>
<th>Author</th>
<th>Date</th>
<th>Design</th>
<th>Age/Grade</th>
<th>Start Times</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owens et al.</td>
<td>2017</td>
<td>Longitudinal</td>
<td>Grades 7-12</td>
<td>7:20 to 8:10 (high schools and secondary schools); 8:00 to 7:30 (middle schools)</td>
<td>Positive. High school students with a 50-minute delay slept 30.1 minutes longer on weeknights and reported less daytime sleepiness, whereas middle school students with a 30-minute advance slept 14.8 minutes less and reported more daytime sleepiness.</td>
</tr>
<tr>
<td>Thacher and Onyper</td>
<td>2016</td>
<td>Longitudinal</td>
<td>Grades 9-12</td>
<td>7:45 to 8:30</td>
<td>Mixed. Following a 45-minute delay, an initial increase in sleep duration of 20 minutes did not persist, but improvements in tardiness and disciplinary violations lasted.</td>
</tr>
<tr>
<td>Boergers, Gable, and Owens</td>
<td>2014</td>
<td>Longitudinal</td>
<td>Grades 9-12</td>
<td>8:00 to 8:25</td>
<td>Positive. After a 25-minute delay, mean wake times were later, sleep duration was longer, and bedtimes did not change on school days and nights.</td>
</tr>
<tr>
<td>Edwards</td>
<td>2012</td>
<td>Cross-sectional</td>
<td>Grades 6-9</td>
<td>7:30 vs 8:15</td>
<td>Positive. Later start times corresponded with higher standardized tests scores, less time spent watching TV, more time spent doing homework, and fewer absences.</td>
</tr>
<tr>
<td>Owens, Belon, and Moss</td>
<td>2010</td>
<td>Longitudinal</td>
<td>Grades 9-12</td>
<td>8:00 to 8:30</td>
<td>Positive. The delayed start time was associated with longer school night sleep duration, earlier bedtimes, and later rise times.</td>
</tr>
<tr>
<td>O’Malley and O’Malley</td>
<td>2008</td>
<td>Longitudinal</td>
<td>Grades 9-12</td>
<td>7:35 to 8:15</td>
<td>Positive. A later start time was associated with longer weekend sleep duration.</td>
</tr>
</tbody>
</table>

**Figure 1.4: Studies with Delays in School Start Time of an Hour or More (2007-2018)**

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<thead>
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<th>Author</th>
<th>Date</th>
<th>Design</th>
<th>Age/Grade</th>
<th>Start Times</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foss, Smith, and O’Brien</td>
<td>2018</td>
<td>Times Series¹</td>
<td>16-17 years</td>
<td>7:30 to 8:45</td>
<td>Positive. Adolescent daytime car crashes decreased in a county in which high school start times were delayed by over an hour.</td>
</tr>
<tr>
<td>Vorona et al.</td>
<td>2014</td>
<td>Cross-sectional</td>
<td>16-18 years</td>
<td>7:20 vs 8:45</td>
<td>Positive. Adolescent car crash rates were lower in the county with the later start time.</td>
</tr>
<tr>
<td>Vorona et al.</td>
<td>2012</td>
<td>Cross-sectional</td>
<td>16-18 years</td>
<td>7:20 vs 8:45</td>
<td>Positive. Adolescent car crash rates were lower in the county with the later start time.</td>
</tr>
<tr>
<td>Author</td>
<td>Date</td>
<td>Design</td>
<td>Age/Grade</td>
<td>Start Times</td>
<td>Findings</td>
</tr>
<tr>
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<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Hinrichs</td>
<td>2011</td>
<td>Longitudinal/Cross-sectional</td>
<td>Grades 10-12</td>
<td>7:15 to 8:40²</td>
<td><strong>Null.</strong> Hinrichs found no association between school start times and achievement on standardized assessments or attendance rates.</td>
</tr>
<tr>
<td>Danner and Phillips</td>
<td>2008</td>
<td>Longitudinal</td>
<td>Grades 6-12</td>
<td>7:30 to 8:30</td>
<td><strong>Positive.</strong> In the school year proceeding the start time change, students averaged from 12 minutes (Grade 9) to 30 minutes (Grade 12) additional minutes of sleep per night.</td>
</tr>
<tr>
<td>Wolfson et al.</td>
<td>2007</td>
<td>Cross-sectional</td>
<td>Grades 7-8</td>
<td>7:15 vs 8:37</td>
<td><strong>Mixed.</strong> Delayed start times were positively associated with Grade 8 students’ achievement but not with Grade 7 students’ achievement.</td>
</tr>
</tbody>
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¹ Time series analyses relies on longitudinal, rather than cross-sectional, data.

² Start times listed for the Minneapolis portion of the study only.

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**Figure 1.5: Studies with Variable Delays in School Start Time (2007-2018)**

<table>
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<th>Author</th>
<th>Date</th>
<th>Design</th>
<th>Age/Grade</th>
<th>Start Times</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temkin et al.</td>
<td>2018</td>
<td>Cross-sectional</td>
<td>Grades 7-8</td>
<td>7:23 vs 8:00 (average start times)</td>
<td><strong>Positive.</strong> Attending a later starting school correlated with 17 more minutes of sleep per weeknight and students who reported feeling more awake and less sleepy.</td>
</tr>
<tr>
<td>McKeever and Clark</td>
<td>2017</td>
<td>Longitudinal</td>
<td>Grades 9-12</td>
<td>8:30 or earlier to 8:35-9:15</td>
<td><strong>Positive.</strong> Delays in start time were associated with improvements in attendance and graduation rates two years following the delay</td>
</tr>
<tr>
<td>Nahmod et al.</td>
<td>2017</td>
<td>Cross-sectional</td>
<td>Grades 9-12</td>
<td>7:00-8:30 or later (range)</td>
<td><strong>Positive.</strong> Students with start times between 7:00 a.m. and 7:29 a.m. slept an average of 46 minutes less per school night than those with start times of 8:30 a.m. or later.</td>
</tr>
<tr>
<td>Wahlstrom, Berger, and Widome</td>
<td>2017</td>
<td>Cross-sectional¹</td>
<td>Grades 9-12</td>
<td>7:35-8:55 (range)</td>
<td><strong>Positive.</strong> Longer sleep duration was associated with fewer mental health and substance-use related behaviors and issues. Later school start times were associated with longer sleep duration.</td>
</tr>
<tr>
<td>Paksarian et al.</td>
<td>2015</td>
<td>Longitudinal</td>
<td>13-18 years</td>
<td>7:05-9:22 (range)</td>
<td><strong>Mixed.</strong> Later start times associated with increased sleep for boys in urban areas. No significant effects for delays past 8:00 a.m.</td>
</tr>
<tr>
<td>Wahlstrom et al.</td>
<td>2014</td>
<td>Longitudinal</td>
<td>Grades 9-12</td>
<td>7:30-7:50 to 8:00-8:55</td>
<td><strong>Positive.</strong> A start time of 8:30 a.m. or later allowed for more than 60 percent of students to sleep for at least eight hours per school night. The impact on achievement, attendance, and driving safety was mixed but trended positive.</td>
</tr>
</tbody>
</table>

¹ Time series analyses requires longitudinal, rather than cross-sectional, data.
In the following paragraphs, Hanover discusses the effects of school start times on academic achievement, sleep habits, and other outcomes for adolescents in greater detail.

**EFFECTS ON ACADEMIC ACHIEVEMENT**

Research focusing on the effects of school start times on student achievement remains inconclusive, with different studies indicating positive, mixed, or no statistically-significant impacts of delays to school start times. Wheaton, Chapman, and Croft note that “some evidence suggests a positive association between later school start times and academic performance,” but that “the association may be relatively weak and not universal.”\(^2^8\) Further complicating research findings, studies on the effects of school start times on academic achievement are typically correlational in nature and are, thus, unable to provide causal evidence to confirm that changes in school start times lead to differences in student academic achievement.\(^2^9\) Research focusing on the effects of school start times on academic achievement is also limited. For example, of the 38 studies included in the review by Wheaton, Chapman, and Croft, only 10 studies examined the effects of school start times on student achievement. Similarly, as Keller et al. note in a 2015 study on school start times in Kentucky elementary schools, “a large scale investigation of the potential impact of public school start times on academic achievement is lacking.”\(^3^0\)

**Positive Effects**

Several studies suggest a positive correlation between delayed school start times and academic performance. Wheaton, Chapman, and Croft found that, of the 10 studies included in their analysis that examined the effects of school start times on student achievement, six U.S.-based studies suggested a positive association between later school start times and improved student achievement. However, of these six studies, only three had *completely*


positive findings: a 2011 study published by Carrell, Maghakian, and West, a 2012 study published by Finley Edwards, and a 2005 study by Arlington Public Schools.\(^{31}\)

In a multi-year study of first-year students at the U.S. Air Force Academy (USAFA), Carrell, Maghakian, and West determined that a delayed school start time had a causal effect on student academic achievement. In this study, Carrell, Maghakian, and West assessed the effects of school start times on USAFA first-year students from 2004 to 2008, a dataset consisting of over 6,000 students.\(^{32}\) This dataset’s unique features, as shown in Figure 1.6 below, allowed Carrell, Maghakian, and West to establish *causality*, rather than merely *correlation* or *association*. As similar causal studies are rare, the Brookings Institute considered the findings particularly “compelling evidence.”\(^{33}\)

**Figure 1.6: Characteristics of Carrell, Maghakian, and West’s Study of USAFA First-Years**

- Students in their freshman year at USAFA are required to take a series of core courses in which attendance in their assigned section is mandatory.
- Students are randomly assigned to course sections and cannot choose which periods they take their classes.
- Not every student is assigned to a first period course.
- [The authors] exploit the fact that USAFA runs on an M/T schedule. On M Days, students have one set of classes and on T Days they have a different set of classes. The M/T schedule runs every other day. Thus, some students may have first period classes on both M and T days, others may only have a first period class on one of the schedule days, and some may not have any first period classes.
- [The authors] exploit two distinct policy changes in the USAFA class schedule. Prior to academic year 2006–2007 (AY 2006), the academic day started at 7:30 a.m. In AY 2006, the school day was moved 30 minutes earlier, starting at 7 a.m. In AY 2007, the start time was moved to 7:50 a.m.

*Source: American Economic Journal: Economic Policy*\(^{34}\)

In the Carrell, Maghakian, and West study, students with a 7:00 a.m. start time performed worse in their first period and following classes when compared to students with a start time of 7:50 a.m. The authors found that a delayed class start time of 50 minutes yielded “the equivalent benefit as raising teacher quality by roughly one standard deviation.”\(^{35}\) Students assigned to a 7:00 a.m. start time performed “a statistically significant 0.140 standard deviations lower on average in comparison with [students assigned to a class with] the latest start time,” while students starting at 7:50 a.m. did not perform at a statistically lower level. This finding aligns with research indicating that melatonin production peaks at about 7 a.m. and stops at about 8 a.m.\(^{36}\)

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\(^{34}\) Figure bullets quoted verbatim from: Carrell, Maghakian, and West, Op. cit., pp. 67–67.

\(^{35}\) Ibid., pp. 79–80.

\(^{36}\) Ibid., p. 75.
Carrell, Maghakian, and West argue that their findings are applicable to the high school student population because they consider only freshman college students who, like high school seniors, “are still adolescents and have the same biological sleep patterns and preferences as those in their earlier teens.”\textsuperscript{37} Moreover, the authors note that the fact that early school start times negatively impacted the USAFA sample—a group of students with a history of high academic achievement and a preference for a regimented lifestyle—suggests that average students may experience even greater detrimental effects.\textsuperscript{38}

Similarly, a 2012 study by Edwards finds that a start time of 8:00 a.m. or later is associated with higher student achievement, especially among low-achieving students. For his study, Edwards used student achievement and demographic data from North Carolina’s Wake County Public School System (WCPSS) that were collected between 1999 and 2006. Slightly over half of WCPSS middle schools over that period began at 7:30 a.m., while the others began at either 8:00 a.m. or 8:15 a.m.\textsuperscript{39} Edwards’ findings indicate that starting schools one hour later increased standardized test scores by 1.8 percentile points in mathematics and 1.0 percentile points in reading. Notably, the effects on students in the bottom third as opposed to the top third of test-takers were twice as large. In addition, a one-hour delay in middle school start time was associated with a 2.0 and 1.6 percentage point increase in high school mathematics and reading scores, respectively.\textsuperscript{40}

A 2005 study by Arlington Public Schools (APS) in Virginia suggests that later school start times had positive impacts on middle and high school students, while earlier start times had negative impacts. The APS study evaluated a change in high school start times from 7:30 a.m. to 8:15 a.m. To accommodate districtwide transportation needs, APS also shifted middle school start times from 8:10 a.m. to 7:50 a.m. While the grade point averages of high school students improved after the change, APS observed some academic decline at the middle school level. Therefore, APS concluded that “a more effective approach might have been to shift elementary start times [instead of middle school start times].”\textsuperscript{41}

Mixed or No Effects

Several studies find that later school start times have mixed effects on student grades and standardized test scores. In the most recent of these studies, Wahlstrom et al. obtained mixed results when evaluating the effects of later school start times on the academic achievement of 9,000 students in eight high schools across Minnesota, Colorado, and

\begin{flushleft}
\textsuperscript{37} Ibid., p. 63.
\textsuperscript{38} Ibid.
\textsuperscript{40} Ibid., p. 970.
\textsuperscript{41} This report is no longer publicly available but was cited in a past Hanover report titled “School Start Times and Student Outcomes” (April 2016), which is available through the Customer Portal. Hanover takes the description of this study’s findings verbatim from that report.
\end{flushleft}
Wyoming. Student performance on standardized tests increased following the start time change at three high schools, but decreased in two high schools. Similarly, student GPA in core courses increased significantly across three high schools following the start time change, but did not increase across all subject areas in two high schools.

Other research suggests that later school start times have little to no effect on academic achievement. For example, in a 2011 study, Peter Hinrichs examined the effects of later school start times on standardized test scores in Minneapolis-Saint Paul, Kansas, and Virginia from 1993 to 2002. In Minneapolis, where high schools delayed their start times from 7:15 a.m. to 8:40 a.m. in the 1997-98 school year, Hinrichs found no indication that this policy change affected test scores or attendance patterns. Similarly, neither ACT scores in Kansas or End of Course (EOC) scores in Virginia indicated any effect of later school start times on student achievement (specific start times varied across Kansas and Virginia). However, there are considerable limitations of this research. ACT scores may not accurately reflect student learning. Hinrichs was also unable to decouple the impact of schedule changes from other district and school changes (although this criticism could be leveled at many studies on school start times), and the pool of students who chose to take the ACT was not necessarily representative of the entire student body.

A smaller, cross-sectional study finds that a delay in school start time to 8:37 a.m. was associated with improved student achievement for Grade 8 students but not for Grade 7 students. In their 2007 study involving two middle schools with different start times in demographically similar New England districts, Wolfson et al. examined student grades in addition to nightly sleep. The authors found that Grade 8 students attending a school with a start time of 8:37 a.m. performed better compared to Grade 8 students attending a middle school that started at 7:15 a.m. However, the authors found no statistically significant differences in fall quarter grades at the Grade 7 level. It is worth noting, however, that the total sample size of this study was 205 students.

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43 The authors examined grade point averages for first- or third- period courses in mathematics, English, social studies, and science. However, for Mahtomedi Public Schools and South Washington County high schools, the authors examined course grades. See: Ibid., pp. 40–41.


48 Wolfson, A. et al. “Middle School Start Times: The Importance of a Good Night’s Sleep for Young Adolescents.” Behavioral Sleep Medicine, 5, 2007. pp. 198–203. https://pdfs.semanticscholar.org/ac06/e8dc184d5f3c2bd362707f1c7f135d5ac11e.pdf
EFFECTS ON SLEEP

As noted, most research on school start times focuses on the association between start times and adolescent sleeping patterns. In their 2016 literature review, Wheaton, Chapman, and Croft note that “because delaying school start times is primarily intended to address the problem of insufficient sleep among adolescents, most of the studies [included in their review] focused on the association between school start times and sleep variables.” 49 While studies consistently find that students attending schools with later start times sleep in longer compared to students with earlier classes, the association between school start times and bedtime is mixed. Some studies observe no correlation between them, while others find that students with later start times have later bedtimes when compared to their peers attending schools with an earlier start. Nevertheless, as the following subsections describe, students with later start times consistently sleep longer, even when they go to bed later.50

POSITIVE EFFECTS

Research indicates that delayed school start times typically result in more sleep for adolescent students. In their 2016 literature review, Wheaton, Chapman, and Croft included 31 U.S.- and foreign-based studies that examined the connection between school start times and school night sleep. In 29 of these studies, a later start time is associated with longer weeknight sleep duration, primarily due to the delay of rise times. Wheaton, Chapman, and Croft note that “most of the studies [see] a significant increase in sleep duration even with relatively small delays in start times of half an hour or so.”51 When examining the 20 U.S.-based studies specifically, seven of them “[find] that students got at least one additional minute of sleep for every two minutes of difference in start time.”52 While six studies observe a later bedtime among students attending schools with later start times, these students still slept more in comparison with peers attending schools with earlier start times.53

LONGITUDINAL EVIDENCE

Experimental studies find that a 25-minute or greater delay to a start time of 8:30 a.m. or later results in significant increases in students’ nightly sleep duration. In a 2016 literature review published in Sleep Medicine Reviews, Minges and Redeker review experimental studies, identifying three U.S.-based studies that employ a “pre-post no control” design (i.e., a longitudinal design).54 As Figure 1.7 describes on the following page, the three U.S.-based studies indicate that a delay of 25 minutes to an hour in school start times corresponded with increases in sleep duration of 12 to 45 minutes.

50 Ibid.
51 Ibid., p. 363.
52 Ibid., p. 375.
53 Ibid.
Figure 1.7: U.S. Experimental Studies Examining the Effects of School Start Times on Sleep

<table>
<thead>
<tr>
<th>STUDY</th>
<th>DESCRIPTION</th>
<th>OUTCOME</th>
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<tbody>
<tr>
<td>Boergers et al. (2014)55</td>
<td>The study measured the effects of a delay in the school start time (from 8:00 a.m. to 8:25 a.m.) during the winter term at an independent boarding and day school. 197 students completed a sleep habits survey before and during the change, as well as in the spring term after the change was reversed.</td>
<td>Positive. The delay in school start time corresponded with a significant increase in weekday sleep duration of 29 minutes. The percentage of students receiving at least eight hours of sleep increased from 18 to 44 percent. Grade 9 and 10 students were most likely to report increased sleep duration. Sleep duration reverted to original levels when the earlier start time was reinstated.</td>
</tr>
<tr>
<td>Owens et al. (2010)56</td>
<td>The study measured the effects of a two-month change in school start time, a delay from 8:00 a.m. to 8:30 a.m., at a New England boarding school. 201 students in Grades 9-12 completed a sleep habits survey before and after the change.</td>
<td>Positive. Following the delay, the average school night sleep duration increased by 45 minutes, the number of students getting less than seven hours of sleep decreased by 79 percent, and the percentage of students reporting at least eight hours of sleep increased from 16 to 55 percent. The average bedtime advanced by 18 minutes.</td>
</tr>
<tr>
<td>Danner et Phillips (2008)57</td>
<td>In the 1999-2000 school year, a county-wide school district in Kentucky delayed middle and high school start times by an hour from, respectively, 8:00 a.m. and 7:30 a.m. to 9:00 a.m. and 8:30 a.m. Roughly 10,000 middle and high school students completed a sleep habits survey in the year preceding the change and then again in April of 2000. The authors only provided results at the high school-level.</td>
<td>Positive. In the school year proceeding the change, students averaged from 12 minutes (Grade 9) to 30 minutes (Grade 12) additional minutes of sleep per night. Changes in average sleep were significant for all grade levels. The percentage of students sleeping at least eight hours on a weeknight increased from 36 to 50 percent. The average amount of additional weekend sleep decreased from 1.9 to 1.1 hours.</td>
</tr>
</tbody>
</table>

Source: Journal of Developmental & Behavioral Pediatrics, Archives of Pediatric and Adolescent Medicine, and Journal of Clinical Sleep Medicine

Additionally, in a quasi-experimental 2017 study of school start time changes in Fairfax County Public Schools (VA), Owens et al. found that changing school start times significantly impacted student sleep duration and daytime sleepiness. Specifically, high school students with a 50 minute delay (from 7:20 to 8:10 a.m.) slept 30.1 minutes longer on weeknights and reported less daytime sleepiness, whereas middle school students with a 30-minute advance (from 8:00 to 7:30 a.m.) slept 14.8 minutes less and reported more daytime sleepiness.58

Another similar longitudinal study by O'Malley and O'Malley examined the impact of a 30-minute delay in school start times on students in one high school in Connecticut. They found that delaying the school start time from 7:35 a.m. to 8:15 a.m. corresponded with an average increase in total sleep by 34 minutes per school night.  

**CROSS-SECTIONAL EVIDENCE**

Findings from cross-sectional studies also support a high school start time of 8:30 a.m. or later. For example, in a 2018 study, Temkin et al. measured differences in the sleep habits of 343 students in Grades 7-8 at three schools with an average start time of 7:23 a.m. and 630 students in eight schools with later start times (an average start time of 8:00 a.m.) using the School Sleep Habits Survey.  

The authors found that students attending earlier starting schools averaged 8 hours and 9 minutes of sleep, in comparison with 8 hours and 23 minutes for students attending later starting schools. After applying controls for demographic factors, the authors associated a later start time with longer sleep duration of approximately 17 minutes, roughly a minute of extra sleep for every two minutes of delay in start time. Students attending later starting schools were also less likely to report daytime sleepiness, and more likely to report being wide awake.

Similarly, in study published in 2018, Nahmod et al. used a large, diverse sample from a subsample of the Fragile Families and Child Wellbeing Study and found that later school start times were positively associated with increased sleep duration. Specifically, students with start times between 7:00 a.m. and 7:29 a.m. slept an average of 46 minutes less per school night than those with start times of 8:30 a.m. or later. The researchers also found that students who started school at 8:30 a.m. or later were the only group to obtain the recommended 8 hours of sleep on school nights.

Furthermore, in a 2014 study, Wahlstrom examined sleep habit survey data from eight public high schools across Minnesota, Colorado, and Wyoming during the 2010-11 to 2012-13 school years. The population was ethnically and socio-economically diverse, with the percentage of white students ranging from 60 to 90 percent and the percentage of students receiving free or reduced-price lunch ranging from 10 to 34 percent. While all schools adjusted their school start times, Wahlstrom collected pre- and post-change data for just two schools; for the other schools, only post-change data was collected. Post-change start times ranged from 8:00 a.m. to 8:55 a.m. across schools, with half of the schools starting at 8:30 a.m. or later.

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64 Ibid., p. 24.
Wahlstrom found that a start time of 8:30 a.m. or later allowed for more than 60 percent of students to sleep for at least eight hours per school night. Correspondingly, in a 2011 cross-sectional study of 1,941 students across five high schools, Ming et al. found an association between a start time of 7:30 a.m. or earlier and decreased weekday sleep duration and sleep quality, compared with a start time after 7:30 a.m.

Several cross-sectional studies suggest that a delay in school start times of an hour or more can increase adolescents’ school night sleep duration by over 30 minutes per night. For example, in an earlier study, Wahlstrom found that a delay in school start time from 7:15 a.m. to 8:40 a.m. at seven high schools in Minneapolis Public School District (MN) corresponded with students sleeping 50 minutes longer each night, in comparison with students at a demographically similar district with a start time of 7:30 a.m. Correspondingly, in a 2007 study of two diverse New England urban school districts, Wolfson et al. found that students attending a middle school that started at 8:37 a.m. slept from 37 to 65 minutes longer per weeknight (depending on the survey period), in comparison with students attending a middle school starting at 7:15 a.m.

Moreover, in a 2007 study with a nationally representative sample, Adam, Snell, and Pendry found that a one-hour delay in start time corresponded with 34 minutes of additional sleep for adolescents. From a sample of 2,454 children (from ages 5.5 to 11.9) and adolescents (from ages 12 to 19.1), Adam, Snell, and Pendry used a cross-sectional method to examine the associations between “demographic characteristics, school schedules, activity choices, family functioning, and sleep behaviors.” Of these, “the largest effect sizes were for the impact of school start times and especially the effect of travel time to school on total hours of weekday sleep.” For adolescents, an hour delay corresponded with 0.57 hours of additional sleep per night and a delay of school day wake time by 0.62 hours.

**Mixed or No Effects**

However, a smaller body of literature finds that delayed school start times are not associated with lasting sleep gains for adolescent students. For example, in an experimental study published in 2016, Thacher and Onyper examined sleep habits, academic performance, and other academic-related factors of students from a public high school in upstate New York, which delayed its start time by 45 minutes from 7:45 a.m. to 8:30 a.m. during the 2012-13 school year.

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70 Ibid., p. 16.  
71 Ibid., p. 12.
school year. While surveys of student sleep habits indicated that students were sleeping for an average of 20 minutes longer in the fall following the change, by the spring, students reported sleeping for the same amount of time as they did before the change. However, the authors found lasting improvements in tardiness and disciplinary violations.

Additional research suggests that delays in school start times past 8:00 a.m. do not have an impact on adolescents’ average sleep duration. In what the authors describe as “the largest study to date of adolescents from across the United States,” Paksarian and Rudolph examined a subsample of a nationally representative cross-sectional survey of over 7,300 students aged 13 to 18 years old. After adjusting for variables such as age, sex, school level, urbanicity, and student employment, the authors found that students overall, as well as students from specific subgroups, did not sleep longer, on average, with school start time delays later than 8:00 a.m. However, Paksarian and Rudolph identified some differences in the effects of delayed start times before 8:01 a.m. by student gender and school location. Specifically, they found that:

- **Male adolescents appear to benefit from start time delays before 8:01 a.m., but female adolescents appear to be unaffected.** The data shows that for each half-hour delay in start time before 8:01 a.m., male students slept approximately 20 minutes longer; however, school start time was not associated with sleep duration for female students, no matter the delay was before or after 8:01 a.m.

- **Increases in adolescent average sleep duration were most associated with male students living in major metropolitan counties.** For male adolescents in major metropolitan counties, each half-hour delay in start time before 8:01 a.m. was associated with nearly 34 minutes of extra sleep each night. Later school start times were unassociated with sleeping patterns for male students living in urbanized counties, and negatively associated with male students living in nonurban counties (sleep duration was 20 minutes less for these students on weeknights for each half-hour delay in start time before 8:01 a.m.).

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72 Published after Minges and Redeker’s and Wheaton, Chapman, and Croft’s 2016 reviews were submitted and so not included.


75 Bullets adapted from: Ibid.
EFFECTS ON BEHAVIORAL AND OTHER STUDENT OUTCOMES

The following subsections discuss the effects of school start times on secondary students’ driving safety, attendance and graduation rates, mental health, and extracurricular participation.

DRIVING SAFETY

Surveys indicate that adolescents are more likely to drive when drowsy, a leading cause of fatal crashes for teen drivers. The CDC finds that teens (16 to 19 years old) are the most at-risk group for motor vehicle crashes, as they are nearly three times more likely to be in a fatal crash than drivers aged 20 years and older.\textsuperscript{76} Adolescents are also more likely to drive when drowsy. According to a survey by the AAA Foundation for Traffic Safety (AAA Foundation), one in seven licensed drivers of ages 16 to 24 years old admitted to having nodded off at least once while driving in the past year. In comparison, only one in 10 of all licensed drivers over the same period reported falling asleep while driving. Moreover, the AAA Foundation estimates that roughly one in six crashes involves a drowsy driver.\textsuperscript{77}

The CDC cites drowsy driving as one of the eight leading causes of teen car crashes, noting that high school students who sleep less than nine hours per night are more likely to exhibit the risk behaviors shown in Figure 1.8 below.\textsuperscript{78}

\textbf{Figure 1.8: Driving-Related Risk Behaviors Associated with Insufficient or Excessive Sleep}

\begin{itemize}
  \item Infrequent bicycle helmet use
  \item Infrequent seatbelt use
  \item Rode with a drinking driver
  \item Drinking and driving
  \item Texting while driving
\end{itemize}

Source: CDC\textsuperscript{79}

Available research also suggests that later school start times reduce the percentage of teenage drivers in accidents. Wheaton, Chapman, and Croft identified four studies that assessed the impact of school start times on motor vehicle crashes, all of which are U.S.-based studies. Figure 1.9 provide a description and summary of findings from the studies from the Wheaton, Chapman, and Croft literature review, as well as two more recent empirical studies published in 2017 and 2018. These studies tend to consider delays in start times to 8:30 a.m. or later.

\textsuperscript{79} Figure adapted from: Wheaton et al., Op. cit.
## Figure 1.9: Studies on School Start times and Adolescent Driving Crashes

<table>
<thead>
<tr>
<th>STUDY</th>
<th>DESCRIPTION</th>
<th>FINDINGS</th>
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<tbody>
<tr>
<td>This study examines adolescent car crashes in Forsyth County, North Carolina before and after the county school district changed its school start time from 7:30 a.m. to 8:45 a.m., as well as adolescent crash rates in three counties with comparable levels of urbanization and driving environments.</td>
<td><strong>Positive.</strong> Car crash rates among adolescents ages 16 to 17 years old in Forsyth county decreased by 14 percent following the 75-minute delay in school start times. There were no significant changes in the other three counties that did not change their start times.</td>
<td></td>
</tr>
<tr>
<td>Wahlstrom et al. (2014)</td>
<td>The study analyzes vehicle crash data from Minnesota, Colorado, and Wyoming drivers ages 16 to 19 years old. The authors examine the number of crashes involving teen drivers in the area surrounding eight high schools before and after these schools implemented a schedule change, delaying their starting times. Pre-delay start times varied from 7:30 a.m. to 7:50 a.m. and post-delay start times from 8:00 a.m. to 8:55 a.m.</td>
<td><strong>Mostly Positive.</strong> Across the four communities for which Wahlstrom had crash data, two communities saw a decrease in the rate of adolescent car crashes of 65 to 70 percent following the implementation of delays in schools start times. A third district saw a decrease of six percent, while the fourth experienced an increase of nine percent in adolescent car crashes.</td>
</tr>
<tr>
<td>Vorona et al. (2014)</td>
<td>This study examines adolescent (16 to 18 years old) car crashes in Chesterfield and Henrico Counties (CC and HC, respectively) for the 2009-10 and 2010-11 school years. CC had a high school start time of 7:20 a.m., while HC high schools began at 8:45 a.m. Both counties are demographically similar and adult crash rates and traffic congestion did not differ between counties.</td>
<td><strong>Positive.</strong> CC adolescents manifested a statistically higher crash rate of 48.8/1000 licensed drivers versus Henrico's 37.9/1000 for 2009-10. In 2010-11, adolescents ages 16 to 17 years old in CC demonstrated a statistically significant higher crash rate (53.2/1000 versus 42.0/1000). For adolescents ages 16 to 18, a similar (but statistically non-significant) trend was found. Crash peaks occurred one hour earlier in the morning and two hours earlier in the afternoon in Chesterfield, consistent with commute times.</td>
</tr>
<tr>
<td>Vorona et al. (2011)</td>
<td>This study examines adolescent (16 to 18 years old) car crashes in Virginia Beach and Chesapeake Counties (VBC and CC, respectively) over 2007-2008. High schools in VBC started between 7:20 and 7:25 a.m., while those in CC started at either 8:40 or 8:45 a.m.</td>
<td><strong>Positive.</strong> Despite similar demographics and no obvious traffic-related explanations, less teen-related accidents occurred in VBC than in CC (46.6/1000 in comparison with 65.8/1000).</td>
</tr>
</tbody>
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This study examines the teen crash rate in a county-wide district in Kentucky two years prior to and two years following a delay in school start times. Specifically, in 1999, this district’s high and middle schools delayed their start times by one hour, respectively, to 8:30 a.m. and 9:00 a.m. Positive. The authors found that a delay in school start time corresponded with a drop in the teen crash rate by 16.5 percent in comparison with the rate for the two years preceding the schedule change. In contrast, the statewide teen crash rate increased by 7.8 percent over this period.

Source: Center for Applied Research and Educational Improvement, *Journal of Clinical Sleep Medicine and Accident Analysis & Prevention.*

### ATTENDANCE AND GRADUATION

Research suggests that later school start times are associated with decreased rates of tardiness and absence. Six studies included in Wheaton, Chapman, and Croft’s review suggest that “earlier start times [are] also related to more frequent tardiness and more absences.” In addition, in his 2012 study of WCPSS students, Edwards found evidence that students who started school one hour later had 1.3 fewer absences in comparison to the median of five absences. Similarly, Wahlstrom found that three high schools included in her study experienced significant increases in attendance after delaying start times, while no high schools experienced significant decreases in attendance. While Wolfson et al. discovered no significant differences in absence rates between two middle schools with different start times, the authors found a significant difference in the tardiness rates between the two schools, with the middle school starting at 8:37 a.m. reporting fewer tardy students compared to the middle school starting at 7:15 a.m. Lastly, in a study of a delayed start time at an independent school in Rhode Island published in 2010, Owens et al. found that teacher-reported first class absences and tardies decreased by 45 percent following the schedule change. While these positive findings suggest that a delay in school start times may improve student attendance, results should be interpreted with caution due to the small sample sizes in the majority of these studies.

In a wide-scale, longitudinal study published in *Sleep Health* in 2017, start times delayed from 8:30 a.m. or earlier to 8:35 a.m. or later corresponded with significant increases in student graduation and attendance rates across a diverse set of high schools. McKeever and Clark examined the impact of delayed start times on high school absence and graduation rates across 29 schools in eight school districts in seven states that all delayed their start times from 8:30 a.m. or earlier to between 8:35 a.m. and 9:15 a.m. On average, districts delayed start times by approximately an hour. Across these schools, the mean graduation rate rose from 79 percent to 88 percent after later start times were implemented. Similarly, the mean attendance rate across schools prior to the delays was 90 percent and rose to 94 percent post-delay. Further statistical analysis suggests that the increases in graduation and

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attendance rates are significant. Due to the scope of the study, the authors note that the results are “intended to be generalized to all high schools in the United States,” although the participating districts were not selected randomly, but were based on their participation in the Children’s National Medical Center’s Division of Sleep Medicine study.\(^90\)

**Mental Health**

Several studies associate later school start times with improved student mental health. Wheaton, Chapman, and Croft note that “sleep is strongly linked with many psychiatric disorders, including depression and anxiety” and there is “evidence of a causal relationship between insufficient sleep and depression, as well as mood in general.”\(^91\) Consequently, a small number of studies include depression assessments. Four studies in Wheaton, Chapman, and Croft’s review find that students at schools with later start times received lower depression scores in comparison with students at schools with earlier start times.\(^92\) Similarly, two experimental studies find “significant decreases in the depression scale, depressed mood score, and proportion of students who were irritated or annoyed relative to post-intervention [i.e., a delay in start time].”\(^93\)

Additionally, in a 2017 study, Wahlstrom, Berger, and Widome examined the sleep duration, mental health and behavior, and substance-use of 9,089 students in Grades 9-12 at high schools in five districts across the U.S. with start times ranging from 7:35 to 8:55 a.m. They found that (1) later school start times were associated with greater sleep duration and later wake-up times, and (2) greater sleep duration was significantly correlated with fewer mental health issues and substance-use behaviors. Specifically, the authors report that each additional hour of sleep corresponded with a 28 percent reduction in the likelihood of a student reporting that he or she felt “unhappy, sad, or depressed.” However, later start times were also associated with increased self-reported substance use.\(^94\) While one quasi-experimental study included in Minges and Redeker’s review revealed no significant differences in students’ mood following an hour delay in start time for students 13 to 16 years old, the delayed start only occurred on one day of the week. Moreover, only 55 students were included in the intervention group of the study, which took place in Norway.\(^95\)

**Extracurricular Participation**

Several studies find that delays in school start times do not affect participation rates in afterschool activities. Only a small number of studies on school start times examine their effects on extracurricular participation. Of these, Danner

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\(^92\) Ibid.


and Barbara’s 2008 study of students in Grades 6-12 at a county-wide school district in Kentucky has the largest sample size (approximately 10,000 students, on average, across multiple years). In 1999, this district’s high schools and middle schools delayed their start times by one hour to 8:30 a.m. and 9:00 a.m., respectively. In addition to data from a sleep habits survey conducted in the years before and after the change, schools gathered participation rates in afterschool activities, including sports and co-curricular activities. The study finds that in the 1998-99 to the 1999-00 school years, there was a slight increase in the percentage of students who reported working 10 hours or more per week. However, “there were no significant differences in hours spent on homework, school sports, organized community sports, music activities, volunteer work, or hanging out with friends.”

Similarly, in her 2002 study of seven comprehensive high schools in the Minneapolis Public School District, Wahlstrom found that a delay in the high school schedule from between 7:15 a.m. and 7:35 a.m. to 8:40 a.m. did not affect participation rates in afterschool extracurricular activities. Based on 578 teachers’ responses to a survey administered in the fall of 1996 before the change and 335 responses in the spring of 1998 following the change, Wahlstrom discovered that the “actual participation rates in afterschool activities, including sports and co-curricular activities, remained at the same levels after the implementation of the later high school start time as they had been before the change.” However, coaches and activity leaders were generally supportive of the change because they perceived students as less tired and more mentally alert by the end of the day.

The findings of these larger-scale studies of public secondary schools mirror those from two smaller studies of private schools. These smaller-scale studies also find that a delay in school start times did not impact students’ extracurricular participation.

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98 Ibid.
SECTION II: CONSIDERATIONS FOR CHANGING SCHOOL START TIMES

The following section discusses district- and school-level strategies for managing challenges associated with changes to school start times, including transportation considerations; athletics, extracurricular activities, and student employment considerations; and considerations related to families’ schedules and community support. Information about these challenges is synthesized from the secondary literature, as well as primary research conducted by Hanover that includes in-depth interviews with school and district leaders that have considered and/or implemented a change in school start times. Each of these subsections concludes with a discussion guide that district leaders can use to support internal conversations around the impact of changing school start times.

OVERVIEW

While many districts acknowledge the benefits of later start times for adolescents, logistical or financial constraints may prevent them from making the shift. Indeed, the National Sleep Foundation identifies eight major obstacles faced by districts that attempt to delay high school start times, as outlined in Figure 2.1.

Figure 2.1: Challenges Associated with Changes to School Start Times

<table>
<thead>
<tr>
<th>LOGISTICAL CHALLENGE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation</td>
<td>Although transportation challenges vary, districts often cite concerns such as scheduling, costs, recruitment of bus drivers, and routing difficulties when considering changes to school schedules.</td>
</tr>
<tr>
<td>Extracurricular Activities</td>
<td>Students and parents argue that later release times result in less time available for after-school activities, especially during daylight hours. They also question the availability of school resources (e.g., more teams vying for the same gym or field during the same limited time intervals). In addition, later release times may require students to leave class early to attend extracurricular events or games.</td>
</tr>
<tr>
<td>Reduced Access to Community Resources</td>
<td>Some argue that following a later release, students will have less time to access community resources, such as the library.</td>
</tr>
<tr>
<td>Effects on Staff</td>
<td>Many teachers, administrators, and coaches worry that a later start time will lead to a reduction in the amount of time they are able to spend with their own families.</td>
</tr>
<tr>
<td>Stress on Family Routines</td>
<td>The families of students that will be affected by changes in school start times are resistant because of the effects it will have on their daily routines and schedules.</td>
</tr>
<tr>
<td>Community Opinions</td>
<td>Oftentimes, the community is not familiar with the research-based benefits associated with later school start times so they are resistant to proposed changes.</td>
</tr>
<tr>
<td>Student Resistance</td>
<td>Students may also be accustomed to a specific schedule and might also be resistant to proposed changes.</td>
</tr>
</tbody>
</table>

Source: The National School Foundation

100 Figure text adapted from: “Eight Major Obstacles to Delaying School Start Times.” National Sleep Foundation. https://sleepfoundation.org/sleep-news/eight-major-obstacles-delaying-school-start-times
These challenges are reported in other studies as well. In 2014, for example, the Children’s National Medical Center (CNMC) conducted a national survey of school districts that had recently implemented changes to their bell schedules. Respondents were asked to rank their district’s challenges on a scale of 1 to 5, where items ranked as “1” mark primary concerns within the district.101 The most prominent concerns across districts included:102

- Traffic flow at school;
- Changes in parents’ work schedules;
- After-school extracurricular program attendance;
- Changes in teachers’ work schedules; and
- Before-school athletics practices and schedules.

**TRANSPORTATION CONSIDERATIONS**

**Delaying school start and dismissal times may increase community traffic congestion and lengthen commutes for students, parents, and teachers to and from school and work.** For example, Greenwich Public Schools (CT) opted to delay middle school start times by 15 minutes to 8:00 a.m. and high school start times by an hour to 8:30 a.m. for the 2017-2018 school year, which caused “noticeably increased congestion around town.”103 School start times in Greenwich now exacerbate morning rush hour traffic, increasing commute times and even prompting frustrated parents to make illegal driving maneuvers or let their high schoolers out in the middle of the street in an attempt to bypass the designated drop-off zone and avoid the school traffic congestion. While community members assert that traffic congestion has worsened following the delay in school start times, unforeseen problems with new school buses bottoming out as they exit the high school campus, as well as local construction affecting bus routing, have also contributed to the increased traffic.104

**Districts in which teachers face long commutes to work should also consider how a change in school start times might affect teachers’ commuting time.** For example, starting in the 2018-19 school year, Palo Alto Unified School District (CA) plans to delay start times at one of its two high schools from the current start time of 8:15 a.m. to 8:30 a.m. (on odd-numbered days) and 10:05 a.m. (on even-numbered days). On even-numbered days, the new schedule

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102 Bulleted points taken verbatim from: Ibid., p. 13.


104 Ibid.
offers a flexible morning period, allowing students to come in as early as 8:30 a.m. to use the library, testing center, peer tutoring center, student center, or gym and wellness center, or to arrive at school in time for their first class at 10:05 a.m. During the flexible morning period, teachers will collaborate in staff and team meetings. While this delay in start times is only 15 minutes for teachers, a district committee acknowledged that this will likely impact teachers who commute from outside of Palo Alto by lengthening their evening commute.\footnote{Kadvany, E. “Paly to Move to Later Start Times.” Palo Alto Online, May 4, 2018. https://www.paloaltoonline.com/news/2018/05/04/paly-to-move-to-later-start-times}

Similarly, teachers in Montgomery County Public Schools (MD) expressed general opposition to different options for delaying high school start times, partially due to the potential effects of delayed dismissal times on evening commutes. Over 60 percent of teacher respondents in a union survey reported that they did not support changing the start times to 35 minutes later. In open responses, teachers cited conflicts with their personal schedules and potential to be caught in commuter traffic as reasons to oppose the shift.\footnote{Zauzmer, J. and D. Hedgpeth. “Teachers Overwhelmingly Oppose Later High School Start Times in Montgomery.” Washington Post, February 6, 2015. https://www.washingtonpost.com/local/education/teachers-overwhelmingly-oppose-later-high-school-start-times-in-montgomery/2015/02/06/c53daf22-ae19-11e4-abe8-e1ef60ca26de_story.html}

## Addressing Transportation Challenges

Districts can develop their own measures to combat traffic congestion issues around schools by developing alternative traffic patterns and by encouraging parents and students to reduce the number of cars entering school grounds. For example, in efforts to mitigate school traffic congestion in preparation for the delay in school start times, high school administrators at Greenwich Public Schools convened a group “to find improvements to the traffic pattern at the high school and at other district schools where complaints have been coming in about congestion.” \footnote{Hanover Research. “Changing School Start Times.” October, 2017. p. 18.}


> “Transportation certainly was the biggest challenge and it was the biggest concern that people had early on too. It looked good on paper, until you actually run it in real time.” – Anonymous District Administrator

> “With the help of the city and the transportation council we made some changes to the traffic patterns in front of the building. We were able to change the flow so it wasn’t quite as congested.” – Anonymous District Administrator
safer driving to reduce illegal U-turns and mid-street drop-offs.\textsuperscript{109}

**Schools may also take an initial first step in reducing traffic by first educating parents and students about any alternative transportation methods at their disposal**, including carpooling options, as well as walking, biking, and/or public transportation.\textsuperscript{110} In walkable districts, school administrators can establish incentive programs to encourage students to walk and bike to school, rather than rely on vehicle transportation.\textsuperscript{111}

Schools may also consider implementing the following logistical programs or measures, suggested by the Center for Problem-Oriented Policing, a non-profit organization endorsed by the U.S. Department of Justice Office of Community Oriented Policing Services that works towards community-minded problem-solving:\textsuperscript{112}

**Alternate drop-off locations.** Schools can establish multiple drop-off locations to disperse drop-off traffic, rather than requiring all students to be dropped off in one location. Students can convene at different drop-off locations close to school where school staff or volunteers meet them to escort them safely to school.

**Alternate drop-off times.** Schools can also assign parents designated pick-up and drop-off times or days to stagger parents’ arrivals to school. Assigning specific times or days for each family for pick-up and drop-off may further encourage carpooling and a reduction in the overall number of vehicles congesting school traffic.

**Designated zones.** Designated curbside drop-off zones and enforced no-parking zones may help to alleviate both congestion in a single drop-off area as well as discourage unsafe street-side drop-offs. Safe and visible crosswalks or crossing guards should accompany any approved drop-off zones to further encourage safe drop-off and driving practices in the school zone.

**Urban districts may be able to mitigate logistical and financial challenges caused by start time changes by coordinating with public transit authorities.**\textsuperscript{113} Denver Public Schools (CO), for example, reduced transportation costs by $750,000 through a plan that provided high school students who lived more than 3.5 miles from their school or who attended magnet schools with free city bus passes.\textsuperscript{114} Suburban or rural districts, however, may have less


\textsuperscript{111} “Responses to the Problem of Traffic Congestion Around Schools.” Center for Problem-Oriented Policing. http://www.popcenter.org/problems/school_traffic/3

\textsuperscript{112} Text adapted from: Ibid.


opportunity to incorporate public transportation into a start times plan. At the same time, experts suggest that transportation obstacles associated with changing school start times may present greater challenges for suburban districts than urban districts, as students in suburban districts must travel farther distances to attend their neighborhood schools. A 2012 study of labor market access to transit conducted by the Brookings Institution finds that transit coverage in the suburban regions of metropolitan areas is often less dense than coverage in central cities. This finding suggests that a lower percentage of students in suburban school districts can rely on existing transit networks for the commute to school.

GUIDING DISCUSSION QUESTIONS

✓ How would a change in school start times affect students’ commute to school?
✓ How would a change in school start times affect students’ access to and/or use of public transportation?
✓ How would a change in school start times affect teachers and staff who commute to the district from outside of the community?
✓ How would a change in school start times affect community traffic patterns? During what hours are routes to the district’s schools busiest?
✓ How could the district increase school drop-off and pick-up efficiency to reduce traffic congestion?
✓ Is encouraging carpooling and incentivizing walking and biking a feasible option for students and their families?

ATHLETICS, EXTRACURRICULAR ACTIVITIES, AND STUDENT EMPLOYMENT

Revising school schedules may affect a variety of extracurricular and after-school activities, including athletics, tutoring programs, employment opportunities, and the general availability of school facilities. Because later school start times often result in later release times, a later start to the school day has the potential to reduce the time available after school for extracurricular activities or events due to available daylight hours and resulting competition for athletic facilities, such as gyms and fields. Demand for athletic facilities may negatively impact junior varsity athletics (since varsity athletics often take precedence regarding scheduling) and programs that require specialized facilities, such as swimming and golf, in particular. Later releases for middle and high school students may also require students to leave class early to attend events or competitions,

resulting in decreased classroom time for students who participate in extracurricular activities.\textsuperscript{118}

If districts fail to coordinate schedule changes with community organizations that support extracurricular activities, students may lose opportunities to participate in these activities.\textsuperscript{119} For example, an analysis of delayed start time options in Seattle Public Schools (WA) found that several options would reduce the time available for community use of district athletic fields by around one hour per day.\textsuperscript{120} In addition, delayed start times would create logistical problems for athletic activities that rely on the City of Seattle Parks and Recreation Department for facilities, as outdoor playing fields require practices to end by 5:00 p.m. and games to end by 6:00 p.m. The City of Seattle Parks and Recreation Department maintains a very limited number of swimming pools, which could also impact the scheduling of swimming events.\textsuperscript{121} Taken from this example, district leaders should be thoughtful about access to facilities when school hours shift later into the afternoon.

Regarding the effect of school start times on participation in after-school activities, the National Sleep Foundation reports that school districts that change their school start times experience few changes related to student participation in school-based extracurricular activities.\textsuperscript{122} Similarly, during in-depth interviews that Hanover conducted with districts that instituted later high school start times, participants reported that, while students, parents, and coaches had to adjust to a later start time for athletic events, the change in school start times did not affect the number of students participating in after-school activities and sports.\textsuperscript{123}

Non-school-based extracurricular participation and student work schedules may also be negatively influenced by school start time delays, as delayed dismissal times may reduce the hours available for students to participate in non-school activities or work or after school. Indeed, employment and after-school activities are particular concerns for stakeholders. A survey conducted by Montgomery County Public Schools (MD) found that one-third of


students believed that later start times would make it more difficult for them to work after school and participate in extracurricular clubs.\textsuperscript{125}

However, research suggests that with increased amounts of sleep, students can finish their homework faster and as a result, may have additional time after school to participate in community-based extracurricular activities. Regarding the potential impact on student work schedules outside of school, the National Sleep Foundation offers the following:\textsuperscript{126}

...studies have shown that employers indicate a change in start times has not affected their business or the number of hours their student employees can work. They indicate that extra help is not usually needed until school gets out anyway, so they can easily adjust to the new schedule. Other researchers have found that students who are employed for more than 15 hours per week are negatively impacted academically, so working fewer hours may be better for students who don’t rely on the income for substantive needs.

**ADDRESSING EXTRACURRICULAR AND ATHLETICS CHALLENGES**

To ensure that athletic teams have time to practice and compete, districts commonly add lights to fields and courts to account for the reduced after-school daylight hours caused by a delay in school start times. Districts may install permanent lights, as well as rely on portable light fixtures that can be moved between venues.\textsuperscript{127} For example, when Greenwich Public Schools delayed their high school start times by an hour starting in the 2017-18 school year, their football team was left with little daylight for after-school practices. Consequently, the district has begun to seek solutions to increase the legally permitted frequency and duration of its athletic light usage, despite zoning restrictions and pushback from a neighboring residential area. In addition to pursuing possibilities to use their stadium lights more often, the district is also considering using a nearby, lighted university field to ensure athletic participants have a safe, well-lit space for games and for practice.\textsuperscript{128}

Many school districts have also developed creative scheduling solutions that provide additional time for extracurricular involvement.\textsuperscript{129} For example, after implementing later middle school and high school start times, Bedford County Public Schools (VA) created early online classes and offered early dismissal for athletes.\textsuperscript{130} School districts may be able to mitigate the impact of delayed dismissal times on interscholastic athletic events and student-

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athletes’ instructional time by coordinating schedule revisions with other districts in the same athletic conference.\textsuperscript{131} Districts interviewed by Hanover acknowledge that early dismissals for games, competitions, and tournaments are an accepted disadvantage to the time shift, and they try to schedule games that are a further distance later in the day, and earlier in the year before it gets dark, to decrease early dismissals.\textsuperscript{132}

\textbf{In addition, school districts may wish to coordinate schedule changes with community organizations that provide access to extracurricular activities.}\textsuperscript{133} Outside activities such as dance lessons or jobs are harder for administrators to work around as they have no control over when these programs start. However, a few districts mentioned working with individual students to customize their school schedule to be flexible with external opportunities.\textsuperscript{134} For example, Seattle Public Schools (WA) recommended that individual counselors arrange schedules for students who needed to work or who participated in extracurricular activities that would conflict with the standard school schedule.\textsuperscript{135} Similar to athletics, though, some research suggests that changes to school start times may not have substantial negative impacts on non-athletic after-school activities. For instance, Howard County Public School System’s (MD) preliminary impact report suggested that employers did not report that delayed dismissal times negatively affected their business or the number of hours students worked.\textsuperscript{136}

Additional strategies implemented by other districts nationwide to mitigate the effects of delays in school start times on athletics participation and student-athletes’ class time include:\textsuperscript{137}

- Taping athletes on the bus ride to the competition to save time;
- Holding some practices before school;
- Scheduling athletes in a PE class at the end of the day and releasing them early to go to competitions/games;
- Releasing students early on game days; and
- Replacing after-school remediation with during-school (e.g., lunch) or before-school help, so athletes could proceed directly to practice instead of having a gap between dismissal and practice.

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  \begin{verbatim}
  \end{verbatim}
  \begin{verbatim}
  http://www.boarddocs.com/mabe/hcpsmd/Board.nsf/files/9G7JT24EA630/$file/02%202013%20High%20School%20Late%20Start%20LBR.pdf
  \end{verbatim}
  \item Bulleted points take verbatim with minor adjustments from: Payne, P. “Report from SLEEPinFairfax: Successful Practices and Approaches to Changing School Start Times.” Start School Later.
  \begin{verbatim}
  http://www.startschoollater.net/successful-approaches-thanks-to-sleepinfairfax.html
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\end{itemize}
In coordination with a delay in school start times, districts may also reduce instructional and non-instructional time during the day to mitigate the effects of the delay on school dismissal times. For example, Northwest Suburban High School District 214 (IL) is delaying school start times by approximately 30 to 45 minutes, depending on the school, starting in the 2018-19 school year. To prevent schools from ending 30 to 45 minutes later, the district is eliminating weekly late starts and shortening class and lunch periods by between two and five minutes each. As a result, the delay in school dismissal times is closer to 25 minutes.138

GUIDING DISCUSSION QUESTIONS

✓ How will changing school start times impact athletics and other after-school extracurricular activities across the district?
✓ How will changing school start times affect the availability of athletic facilities across the district?
✓ Do other institutions and organizations in the community have athletic facilities the district may access to alleviate scheduling issues?
✓ Will student-athletes have to leave school early and miss instructional time to attend competitions? Can the district adjust schedules and/or coordinate with other districts to reduce the impact of delayed start times on student-athletes’ instructional time?
✓ What additional costs will the district incur from moving athletics and extracurricular activities later in the evening (e.g., costs related to additional lighting for fields)?
✓ What are the barriers to increasing lighting for fields (e.g., financial barriers, legal barriers, community push-back)?
✓ How will changing school start times impact students who work after school?
✓ Are their opportunities for shortening instructional or non-instructional periods during the day to mitigate the effect of a delay in school start times on school end times?

FAMILY SCHEDULES AND COMMUNITY SUPPORT

Students’ families typically have pre-existing schedules and obligations that may be adversely impacted by adjustments to school schedules. Community stakeholders in districts considering school start time changes often express apprehensions related to work schedules, childcare, student drop off/pick up, necessary household chores, extracurricular activities, family time, and meal preparation.139 For example, teachers and administrators in Long Beach Unified School District (CA) expressed concern that a proposed start time change would result in students being dropped off at school before supervision was available, while parents noted that delayed dismissal times would reduce after-school family time.140 Indeed, Hanover’s interviews revealed that

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the most prevalent complaint districts received about delayed start times came from parents who were accustomed to dropping their student off at school at a specific time before work.141

**Given these findings, districts should consider how the success of a change in school start times hinges on the extent of community support.** Given the impact a change in school start times can have on district stakeholders, district leaders may be reluctant to pursue a delay in school start times without strong community support. For example, Pinellas County Schools (FL) had to forgo a plan to delay high school start times from 7:05 a.m. to 9:00 a.m. after a community poll revealed that most parents opposed the district’s plan.142 Accordingly, districts emphasize the importance of soliciting community input and establishing transparency when considering changes to school start times.143

**ADDRESSING CHALLENGES RELATED TO FAMILY SCHEDULES AND COMMUNITY SUPPORT**

To accommodate families that need to drop off their child at school before the start of the first period, districts may establish supervised areas for students who arrive early. For example, several districts interviewed by Hanover that delayed high school start times established early drop-off sites at which parents can drop off high school students before the official start of the school day. District leaders acknowledge that this is not an ideal situation as it reduces the time intended for students to sleep longer but note that the arrangement is based on community feedback and parent needs.144

Similarly, on days when classes start at 10:05 a.m., Palo Alto High School plans to offer students the flexibility to arrive starting at 8:30 a.m. or earlier, to accommodate students who “[prefer] a consistent morning schedule or [need] to be dropped off by parents at the same time every day, as well as [students] who [prefer] to arrive part way through the flex start to avoid traffic but still have some time on campus before the first class.”145 To address similar concerns, after encountering community resistance to delayed school start times, West Hartford Public Schools (CT) adopted a flexible start time, which gave high school students the option of coming to school at 8:15 a.m. (the start of second period) or 7:30 a.m. (the beginning of first period). The district converted first period into a study hall period and dismissal time for all students was 2:15 p.m.146

**Districts should involve students, teachers, families, and community members in any decision to change school start times.** The National Sleep Foundation notes that community members can more easily adjust to school start time changes if they are informed and given adequate time to prepare. Districts may gather feedback through a variety of means including hotlines, message boards, or community meetings, as well as surveys and focus groups.147

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Indeed, several district interviewed by Hanover created task forces comprising diverse stakeholders, administered community surveys, conducted focus groups, and broadly collected input from students, teachers, parents, and other community members to assess their initial level of support, establish transparency in the decision-making process, and increase community buy-in around potential changes to school start times.\textsuperscript{148}

It is critical that districts clearly communicate the purpose of any stakeholder surveys, which is typically to gather feedback on what to consider when evaluating a change to school start times, rather than allow community members to vote democratically whether to implement a change. For example, one district interviewed by Hanover experienced challenges when the majority of students responded that they did not support a change in school start times and the school board still voted in favor of making a change. As a district leader commented, “in the students’ minds, it was a vote and it got voted down. But we had to work with them [to make them realize that] this was not a vote, this was feedback.”\textsuperscript{149}

**GUIDING DISCUSSION QUESTIONS**

- Does the district anticipate that parents would want to drop off their children at the same time that they do currently, regardless of a delay in school start times?
- Would the district be willing to offer supervision for students who arrive before school starts?
- Is the district willing to start a task force, host open community forums, and/or administer surveys to collect feedback on proposed changes to school start times?
- How will the district communicate around deliberations and decisions whether to change school start times?
- What community engagement strategies can the district use to address pushback against school start time changes?

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