

SCHOOL START TIMES AND STUDENT OUTCOMES

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In the following report, Hanover Research reviews literature examining the relationship between school start times and a variety of academic and non-academic student outcomes.

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EXECUTIVE SUMMARY AND KEY FINDINGS

INTRODUCTION

In recent years, districts across the United States have considered delaying school start times to better align with adolescent sleep cycles. In the following report, Hanover Research reviews the literature regarding the various effects of school start times on elementary, middle, and high school students. After discussing trends in school start times nationwide, **Section I** summarizes findings regarding the impact of school start times on a variety of academic outcomes. In addition to examining effects on other school-related outcomes, such as attendance, tardiness, attentiveness, and participation in extracurricular activities, **Section II** also explores relationships between school start times and health-related outcomes, including sleep and car accident rates.

KEY FINDINGS

STATE AND NATIONAL TRENDS

- **The American Academy of Pediatrics recommends a start time of 8:30 a.m. or later for adolescent students.** However, the Centers for Disease Control and Prevention estimated a national average start time of 7:59 a.m. for high schools and an average start time of 8:04 a.m. for middle schools during the 2011-2012 school year. On average, middle, high, and combined schools in Connecticut started at 7:46 a.m., with nearly three-fourths of schools that serve adolescents starting before 8:00 a.m.

SCHOOL-RELATED OUTCOMES

ACADEMIC ACHIEVEMENT

- **Evidence that school start times impact adolescent academic achievement remains inconclusive.** The research base includes studies examining a variety of academic outcomes, including standardized test scores, course grades, and grade point averages. However, whereas some studies find positive effects associated with later school start times, other studies reveal mixed effects. Meanwhile, other studies observe no effects. Such variation in results may reflect the studies' methodological limitations, including the inability to observe and control for the range of other factors that also influence academic outcomes.

ATTENDANCE AND TARDINESS

- **Although delayed school start times may decrease tardiness, the effect on attendance rates appears uncertain.** Despite finding no positive impact on attendance, a 2007 study of middle school students by Wolfson et al. concluded that later school start times decreased tardiness. Specifically, tardiness proved four times more likely in early-starting schools than in late-starting schools. A 2014 study by

Wahlstrom et al. of high school students detected mixed signals in attendance rates post-start time delays; however, the same study revealed an overall reduction in tardiness.

NON-SCHOOL-RELATED OUTCOMES

SLEEP

- **Delayed school start times enable middle school and high school students to receive more sleep.** A 2013 study by Boergers, Gable, and Owens found that high school students generally did not adjust bedtimes after a school start time change, resulting in increased sleep almost equivalent to the start time delay (i.e., 25 minutes). Similarly, a 2010 study by Owens et al. concluded that a 30-minute school start time delay increased total sleep time by an average of 45 minutes – due to the combined impact of the change in school schedule and the shift in student bedtimes.

CAR ACCIDENTS

- **Studies associate later high school start times with lower car accident rates for teens.** A 2008 study by Danner and Phillips found that motor vehicle accident rates for 17-18 year olds decreased 16.5 percent following a delay in a Kentucky county's high school start times. Vorona et al.'s 2011 study observed lower car accident rates for 16-18 year olds in Chesapeake, Virginia, than in Virginia Beach, where high schools started roughly 75-80 minutes earlier.

SECTION I: SCHOOL START TIMES AND ACADEMIC OUTCOMES

After discussing trends in school start times nationwide, this section summarizes findings regarding the impact of school start times on a variety of academic outcomes.

BACKGROUND

Optimal school start times have been debated at the national and local levels for more than a decade. In August 2014, the American Academy of Pediatrics (AAP) released a policy statement that heightened the national attention paid to the issue. In the policy statement, AAP identified insufficient sleep in adolescents as a public health issue, recognizing early school start times as “a key modifiable contributor” to chronic sleep loss. The AAP recommended that districts delay school start times for adolescents to 8:30 a.m. or later in order to improve students’ health, safety, and academic outcomes.¹ More recently, Wheaton, Ferro, and Croft’s 2015 supplementary report, published by the Centers for Disease Control and Prevention (CDC), supported the AAP recommendation for later school start times, agreeing that widespread lack of sleep among adolescent students constitutes a “substantial public health concern.”²

The emphasis placed on the relationship between school start times and student sleep patterns stems from research regarding the unique sleep needs of adolescents. Experts postulate that aging impacts the amount of sleep required and the way people regulate sleep. In an article published in the *Journal of Adolescent Health*, Dahl and Lewin specify that the transition from childhood into adolescence systematically alters sleep in the following four ways:³

- There is a decrease in the duration of non-REM and REM sleep.
- A more adult-like pattern of REM sleep develops.
- There are increases in daytime sleepiness.
- There is a shift in the circadian pattern toward a more owl-like tendency for later bedtimes and wake-up times.

Perhaps the most important change to consider in the context of school start times is the shift in the circadian pattern. The circadian rhythm regulates the timing associated with waking and sleeping during a daily cycle. During puberty, biological circadian changes occur,

¹ “School Start Times for Adolescents.” American Academy of Pediatrics, 2014. p. 647.

<http://pediatrics.aappublications.org/content/pediatrics/early/2014/08/19/peds.2014-1697.full.pdf>

² Wheaton, A.G., G. A. Ferro, and J. B. Croft. “School Start Times for Middle School and High School Students- United States, 2011-12 School Year.” Centers for Disease Control and Prevention, August 2015.

http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6430a1.htm?s_cid=mm6430a1_w

³ Bullet points taken verbatim from: Dahl, R. and D. Lewin. “Pathways to Adolescent Health: Sleep Regulation and Behavior.” *Journal of Adolescent Health*, 2002. p. 177.

<http://www.sciencedirect.com/science/article/pii/S1054139X02005062#>

causing teens to develop a preference for staying awake and sleeping in later.⁴ The National Sleep Foundation describes widespread sleep deprivation among adolescents as “largely driven by a conflict between teens’ internal biological clocks and the schedules and demands of society.”⁵

SCHOOL START TIMES

Wheaton, Ferro, and Croft’s 2015 supplementary report for the CDC examined U.S. Department of Education data from the Schools and Staffing Survey (SASS). The report noted an estimated national average start time for middle, high, and combined schools of 8:03 a.m. during the 2011-2012 school year. Moreover, in 42 states, between 75 and 100 percent of public schools serving adolescents started before 8:30 a.m. In fact, only 17.7 percent of middle, high, and combined schools complied with the AAP’s recommended start time of 8:30 a.m. or later. In particular, high schools started at 7:59 a.m. on average, with more than 40 percent of high schools reporting start times before 8:00 a.m.⁶ Figure 1.1 illustrates the distribution of school start times, overall and by school level.

Figure 1.1: School Start Times by School Level (2011-2012)

SCHOOL LEVEL	AVERAGE START TIME	PERCENTAGE DISTRIBUTION OF MIDDLE, HIGH, AND COMBINED SCHOOL START TIMES			
		Before 7:30 a.m.	7:30 a.m. – 7:59 a.m.	8:00 a.m. – 8:29 a.m.	8:30 a.m. or later
Total	8:03 a.m.	6.7%	31.9%	43.7%	17.7%
Middle	8:04 a.m.	4.8%	35.9%	40.4%	18.9%
High	7:59 a.m.	9.5%	33.0%	43.1%	14.4%
Combined	8:08 a.m.	3.5%	21.6%	51.5%	23.4%

Source: Wheaton, Ferro, and Croft⁷

Notably, school start times varied across states. The data revealed that Alaska and North Dakota had the highest percentages of schools reporting start times of 8:30 a.m. or later (76.8 percent and 78.5 percent, respectively), and both states also had the latest average school start times (8:33 a.m. and 8:31 a.m., respectively). Conversely, Louisiana maintained the earliest average school start time (7:40 a.m.), with 83 percent of middle, high, and combined schools beginning before 8:00 a.m. Figure 1.2 presents relevant school start time information for Connecticut, as well as for Alaska, Louisiana, and North Dakota.⁸

⁴ Ibid.

⁵ “Backgrounder: Later School Start Times.” The National Sleep Foundation. <https://sleepfoundation.org/sleep-news/backgrounder-later-school-start-times>

⁶ Wheaton, A.G., G. A. Ferro, and J. B. Croft. “School Start Times for Middle School and High School Students- United States, 2011-12 School Year.” Op. cit.

⁷ Tabled adapted from: Ibid., pp. 3-4.

⁸ Ibid.

Figure 1.2: School Start Times by State (2011-2012)

STATE	AVERAGE START TIME	PERCENTAGE DISTRIBUTION OF MIDDLE, HIGH, AND COMBINED SCHOOL START TIMES			
		Before 7:30 a.m.	7:30 a.m. – 7:59 a.m.	8:00 a.m. – 8:29 a.m.	8:30 a.m. or later
Alaska	8:33 a.m.	0.0%	11.6%	11.6%	76.8%
Connecticut	7:46 a.m.	13.8%	57.4%	24.0%	4.8%
Louisiana	7:40 a.m.	29.9%	53.1%	12.1%	*
North Dakota	8:31 a.m.	0.0%	2.8%	18.7%	78.5%

Source: Wheaton, Ferro, and Croft⁹

*Denotes a reporting standard that was not met (standard error ≥ 0.5 or a response rate $< 50\%$)

A 2014 study by Wahlstrom et al. published by the Center for Applied Research and Educational Improvement at the University of Minnesota suggests that adolescent students also favor delayed start times. Approximately 75 percent of high school students surveyed in Minnesota, Colorado, and Wyoming cite an ideal school start time of 8:30 a.m. or later, and roughly half support start times of 9:00 a.m. or later. Figure 1.3 presents high school students’ perceptions of ideal start times.¹⁰

Figure 1.3: High School Students’ Perceptions of Ideal Start Times

IDEAL START TIME	PERCENTAGE OF RESPONDENTS
7:00 a.m.	3.2%
7:30 a.m.	5.1%
8:00 a.m.	16.3%
8:30 a.m.	24.8%
9:00 a.m.	35.8%
Later than 9:00 a.m.	14.8%

Source: Wahlstrom et al.¹¹

EFFECTS OF LATER SCHOOL START TIMES ON ACADEMIC ACHIEVEMENT

Research on the relationship between school start times and academic achievement remains inconclusive, with different studies indicating positive, mixed, or no statistically-significant effects associated with school start time delays. However, the methodologies typically used in such studies complicate attempts to demonstrate causality. Most studies are correlational in nature and, thus, unable to provide empirical proof that changes in school start times lead to differences in academic achievement.¹² Likewise, the available

⁹ Tabled adapted from: Ibid., pp. 3-4.

¹⁰ Wahlstrom, K.L. et al. “Examining the Impact of Later High School Start Times on the Health and Academic Performance of High School Students: A Multi-Site Study.” Center for Applied Research and Educational Improvement, February 2014. p. 25.
<http://conservancy.umn.edu/bitstream/handle/11299/162769/Impact%20of%20Later%20Start%20Time%20Final%20Report.pdf?sequence=1&isAllowed=y>

¹¹ Table adapted from: Ibid., p. 25.

¹² Carrell, et al. “A’s from Zzzz’s? The Causal Effect of School Start Time on the Academic Achievement of Adolescents.” University of California at Davis, October 5, 2010. p. 63.
<http://www.econ.ucdavis.edu/faculty/scarrell/sleep.pdf>

research on school start times often tends to focus on one school or district, confounding efforts to generalize the results.¹³

POSITIVE EFFECTS

SECONDARY SCHOOL STUDENTS

Several studies find that later school start times positively impact academic achievement among adolescents. A 2012 study by Edwards revealed that later school start times improved the performances of middle school students on standardized tests in reading and mathematics. Specifically, Edwards associated starting school one hour later with increases in standardized test scores equal to 1.8 percentile points in mathematics and 1.0 percentile point in reading. He also determined that later school start times especially benefitted low-performing students, as the effects proved twice as large for students who scored among the bottom third as opposed to the top third of test-takers. The positive effects also persisted into high school. Edwards analyzed Grade 10 comprehensive exam data, associating a one-hour delay in middle school start times with 2.0- and 1.6-percentile point increases in high school mathematics and reading scores, respectively.¹⁴

A 2005 study by Arlington Public Schools (APS) in Virginia found that earlier and later school start times led to negative and positive effects for adolescents, respectively. The APS study evaluated a high school start time change from 7:30 a.m. to 8:15 a.m. To accommodate districtwide transportation needs, APS also shifted the middle school start time, from 8:10 a.m. to 7:50 a.m. Whereas the grade point averages of high school students improved, APS observed some academic declines at the middle school level. Thus, APS concluded that “a more effective approach might have been to shift elementary start times.”¹⁵

Studies that examine academic achievement at different times during the school day also inform school start time considerations. For example, Cortes, Bricker, and Rohlfs conducted a 2012 study of high school students in Chicago Public Schools. The results associated first-period courses with lower course grades and test scores.¹⁶ Certain student subgroups appeared disproportionately affected, as the study found that the impact “became greater as the amount of exposure increased over the course of the academic year for black

¹³ Keller, P., et al. “Earlier School Start Times as a Risk Factor for Poor School Performance: An Examination of Public Elementary Schools in the Commonwealth of Kentucky.” *Journal of Educational Psychology*, June 16, 2014. p. 237. <http://www.apa.org/pubs/journals/releases/edu-a0037195.pdf>

¹⁴ Edwards, F. “Early to rise? The effect of daily start times on academic performance.” *Economics of Education Review*, 31, 2012. p. 970. <http://teensneedsleep.files.wordpress.com/2011/04/edwards-early-to-rise-the-effect-of-daily-start-times-on-academic-performance-published-version.pdf>

¹⁵ “Impact of 2001 Adjustments to High School and Middle School Start Times.” Arlington Public Schools, June 2005. p. 19. <http://www.fcps.edu/fts/taskforce07/documents/arlington605.pdf>¹⁶ Cortes, K., J. Bricker, and C. Rohlfs. “The Role of Specific Subjects in Education Production Functions: Evidence from Morning Classes in Chicago Public High Schools.” *The B.E. Journal of Economic Analysis & Policy*, 12:1, 2012. <http://users.nber.org/~cortesk/bejeap2012.pdf>

¹⁶ Cortes, K., J. Bricker, and C. Rohlfs. “The Role of Specific Subjects in Education Production Functions: Evidence from Morning Classes in Chicago Public High Schools.” *The B.E. Journal of Economic Analysis & Policy*, 12:1, 2012. <http://users.nber.org/~cortesk/bejeap2012.pdf>

students.”¹⁷ Further, attending early morning mathematics courses impacted performance in other subjects and had long-term adverse effects. For example, Cortes Bricker, and Rohlfs found that having first-period mathematics courses negatively affected students’ reading test scores. Likewise, the study associated having first-period Algebra I courses with lower course grades in Algebra II.¹⁸ Thus, Cortes Bricker, and Rohlfs recommend that “math classes for at-risk students should be scheduled after first period” and “math teachers’ preparation time should be scheduled during first period.”¹⁹

Meanwhile, a 2010 study by Carrell et al. observed the impact of first-period scheduling on the course grades of first-year students at the United States Air Force Academy (USAFA). The study found “a positive causal relationship between start time and academic performance for the students at USAFA,” with earlier course times negatively affecting students’ course grades.²⁰ Students performed worse in first-period courses, as well as all other courses. However, as start times moved later, from 7:00 a.m. to 7:50 a.m., the negative effects diminished.²¹ Although the study examined college students, Carrell et al. defend the applicability of the results to high school students. The authors note that, as adolescents, first-semester college students have the same sleep patterns as high school-aged teens. Moreover, according to the authors, 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.²²

ELEMENTARY SCHOOL STUDENTS

Most research on school start times focuses on adolescents. However, some evidence that school start times affect the academic achievement of elementary school students exists. Keller et al. evaluated the impact of school start times on elementary school students’ scores on the Kentucky Performance Rating for Educational Progress (K-PREP).²³ The study associated earlier school start times with lower test scores, albeit only in middle- and upper-class elementary schools.²⁴ The authors, who found the results surprising, attributed the students’ lower test scores to the “physical, behavioral, and psychological ramifications of sleep deprivation.”²⁵

¹⁷ Ibid., p. 22.

¹⁸ Ibid., p. 30.

¹⁹ Ibid., p. 32.

²⁰ Carrell, et al. Op. cit., p. 74.

²¹ Ibid., p. 73.

²² Ibid., p. 63.

²³ Keller et al. Op. cit.

²⁴ Ibid., p. 6.

²⁵ Ibid.

MIXED OR NO EFFECTS

SECONDARY SCHOOL STUDENTS

Although several studies associate later school start times with positive academic outcomes, various studies also reveal mixed or no statistically-significant effects. For example, the 2014 study by 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 Wyoming.^{26, 27} The authors found that, for most of the sampled high schools, academic achievement increased following the school start time delay. However, for three sampled high schools, the authors observed evidence of increases and decreases in academic achievement. The authors concluded that, although “there are empirically-based positive outcomes for adolescents whenever the start time of their high school is moved to a later time,” such outcomes appear neither universal nor guaranteed.²⁸

A 2011 study by Hinrichs initially examined the relationship between high school start times and academic achievement in two Minnesota districts, St. Paul Public Schools and Minneapolis Public Schools. High schools in St. Paul Public Schools and Minneapolis Public Schools started at 7:30 a.m. and 8:40 a.m., respectively. Hinrichs found no statistically-significant differences in the two districts’ ACT scores.²⁹ In the same study, Hinrichs also analyzed state test scores for high school students in Kansas and Virginia.³⁰ The results supported his findings from Minnesota. For example, in the case of Kansas, he found that school start times had no effect on state test scores in reading, mathematics, social studies, and science, even after controlling for gender and eligibility for free or reduced-price lunches.³¹

In an attempt to explain why school start times may not impact adolescent students’ achievement on standardized tests, Hinrichs offers the following reasons:³²

- While early start times may cause students to lose sleep and learn less per unit of time, they may learn more outside of school by being awake longer.
- Students may be able to adapt to early start times by re-optimizing sleep patterns, such as catching up on sleep over the weekend.

²⁶ Wahlstrom, et al., “Examining the Impact of Later School Start Times on the Health and Academic Performance of High School Students: A Multi-Site Study.” Op. cit., pp. 8-10.

²⁷ 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.

²⁸ Ibid., p. 52.²⁹ Hinrichs, P. “When the Bell Tolls: The Effects of School Starting Times on Academic Achievement.” *Education Finance and Policy*, 6:4, Fall 2011.

<https://www.aeaweb.org/aea/2011conference/program/retrieve.php?pdfid=60>

²⁹ Hinrichs, P. “When the Bell Tolls: The Effects of School Starting Times on Academic Achievement.” *Education Finance and Policy*, 6:4, Fall 2011. <https://www.aeaweb.org/aea/2011conference/program/retrieve.php?pdfid=60>

³⁰ The use of these data avoided the selection bias that is present in using ACT scores.

³¹ Ibid.

³² Bullet points adapted from: Ibid., pp. 15-16.

- Students may adapt to early schedules with environmental and chemical stimulation, such as caffeine.
- Though students' biological clocks may lead them to perform better later in the day, teachers may perform better earlier in the day, having a counteracting effect.
- Later start times could result in less time spent with parents in the morning, without affecting the amount of time spent with parents in the afternoon or evening.
- Before-school activities might nullify the effects of later start times.
- With later start times, students may miss instructional time in the afternoon due to early dismissal for athletic and extracurricular activities.

Hinrichs' findings substantiated earlier research conducted by Wahlstrom in 2002. In the study, Wahlstrom evaluated data from Minneapolis Public Schools after the district changed the start time of seven high schools from 7:15 a.m. to 8:40 a.m. Analyzing letter grades in courses completed three years prior to and three years after the change, Wahlstrom identified an upward trend, but no statistically-significant differences, as a result of the later school start time.³³ However, Wahlstrom highlighted the limitations of using course grades to measure academic achievement, as "grading is often a subjective action by teachers."³⁴ Wahlstrom opted not to use SAT or ACT scores as an alternative measure, noting that the students who take such exams tend to be more academically gifted than their peers and "have study habits that supersede any tiredness they experience."³⁵

ELEMENTARY SCHOOL STUDENTS

In contrast to Keller et al., the 2012 study by Edwards found that school start times had no effect on elementary school students' academic achievement. Specifically, he examined the impact of school start times on test scores in mathematics and reading, observing no relationship.³⁶ However, since the sampled elementary schools started at 8:15 a.m. or 9:15 a.m., Edwards remains unclear as to 1) whether school start times do not affect elementary school students or 2) whether the school start times in the analysis were not early enough to have an impact.³⁷

³³ Wahlstrom, K. "Changing Times: Findings From the First Longitudinal Study of Later High School Start Times." *National Association of Secondary School Principals Bulletin*, 86:633, December 2002.
<http://teensneedsleep.files.wordpress.com/2011/04/wahlstrom-changing-times-findings-from-the-first-longitudinal-study-of-later-high-school-start-times.pdf>

³⁴ Ibid., p. 11.

³⁵ Ibid.

³⁶ Edwards, F. Op. cit., p. 980.

³⁷ Ibid., p. 981.

SECTION II: SCHOOL START TIMES AND OTHER STUDENT OUTCOMES

This section examines the impact of school start times on other school-related outcomes, such as attendance, tardiness, attentiveness, behavior, and participation in athletics and extracurricular activities. This section also explores relationships between school start times and health-related outcomes, including sleep and car accident rates.

SCHOOL-RELATED OUTCOMES

ATTENDANCE AND TARDINESS

Several studies focused on how delayed school start times affect attendance and tardiness, providing mixed results. Wahlstrom's 2002 study examined attendance data for the two years prior to and the three years after Minneapolis Public Schools delayed high school start times. After the change, average attendance rates did not change significantly for students in Grades 9-11 who remained continuously enrolled in the same high school for two or more years. However, average attendance rates for *discontinuously*-enrolled students in Grades 9-11 did increase. Average attendance rates for students in Grade 12 did not change significantly, regardless of continuity of enrollment. Wahlstrom considers students who remained in school until Grade 12 as committed to graduating, irrespective of school start times.³⁸

Wahlstrom et al.'s 2014 study of high school students in Minnesota, Colorado, and Wyoming analyzed the impact of delayed school start times on tardiness, in addition to attendance. The study revealed some statistically-significant increases in attendance rates when comparing different students in the same grade level before and after the school start time change. However, when observing the same students across grade levels, attendance rates actually decreased following the change. In contrast, a majority of high schools experienced at least some decline in overall tardiness. Moreover, the high schools that delayed start times by the largest margins also tended to record the largest declines in tardiness.³⁹

In a 2007 study, Wolfson et al. assessed the effects of school start times on attendance and tardiness, albeit at the middle school level. The results proved consistent with the findings of Wahlstrom et al.'s 2014 study. Specifically, despite observing no impact on attendance, Wolfson et al. found tardiness almost four times more likely in early- than in late-starting middle schools.⁴⁰

³⁸ Wahlstrom, K. "Changing Times: Findings From the First Longitudinal Study of Later High School Start Times." Op. cit., p. 8.

³⁹ Wahlstrom et al., "Examining the Impact of Later High School Start Times on the Health and Academic Performance of High School Students: A Multi-Site Study," Op. cit.

⁴⁰ Wolfson, A., Spaulding, C. Dandrow, and E. Baroni. "Middle School Start Times: The Importance of a Good Night's Sleep for Young Adolescents." Behavioral Sleep Medicine, 2007. <http://www.ncbi.nlm.nih.gov/pubmed/17680731>

Lastly, the 2005 APS study found that attendance rates tend to decrease as students age, regardless of school start times. For all middle school and high school cohorts examined, the attendance rate fell as the grade level increased, despite later high school start times and earlier middle school start times. Thus, APS concluded that maturity appears to affect attendance rates more than school start times.⁴¹

ATTENTIVENESS, MOOD, AND BEHAVIOR

A number of studies indicate that delayed school start times improve attentiveness, mood, and behavior, primarily due to the increased amount of sleep that students receive. The APS study measured the attentiveness of middle school and high school students before and after the districtwide start time changes. To measure attentiveness, APS administered a survey to students and teachers that asked about students’ readiness to start school, as well as preparedness for, alertness during, and participation in first period. The responses from high school students did not change substantially after the start time delay; however, a higher percentage of high school students reported high levels of first-period participation. In contrast, as seen in Figure 2.1, lower percentages of middle school students reported first-period preparedness, alertness, and participation.⁴²

Figure 2.1: Student Survey Responses

QUESTION	ALL OF THE TIME		SOME OF THE TIME		NONE OF THE TIME		NO RESPONSE	
	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER
High School Students								
Ready to start school	20%	18%	52%	63%	22%	18%	7%	1%
Alert during first period	22%	20%	52%	64%	18%	16%	8%	1%
Prepared for first period	41%	47%	46%	49%	6%	4%	7%	1%
Participated in class discussions during first period	31%	42%	52%	47%	10%	9%	7%	1%
Middle School Students								
Ready to start school	35%	20%	51%	55%	7%	19%	7%	7%
Alert during first period	31%	14%	50%	63%	12%	17%	7%	6%
Prepared for first period	62%	53%	30%	40%	2%	2%	7%	5%
Participated in class discussions during first period	44%	35%	46%	55%	4%	5%	6%	6%

Source: Arlington Public Schools⁴³

Note: After the start time change, high schools started later while middle schools started earlier than previous years.

⁴¹ “Impact of 2001 Adjustments to High School and Middle School Start Times.” Op. cit., p. 12-13.

⁴² Ibid., pp. 12-18.

⁴³ Table adapted from: Ibid.

Figure 2.2: Teacher Survey Responses

QUESTION	STRONGLY AGREE		AGREE		DISAGREE		STRONGLY DISAGREE		NO OPINION		NO RESPONSE	
	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER
High School Teachers												
Alert during first period	1%	12%	25%	41%	38%	17%	9%	11%	22%	24%	6%	5%
Prepared for first period	3%	10%	34%	41%	28%	20%	6%	8%	23%	16%	6%	6%
Participated in class discussions during first period	3%	13%	43%	47%	17%	14%	5%	4%	24%	15%	7%	7%
Middle School Teachers												
Alert during first period	10%	11%	50%	35%	11%	17%	3%	18%	25%	16%	1%	3%
Prepared for first period	8%	5%	55%	46%	10%	31%	1%	8%	26%	18%	1%	1%
Participated in class discussions during first period	10%	10%	58%	50%	7%	16%	0%	7%	24%	17%	2%	1%

Source: Arlington Public Schools⁴⁴

Note: After the start time change, high schools started later while middle schools started earlier than previous years.

Meanwhile, after the start time delay, higher percentages of high school teachers “strongly agreed” and “agreed” with statements describing their students as alert during, prepared for, or participating in first period (Figure 2.2). Middle school teachers’ responses proved less favorable, in line with middle school students’ responses. Middle school teachers referred to middle students as neither as alert nor as prepared for first period after the school start time change. Middle school teachers also noticed a decline in first-period participation.⁴⁵

Wahlstrom’s 2002 study also surveyed teachers to assess changes in high school students following a delay in school start times. Teachers reported higher levels of student alertness after the change. A majority of principals, when interviewed, also observed improvements in students’ mood and behavior. In fact, five of the eight principals dealt with fewer disciplinary referrals following the change. Additional interviews with high school counselors and parents revealed similar impressions, with parents referring to their children as “easier to live with.”⁴⁶

Finally, a 2013 study by Boergers, Gable, and Owens examined changes in high school students’ moods before and after a 25-minute delay in start times from 8:00 a.m. to 8:25 a.m. The study associated inadequate sleep with depression, sleepiness, and caffeine

⁴⁴ Table adapted from: Ibid.

⁴⁵ Ibid.

⁴⁶ Wahlstrom, K. “Changing Times: Findings From the First Longitudinal Study of Later High School Start Times.” Op. cit.

consumption. After school start time change, each of the three areas improved, as more students reported longer durations of sleep.⁴⁷

HOMWORK, ATHLETICS, AND EXTRACURRICULAR ACTIVITIES

School start time debates often raise concerns that delays will reduce students' time to complete homework and opportunities to participate in athletics and extracurricular activities. In his 2012 study, Edwards examined self-reported student data on the amount of time spent each day doing homework and watching television. He found that students who started school one hour later watched 12 fewer minutes of television each day and spent nine more minutes doing homework each week. Edwards hypothesized that students who start school earlier also finish earlier, thus perhaps spending more time watching television and not doing homework before parents return home from work.⁴⁸

In contrast, the 2013 study by Boergers, Gable, and Owens concluded that later school start times did not affect the amount of time high school students spent on homework. The authors further noted "no significant difference in hours spent on...school sports, organized community sports, music activities, volunteer work, or hanging out with friends."⁴⁹ In Wahlstrom's 2002 study, teachers in districts with later school start times similarly reported that rates of participation in afterschool activities did not change, despite shorter practices, extended-day programs, and afternoon rehearsals.⁵⁰ Meanwhile, the 2005 APS study found that student participation in afterschool activities typically remained the same or increased following the school start time changes. Specifically, 65 percent of high school students "indicated that either there was no difference in their participation or that they were participating more."⁵¹ In comparison, 24 percent of middle school students reported no difference in participation, and 42 percent reported greater participation. In fact, the study suggested that the earlier middle school start time actually encouraged additional programs and/or afterschool activities.⁵²

OTHER OUTCOMES

SLEEP

Research indicates that delayed school start times result in more sleep for students, especially adolescents.⁵³ Some studies imply that sleep increases because students went to bed at the same time and woke later. Other studies find that students went to bed later as

⁴⁷ Boergers, J., C. Gable, and J. Owens. "Later School Start Time is Associated with Improved Sleep and Daytime Functioning in Adolescents." *Journal of Developmental & Behavioral Pediatrics*. 2013. <http://www.gwern.net/docs/melatonin/2014-boergers.pdf>

⁴⁸ Edwards, F. Op. cit. p. 982.

⁴⁹ Boergers, J., C. Gable, and J. Owens. Op. cit. p. 15.

⁵⁰ "Wahlstrom, K. "Changing Times: Findings From the First Longitudinal Study of Later High School Start Times." Op. cit.

⁵¹ "Impact of 2001 Adjustments to High School and Middle School Start Times." Op. cit.

⁵² Ibid.

⁵³ Wolfson, A., Spaulding, C. Dandrow, and E. Baroni. Op. cit.

well; however, the later bedtimes did not offset the added sleep gained by students waking later.

For example, the 2013 study by Boergers, Gable, and Owens revealed that high school students' bedtimes remained largely unchanged following the 25-minute start time delay, whereas high school students woke up roughly 24 minutes later. Therefore, high school students generally received more sleep. Specifically, the share of high school students receiving eight or more hours of sleep each night increased from 18 percent to 44 percent. Signs of daytime sleepiness, such as tardiness and falling asleep in class, also decreased significantly.⁵⁴

A 2010 study by Owens et al. yielded similar findings. The authors assessed the impact of a 30-minute delay in a Rhode Island high school's start time from 8:00 a.m. to 8:30 a.m. Survey data indicated that, after the change, students woke later and went to bed earlier. Consequently, the average amount of reported sleep on school nights increased by 45 minutes, and the percentage of students receiving at least eight hours of sleep per night rose from 16.4 percent to 54.7 percent. Students also reported more satisfactory sleep, as evidenced by the reduction in daytime fatigue.⁵⁵

Wahlstrom et al.'s 2014 study of high schools in Minnesota, Colorado, and Wyoming also found that the proportion of students receiving eight or more hours of sleep increased with delayed school start times. Specifically, only 34-44 percent of students attending a high school that started early (i.e., at roughly 7:30 a.m.) received eight or more hours of sleep, compared to 57-66 percent of students attending a high school that started after 8:30 a.m. Interestingly, the authors also observed that high school students who had a phone or computer in their bedrooms were less likely to get eight or more hours of sleep.⁵⁶

Research on younger adolescents produces comparable results. The 2007 study by Wolfson et al. examined the sleep patterns of students in two New England middle schools with start times of 7:15 a.m. and 8:37 a.m. Students in the late-starting middle school woke more than an hour later than students in the early-starting middle school, meaning that, on average, the former students received an additional 50 minutes of sleep each night.⁵⁷ However, contrary to the findings of Boergers, Gable, and Owens, students at the late-starting middle school also reported later bedtimes than students at the early-starting middle school.⁵⁸

Lastly, in a 2008 study, Danner and Phillips assessed 9,966 students in Grades 6-12 within a large Kentucky county. The study included an initial questionnaire that asked students specific questions about sleep habits on school and non-school nights. The authors

⁵⁴ Boergers, J., C. Gable, and J. Owens. Op. cit.

⁵⁵ Owens, J.A. et al. "Impact of Delaying School Start Time on Adolescent Sleep, Mood, and Behavior." *The Journal of the American Medical Association*. 2010. <http://archpedi.jamanetwork.com/article.aspx?articleid=383436>

⁵⁶ Wahlstrom et al., "Examining the Impact of Later High School Start Times on the Health and Academic Performance of High School Students: A Multi-Site Study," Op. cit.

⁵⁷ Wolfson, A., Spaulding, C. Dandrow, and E. Baroni. Op. cit.

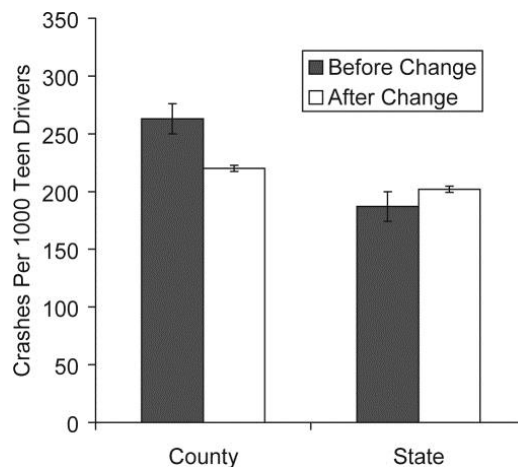
⁵⁸ Ibid.

administered the same survey a year later after high school and middle school start times changed from 7:30 to 8:30 a.m. and from 8:00 to 9:00 a.m., respectively. Comparing sets of responses, Danner and Phillips determined that the average hours of nightly sleep among adolescents increased, while the amount of “catch-up” sleep occurring on the weekends decreased.⁵⁹

CAR ACCIDENT RATES

Most studies associate delayed school start times with a decrease in car accident rates. For example, the 2008 Danner and Phillips study examined motor vehicle accident rates for 17-18 year olds before and after the high school start time change. The authors computed accident rates for the county and the rest of Kentucky – for the two years before and the two years after the high school start time change. The countywide accident rate decreased following the change. Specifically, the county’s accident rate declined 16.5 percent, compared to a statewide increase of 7.8 percent.⁶⁰ Figure 2.3 illustrates the countywide and statewide accident rates before and after the high school start time change.

Figure 2.3: State and County Motor Vehicle Accident Rates for Teen Drivers



Source: Danner and Phillips⁶¹

In Virginia, Vorona et al. compared teen accident rates in Virginia Beach and Chesapeake – two similar, neighboring communities with different high school start times. High schools in Virginia Beach started roughly 75-80 minutes earlier than high schools in Chesapeake. When reviewing car accident data for 16-18 year old drivers in 2007 and 2008, the authors found higher teen car accident rates in Virginia Beach. While Virginia Beach recorded higher car

⁵⁹ Danner, F. and B. Phillips. “Adolescent Sleep, School Start Times, and Teen Motor Vehicle Crashes.” *Journal of Clinical Sleep Medicine*, December 2008. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2603528/>

⁶⁰ Danner, F. and B. Phillips. *Op. cit.*

⁶¹ Graph taken verbatim from: *Ibid.*

accident rates for drivers in all other age groups as well, the difference proved far more pronounced (i.e., by 4.5 times) in the case of teens.⁶²

Finally, Wahlstrom et al.'s 2014 study included car accident data for 16-18 year old drivers in three Minnesota communities and one Wyoming community. In three of the four communities, car accident rates dropped when high schools instituted later start times. The car accident rate actually decreased 70 percent in one community. The authors attributed the 9 percent increase in the fourth community's car accident rate to incidents involving "teens who attend local high schools in other nearby districts with earlier start times."⁶³

⁶² Vorona, R.D. et al. "Dissimilar Teen Crash Rates in Two Neighboring Southeastern Virginia Cities with Different High School Start Times." *Journal of Clinical Sleep Medicine*, 2011. p. 145.
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3077341/>

⁶³ Wahlstrom, K. "Examining the Impact of Later High School Start Times on the Health and Academic Performance of High School Students: A Multi-Site Study." *Op. cit.*, p. 48.

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