

The Effect of School Start Time on Academic Achievement

In this report, we summarize recent studies of the relationship between school start time and academic achievement, the effect of sleep deprivation on learning, the benefits of later high school start times, and the relationship between sleep deprivation and depression.

Introduction

Sleep research suggests that although adolescents have different circadian rhythms than children, they nonetheless need the same amount of sleep as children, if not more. With circadian rhythms that run behind those of children and adults, meaning that teenagers' energy "peaks" later in the day and they therefore have difficulty getting to sleep earlier at night, the school schedule seems at odds with natural sleep cycles of teenagers. In the early 1990s, the sleep habits of over 3,000 Rhode Island students were studied in their last year at a middle school (9th grade) which started at 8:25 and in their first year of high school (10th grade) which started nearly an hour earlier at 7:20 am. This study demonstrated that both ninth and tenth graders went to sleep at similar times, but the tenth graders had significantly less sleep on school nights due to earlier rise times.¹ The tenth graders showed significantly greater daytime sleepiness, especially at 8:30 am. In fact, sleep onset was at *pathological levels* similar to that seen in sleep disorders such as narcolepsy!² Researchers concluded that adolescents who transition to an hour earlier school start time experience a corresponding biological consequence: clinically significant sleepiness.

A study recently published in *Pediatrics* confirmed that adolescents experience sleep deprivation during the academic school year.³ Sixty incoming high school seniors kept sleep/wake diaries beginning in August through 2 weeks after the start of school as well as 1 month in November and 1 month in February. Paper-and-pencil tests assessed mood and vigor and computer-administered tests measured neuropsychologic performance 3 times a day during 2 consecutive days at the beginning and end of November and at the beginning and end of February. Adolescents lost as much as *120 minutes of sleep per night* during the week after the start of school. All students performed better on these tests in the afternoon, and those students in early classes "reported being wearier, being less alert, and having to expend greater effort." The study concludes that the results "demonstrated that current high school start times contribute to sleep deprivation among adolescents. Consistent with a delay in circadian sleep phase, students performed better later in the day than in the early morning."⁴

Although these studies indicate that high school students are pathologically sleepy during the school year, a 2005 national survey of secondary schools reported that only "17% of high schools had even considered opting for later school start times in

¹ E. O'Malley and B. O'Malley, "School Start Time and Its Impact on Learning and Behavior," in *Sleep and psychiatric disorders in children and adolescents* (New York: Informa Healthcare, 2008), 87.

² E. O'Malley and B. O'Malley, "School Start Time and Its Impact on Learning and Behavior," in *Sleep and psychiatric disorders in children and adolescents* (New York: Informa Healthcare, 2008), 87.

³ M. Hansen, "The Impact of School Daily Schedule on Adolescent Sleep," *PEDIATRICS* 115, no. 6 (6, 2005): 1555-1561. <http://pediatrics.aappublications.org/cgi/reprint/115/6/1555>

⁴ *Ibid.*, 1555.

the preceding 3 years.”⁵ In this report, we summarize the research conducted on the relationships between sleep, academic performance, depression and school start time so that our members can make an informed decision regarding school start time.

After discussing the relationship between school start time and academic performance at the elementary, middle and high school level, we then tackle the question of how sleep deprivation affects learning. Following that, we suggest some benefits of a later high school start time (and, conversely, some disadvantages). We end with a discussion of the relationship between sleep deprivation and depression in adolescents.

We have on the whole concentrated on U.S. focused-studies and the most recent experimental studies. The largest study of the relationship between start time and academic achievement was carried out in Minnesota in the late 1990s. We will focus extensively on this example.

Review Conclusions

Below, we summarize the conclusions of recent reviews of the literature on the relationship between sleep and academic performance.

- ❖ **Wolfson and Carskadon, *Sleep Medicine Reviews* (2003):** “Findings strongly indicate that self-reported shortened total sleep time, erratic sleep/wake schedules, late bed and rise times, and poor sleep quality are negatively associated with academic performance for adolescents from middle school through the college years.”⁶
- ❖ **Curcio, Ferrara and DeGennaro, *Sleep Medicine Reviews* (2006):** “As a first observation, regardless of the theoretical framework adopted (dual process hypothesis or sequential processing hypothesis), both REM and NREM sleep seem necessary for learning and memory: thus, for an efficient consolidation of both (declarative) knowledge and (procedural) skills, the worst risk is sleep loss or fragmentation. Moreover, it was shown that an increasing daytime sleepiness, as a consequence of poor sleep quality, can seriously impair students’ cognitive functioning and behavioral performance. Finally, studies with experimental manipulations of the amount and quality of children’s sleep confirmed that poor or fragmented sleep is associated with

⁵ A. Wolfson and M. Carskadon, *A Survey of Factors Influencing High School StartTimes* (NASSP, 2005).

<http://www.duxbury.k12.ma.us/sleep/sleepneedsSurveyInfluencing.pdf>

⁶ A. R Wolfson and M. A Carskadon, “Understanding adolescent’s sleep patterns and school performance: a critical appraisal,” *Sleep Medicine Reviews* 7, no. 6 (2003): 503.

http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6WX7-4D16H1K-4&_user=709071&_coverDate=12%2F31%2F2003&_rdoc=1&_fmt=high&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1335441329&_rerunOrigin=scholar.google&_acct=C000039638&_version=1&_urlVersion=0&_userid=709071&md5=942d0599237d36ec01b8642ee197169c

- behavioral and cognitive difficulties, with reduced academic achievement and learning.”⁷
- ❖ **Yan and Slagle, Blue Valley School District (2006):** “The review...suggests that 1) American adolescents are not having adequate sleep time; 2) insufficient sleep time could impair adolescents’ learning and development; 3) insufficient sleep can be ameliorated but not fully addressed by delaying school start time; but 4) it is not clear whether student academic achievement will improve along with a later school schedule; lastly, 5) insufficient sleep might not be as grave as what the media and some studies have depicted.”⁸
 - ❖ **Stanley, Spradlin, and Plucker, Columbia University (2007):** This literature review found that, “although longer-term studies are needed, short-term results show benefits to later [high school] start times.”⁹

In other words, while the literature reviews suggest caution (as longer-term studies are needed and the relationship between later school time and a causal link between later start times and improved academic achievement has not been proven), preliminary research suggests later high school start times have benefits, and points to a link between increased sleep and improved learning capacity, if not improved academic performance.

Our review of the literature further reinforces and further develops these conclusions. Sleep deprivation is found to limit cognitive flexibility, abstract thinking and “emotional control” as well as memory. We find that in addition to academic benefits, later high school start times have been found to have a positive effect on students’ sleep, attendance, enrollments, behavior, accidents, and “school morale.” Finally, as our research below demonstrates, recent studies have suggested that sleep deprivation may be a risk factor for depression in adolescents.

Methodological Limitations

One of the primary messages from the literature is the need to be circumspect about the findings concerning the relationship between school start times and academic performance. It is consistently noted that major studies of the relationship between sleep, school start time and academic achievement suffer from significant methodological limitations.

⁷ G. Curcio, M. Ferrara, and L. De Gennaro, “Sleep loss, learning capacity and academic performance,” *Sleep medicine reviews* 10, no. 5 (2006): 332-333. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6WX7-4JJGC84-2&_user=709071&_coverDate=10%2F31%2F2006&_rdoc=1&_fmt=high&_orig=search&_sort=d&_docanchor=&view=c&_searchStrId=1335442484&_rerunOrigin=google&_acct=C000039638&_version=1&_urlVersion=0&_u serid=709071&md5=7cbc980001072ba3045cf82e8fc5d9f6

⁸ B. Yan and M. Slagle, *School Start Time and Academic Achievement: A Literature Review* (Blue Valley School District, August 2006), 2. <http://www.cehd.umn.edu/CAREI/Reports/docs/SST-2001ES.pdf>

⁹ K. R. Stanley, T. E. Spradlin, and J. A. Plucker, “The Daily Schedule: A Look at the Relationship Between Time and Academic Achievement,” *Education Policy Brief* 5 (2007): 3. http://ceep.indiana.edu/projects/PDF/PB_V5N6_Summer_2007_EPB.pdf

First, many of the results of relevant studies are based on adolescents' (or teachers) reports of sleepiness/alertness. Subjective data is inherently less reliable than that which is obtained by objective measures.¹⁰

Second, the researchers who conducted the largest study of the relationship between school start time and academic performance – the Minnesota School Start Time Study – admit that comparing grades between schools or districts and within schools across several academic years raises a number of methodological concerns. Comparisons are complicated because classes are titled differently, class period lengths vary, performance may be assessed differently, some students leave the district or move to a different school, and records may be poorly kept.¹¹

¹⁰ Wolfson and Carskadon, "Understanding adolescent's sleep patterns and school performance," 502.

¹¹ Ibid., 499.

Relationship between School Start Time and Academic Achievement

In this section, we summarize studies aimed to determine the relationship between school start time and academic achievement. It should be noted that we operate with a broad definition of academic achievement here, reporting not just the findings on the effect of different start times on grades, but also on the effect of different start times on students' motivation and the effort they put into learning.

Most studies which focus directly on this subject deal with middle school and high school start times. However, the Minnesota Start Time Study offered interesting insights into the effect that earlier and later start times had on elementary school children.

Elementary

In 1997, the Minneapolis public schools changed starting times for most of the schools in the district. Seventy-one elementary schools participated. Start times for the elementary schools were set at 7:40, 8:40 or 9:40 a.m. Schools changed their start time by either one or two hours (earlier or later). Data on how different start times affected the "educational endeavor" were collected through written teacher surveys and focus groups.

Overwhelmingly, those elementary schools that started at 9:40 a.m. rated the experience as negative. A shortened morning (with instruction often not starting until 10 a.m. due to late buses and school breakfast) had a negative effect on teaching and learning: students had too many transitions and too little instruction time in the morning, and were found to be fatigued and disengaged in the afternoon.¹² Often, teachers found that students came to class after having watched T.V. most of the morning, an activity (or perhaps better put, a "passivity") that left them ill-prepared for learning.

Teachers at the elementary schools that moved from a 9:40 a.m. to an 8:40 a.m. start, on the other hand, reported a positive experience, with higher energy and improved learning in the morning and greater energy in the latter part of the day. These schools found that the earlier start allowed the school to engage students when they were at their best for learning.¹³ The earlier start also resulted in increased participation in extracurricular activities, and increased time for work and play after school.

While schools that moved from an 8:40 a.m. to a 7:40 a.m. start also noted children's increased alertness in the morning and energy throughout the day, schools that

¹² P. Kubow, K. Wahlstrom, and A. Bemis, "Starting Time and School Life: Reflections from Educators and Students," *Phi Delta Kappan*, 1999, 370. <http://www.fcps.edu/fts/taskforce07/documents/starttimeschoollife.pdf>

¹³ Ibid.

moved from a 9:40 a.m. start to a 7:40 a.m. start reported negative consequences, including increased tardiness, absences, a more negative climate and lower levels of participation in afterschool activities. While starting an hour earlier was found to be invigorating, starting two hours earlier was found to be overly difficult.

Middle

Seven middle schools in Minneapolis school system moved from a 7:40 a.m. start to a 9:40 a.m. start. Generally, the consensus was that this change was not positive. The 9:40 a.m. start did not provide a sufficient amount of learning in the morning and made for a difficult end-of-the-day as both student and teacher fatigue sapped motivation.¹⁴ Moreover, the later start time created logistical problems for parents who had to leave for work before their children left for school.¹⁵

For purposes of comparison with the Minneapolis district's middle schools, the researchers conducting the School Start Time Study surveyed middle schools in other districts with start times between 7:20 and 8:40 a.m. They found a significant increase in the reported academic grades with progressively later start times. For middle school students, the most rapid increase in performance was seen between 7:30 and 8:00 am, suggesting that the ideal start time for middle school falls at the end of this range.¹⁶

Secondary

In 1997, seven high schools in Minneapolis changed from a 7:15 a.m. start time to an 8:40 a.m. start time. Findings after one year showed that schools with later starting times benefited in these ways:¹⁷

- ❖ Reduced absences;
- ❖ Students reported less difficulty staying awake in class and while taking tests, studying or doing homework, and working on a computer;
- ❖ Fewer students reported that they fell asleep in class, arrived late to school because they had overslept, and felt tired during the day;
- ❖ Students reported that they were getting higher grades;
- ❖ 57% of the teachers reported that a greater number of students were more alert during the first two periods of the day;
- ❖ 51% of the teachers reported that they saw fewer students sleeping at their desks;

¹⁴ Ibid., 369.

¹⁵ Stanley, Spradlin, and Plucker, "The Daily Schedule," 4.

¹⁶ E. O'Malley and B. O'Malley, "School Start Time and Its Impact on Learning and Behavior," 89.

¹⁷ P. Dawson, "More Proof Sleepy Teens Learn Less," *Principal Leadership*, 2005, 47-48.

http://eric.ed.gov/ERICWebPortal/custom/portlets/recordDetails/detailmini.jsp?_nfpb=true&_ERICExtSearch_SearchValue_0=EJ741317&ERICExtSearch_SearchType_0=no&accno=EJ741317

- ❖ In one school district, teachers reported that more students came in early to get extra help.

Researchers also did a cross-sectional comparison of sleep habits and daytime functioning of high school students (n=7168) from three school districts in the Minneapolis/St Paul, Minnesota area: one started classes each day at 8:30 a.m. (District A), one started at 7:25 a.m. (District B) and the last started at 7:15 a.m. (District C). Researchers found that students who get better grades (especially As and Bs) tend to go to bed earlier and get more total sleep on school nights (than especially students who get Ds and Fs). Importantly, amount of sleep was affected by school start time. Students in District A reported similar bedtimes to students in Districts B and C; however, due to the later high school start time, they reported getting up about one hour later and obtaining about an hour more sleep on school nights (these results were significant at the highest level) and having the same weekend sleep habits. District A students reported that they earned higher grades than did District B and C students.¹⁸

A longitudinal study of the effect of the later start time in Minneapolis high schools found a slight improvement in grades from 1995 to 2000, but not a statistically significant one. The researchers note that using letter grades earned as the primary indicator made comparisons and subsequent judgments quite difficult, as discussed above.¹⁹

Conclusion

Some school districts have pushed back school start times for adolescents, and the issue of school starting times is widely debated. Unfortunately, published peer-reviewed studies that investigate the benefits of later school start times are virtually absent in the literature.²⁰ Data collection in studies performed to date is based more on surveillance of parents, teachers, or students and is often self-reported — methods that require some level of validation.²¹ Hence, although preliminary studies about the relationship between later start times and academic achievement are positive, these studies cannot be considered definitive.

¹⁸ *School Start Time Study: Technical Report, Volume II: Analysis of Student Survey Data* (Center for Applied Research and Educational Improvement, 1998). <http://www.cehd.umn.edu/CAREI/Reports/docs/SST-1998VII.pdf>.

¹⁹ *Minneapolis Schools Start Time Study Executive Summary* (Center for Applied Research and Educational Improvement, August 2001). <http://www.cehd.umn.edu/CAREI/Reports/docs/SST-2001ES.pdf>.

²⁰ H. Taras and W. Potts-Datema, "Sleep and Student Performance at School," *Journal of School Health* 75, no. 7 (2005): 249. <http://www3.interscience.wiley.com/journal/118736552/abstract?CRETRY=1&SRETRY=0>

²¹ *Ibid.*

How Lack of Sleep Affects Learning

In this section, we explore the effect that lack of sleep has on the ability of children and adolescents to learn.

Although one might not intuitively link sleep deprivation with hyperactivity, Robert Dahl reports just such a link in his 1999 article, “The Consequences of Insufficient Sleep for Adolescents.” Concerned with the emotional consequences of sleep deprivation, Dahl finds that sleep deprivation can sometimes mimic or exacerbate symptoms of ADHD (attention deficit/hyperactivity disorder), including distractibility, impulsivity, and difficulty with effortful control of attention.²² ADHD is widely thought to make learning more difficult.

Assessing the sleepiness of 12 adolescents (through the Multiple Sleep Latency Test (MSLT) and subjective ratings) and their performance in terms of problem-solving/computational ability, memory, auditory attention, and sustained motor activity during 38 hours of total sleep deprivation, Carskadon and her fellow researchers carried out the first study of the effect of sleep loss on adolescents’ psychomotor and cognitive performances. They found that increase in sleepiness negatively affected memory and computational speed, but not attention and sustained motor activity.²³

In a 1998 study, Randazzo and co-workers directly assessed learning capacity after sleep loss by asking sixteen children ages 10-14 to sleep only 5 hours for a single night and then assessing their attention, vigilance, abstract thinking, memory, learning and creativity together with sleep propensity (as evaluated by the MSLT). Subjects’ performance in verbal creativity (mainly fluency and flexibility) and abstract thinking was impaired by the sleep loss. Scores on the Wisconsin Card Sorting Test (WCST) indicated that sleep loss made learning new abstract concepts increasingly difficult.²⁴

A 2003 experiment involving 77 children (age: M=10.6 years; range= 9.1–12.2 years) attending regular 4th through 6th grade classes demonstrated a significant positive relationship between measures of sleep *quality* and performance. The study participants were assessed using computerized tests on the 2nd day of their normal sleep schedule, and beginning on the 3rd evening the participants were asked to extend or restrict their sleep by an hour on the following 3 nights.²⁵ The study indicated that as sleep quality deteriorated (as measured *objectively* by an activity monitor), children

²² R. Dahl, “The Consequences of Insufficient Sleep for Adolescents,” *Phi Delta Kappan*, 1999, 357.
<http://www.fcps.edu/fts/taskforce07/documents/consequences.pdf>

²³ Curcio, Ferrara, and De Gennaro, “Sleep loss, learning capacity and academic performance,” 328-329.

²⁴ *Ibid.*, 329.

²⁵ A. Sadeh, R. Gruber, and A. Raviv, “The effects of sleep restriction and extension on school-age children: what a difference an hour makes,” *Child Development* 74, no. 2 (2003): 444.
<http://www3.interscience.wiley.com/journal/118865540/abstract>

showed a greater attentional deficit and compromised executive control. These effects were much more evident in younger students, who were found to be more vulnerable to insufficient sleep.²⁶

More recent work has found important relationships between sleep and memory. A 2006 review of the relationship between sleep and learning-memory processes indicates “that both REM and NREM sleep are necessary for learning and memory...and that for an efficient consolidation of both (declarative) knowledge and (procedural) skills, the worst enemy is sleep loss or, also, sleep fragmentation.”²⁷

To summarize, recent research suggests that:

- ❖ Cognitive flexibility, verbal creativity and abstract reasoning abilities may be impaired as a result of sleepiness.
- ❖ Sleep deprivation/fragmentation negatively affects memory and consolidation of knowledge and skills.
- ❖ Deterioration of sleep quality can result in attentional deficit and compromised executive control.

In other words, sleepiness affects attention, verbal creativity, computational speed, memory, and a range of other cognitive and behavioral skills that are related to school performance and learning ability.

Below, we report some grade-level specific findings about the relationship between total sleep time and academic performance.

Middle

- ❖ A 2002 study of middle and high school students in a suburban Maryland school system found no correlation of total sleep time with academic performance.²⁸
- ❖ A survey of 450 students aged 11-15 found significant linear relationships between sleep time and daytime sleepiness and between daytime sleepiness and school achievement (2003). Sleepiness increased significantly with grade level.²⁹

²⁶ Curcio, Ferrara, and De Gennaro, “Sleep loss, learning capacity and academic performance,” 327.

²⁷ Ibid., 326.

²⁸ A. Eliasson et al., “Association of sleep and academic performance,” *Sleep and Breathing* 6, no. 1 (2002): 45. <http://www.springerlink.com/content/dtqgg9bhjwn3w9pg/fulltext.pdf>

²⁹ C. Drake et al., “The pediatric daytime sleepiness scale (PDSS): sleep habits and school outcomes in middle-school children,” *Sleep* 26, no. 4 (June 2003): 455. <http://cat.inist.fr/?aModele=afficheN&cpsidt=14905170>

- ❖ A 2004 study tracked the sleep patterns of over 2,200 students aged 11 to 14 in Chicago. Sleep was found to decrease over time. However, no significant relationship was found between amount of sleep and grades.³⁰

Secondary

- ❖ In a report from 2000, the National Sleep Foundation indicates that high school students who describe themselves as having academic problems and who are earning C's or below in school report getting less sleep, having later bedtimes and having more irregular sleep schedules than students reporting higher grades.³¹ However, the Foundation makes the caveat that a causal relationship has yet to be established.
- ❖ As mentioned above, no correlation between total sleep time and academic performance was found in a 2000 study of suburban middle and high school students in Maryland.³²

Conclusion

While a causal relationship between sleepiness and poor academic performance has yet to be established, experimental interventions have found a strong association between altered child sleep patterns and daytime sleepiness. Sleepiness, in turn, has been linked to attentional deficits, decreased verbal creativity, difficulties with abstract thought and decreased executive control.³³ Lack of REM or EREM sleep has been found to negatively affect the memory, required for consolidating both knowledge and skills. In other words, sleepiness negatively affects the capacities and skills that students need to perform well in an academic setting.

³⁰ K. Fredriksen et al., "Sleepless in Chicago: tracking the effects of adolescent sleep loss during the middle school years," *Child development* 75, no. 1 (2004): 92. <http://www.rhodeslab.org/files/sleepless.pdf>

³¹ *Adolescent Sleep Needs and Patterns: Research Report and Resource Guide* (National Sleep Foundation, 2000), 4. http://www.slrtd.org/slrhs/information/pdf/sleep_and_teens_report.pdf

³² Eliasson et al., "Association of sleep and academic performance," 45.

³³ Sadeh, Raviv, and Gruber, "Sleep patterns and sleep disruptions in school-age children.," 291.

Benefits of Later School Start Times for High School Students

In this section, we outline the benefits reaped by those high schools that have instituted later start times.

More Sleep

The point of later start times would be missed if students did not get more sleep as a result of the later start time. However, it appears that later start times do indeed result in more sleep for adolescents.

In a Kentucky district where middle school start times were changed from 7:30 a.m. to 8:30 a.m. and high school start times were changed from 8:00 a.m. to 9 a.m., the following results were noted:

- 1) The percentage of students who got at least 8 hours of sleep per weeknight increased significantly from 35.7% to 50.0%
- 2) The percentage who got at least 9 hours of sleep increased significantly from 6.3% to 10.8%.³⁴
- 3) Average scores on the Epworth Sleepiness Scale decreased from 8.9 to 8.2, and the proportion of teens that scored 10 or higher dropped from 43.3% to 37%.³⁵

Despite concerns about even later bedtimes due to the later start time, the Minnesota Start Time Study found that “students reported they were going to bed no later than usual as a result of the later start time and that they got about one additional hour of sleep over the course of each night.” Students indicated they were getting “significantly more” sleep.³⁶

Similarly, comparing students in the Minneapolis district with an 8:30 a.m. start with districts with 7:25 a.m. and 7:15 a.m. starts, students in the Minneapolis districts reported similar bedtimes to students in districts that started earlier; due to the later high school start time, they reported getting up about one hour later and obtaining about an hour more sleep on school nights.³⁷

The longitudinal study of the Minnesota school start time change found Minneapolis high school students continued to get an hour’s more sleep each school night (five more hours’ sleep per week) than students whose high schools begin an hour earlier

³⁴ F. Danner and B. Phillips, “Adolescent sleep, school start times, and teen motor vehicle crashes,” *Journal of Clinical Sleep Medicine: JCSM: Official Publication of the American Academy of Sleep Medicine* 4, no. 6 (2008): 534.

<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2603528/>

³⁵ Ibid.

³⁶ Dawson, “More Proof Sleepy Teens Learn Less,” 47.

³⁷ *School Start Time Study: Technical Report, Volume II: Analysis of Student Survey Data.*

through 2000.³⁸ In other words, habits did not shift even several years after the school start change.

Improved Attendance

In the Minneapolis high schools that transitioned to a later start time in 1997, attendance rates for all students in grades 9, 10, and 11 in the district showed statistically significant improvements in the years from 1995-2000. The greatest improvement occurred among 9th grade students. Whereas before the change in start times, 9th grade students had to transition from a 7:40 a.m. start in middle school to a 7:15 a.m. start in high school, after the transition, the high school start was later than the former middle school start. After the later start was initiated, the daily rate of attendance went from 83% to 87%. The probability that this would occur by chance is less than one in a thousand.³⁹

The study indicates that there were no significant differences in average attendance rates for any of the groups in grades 9 to 12 who were continuously enrolled in the same school, as Figure 1 below demonstrates, but there were “notable differences...in the average attendance rates for students in grades 9 to 11 who were *not* continuously enrolled for 2 consecutive years in the same high school.” According to the study authors, the average attendance rate for non-continuously enrolled 9th graders improved by a statistically significant 4% points from 72% before the change in start time to 76% after the change in start time.⁴⁰ Similar improvements occurred for non-continuously enrolled 10th and 11th grade students.

Figure 1: Percentage of Average Attendance Rates for Students in the Same School

	Grade 9		Grade 10		Grade 11		Grade 12	
	Enrolled	Not	Enrolled	Not	Enrolled	Not	Enrolled	Not
Pre-change								
1995-7	93	72	95	76	93	72	93	88
Post-change								
1997-9	94	76	95	78	94	78	91	89
98-2000	94	75	94	78	94	77	89	89

Note: Not = not enrolled for 2 consecutive years in the same school.

Source: Wahlstrom (2001)

Improved Continuous Enrollment

After the change to later start times in the Minneapolis school districts' high schools, researchers found statistically significant increases in continuous enrollment and

³⁸ *Minneapolis Schools Start Time Study Executive Summary*.

³⁹ *Ibid.*

⁴⁰ K. Wahlstrom, “Changing Times: Findings From the First Longitudinal Study of Later High School Start Times,” *NASSP Bulletin* 86 (2002): 8. <http://www.cehd.umn.edu/carei/Reports/docs/SST-2002Bulletin.pdf>

decreases in non-continuous enrollment. Students with poor grades or attendance are most likely to transfer between schools in the district or out of schools in the district in the 9th or 10th grade, when they feel such a change could advantage them.⁴¹ Yet, the percentage of 10th grade students who were continuously enrolled in the Minneapolis district or in the same school increased from 54.4% in 1995-1996 to 65.6% in 1999-2000, a statistically significant change.⁴² In other words, since the later start times were initiated in the district, an increasing number of students are staying in the same school or in the same district for two or more years, while the number of students who move in and out of the district or move from school to school is in steady decline.

Figure 2: Percentage of Enrollment Rates in Same School

	Grade 9		Grade 10		Grade 11	
	Con	Noncon	Con	Noncon	Con	Noncon
1995-1996	49.0	51.0	54.4	45.6	60.8	39.2
1996-1997	52.2	47.8	58.7	41.3	64.0	36.0
1998-1999	58.1	41.9	63.4	36.6	66.8	33.2
1999-2000	57.8	42.2	65.6	34.4	68.5	31.5

Source: Wahlstrom (2001)

Less Tardiness

As would be expected, later school start times were found to result in less tardiness. Principals at the seven high schools in Minneapolis that changed to a later start time noted in the longitudinal analysis of the effect of the changes that fewer students arrived tardy.⁴³ As a result, principal's offices were less busy, both in terms of foot-traffic and record-keeping tasks.

Improved Behavior

In a cross-sectional comparison of high school students at three Minnesota School Districts with different starting times, it was found that students in the district which started the latest (8:30 a.m.) reported fewer sleep/behavior problems than students in the other two districts (which started at 7:25 a.m. and 7:15 a.m. respectively).⁴⁴

Further, parents of students at schools that transitioned to later start times indicated their children were "easier to live with."⁴⁵

⁴¹ Ibid., 7.

⁴² *School Start Time Study: Final Report Summary* (The Center for Applied Research and Educational Improvement, 1998), <http://www.cehd.umn.edu/CAREI/Reports/docs/SST-1998VI.pdf>.

⁴³ Wahlstrom, "Changing Times," 17.

⁴⁴ *School Start Time Study: Technical Report, Volume II: Analysis of Student Survey Data*.

⁴⁵ Wahlstrom, "Changing Times," 17.

Better School Morale

In the longitudinal analysis of start time changes in Minnesota schools, principals, school counselors and nurses surveyed at the Minneapolis schools that initiated later high school start times indicated that the “overall mood” in the schools was much calmer after the transition to a later start time, with students’ temperaments seeming more even. Counselors and nurses indicated that “significantly fewer students were coming to them to report peer relationship problems and/or difficulties with their parents.”⁴⁶

Decreased Incidence of Automobile Accidents

The peak age of sleep-related car crashes is 20 years, and peak time of accidents is between 7:00 and 8:00 am. Students who drive themselves to school early in the morning are at even greater risk of a fall-asleep at the wheel car accident because of the combined effects of their greater cumulative sleep-deprivation, and the challenge of operating a vehicle before their circadian-dependent alertness is fully engaged.⁴⁷

In 1999, the Fayette County Kentucky school district delayed their high school start time by one hour to 8:30 a.m. Following the delay, teen crash rates in that district dropped by 15.6% while crash rates through the rest of the state increased by 8.9% during the same time period.⁴⁸

Urban/Rural Disparities

In our discussion benefits and disadvantages of later start times, one particular finding of the Minnesota School Start Time Study is important to note. According to the researchers who conducted the study, there was a difference in opinion about the later start times among students in urban high school districts and students in suburban high school districts, with suburban students favoring the change and urban students being more critical of it.

Major concerns of the urban high school students (especially 9th grade students) involved the later start’s impact on after-school activities and their own schedules. Students reported that they were more tired, had less time to study and do homework, and had shorter practices or practices at odd hours (i.e. in the morning before school).⁴⁹ Moreover, later school times resulted in more scheduling conflicts, making it impossible for some students to participate in two activities in which they were interested.

⁴⁶ Ibid.

⁴⁷ E. O’Malley and B. O’Malley, “School Start Time and Its Impact on Learning and Behavior,” 88.

⁴⁸ Ibid., 89.

⁴⁹ Kubow, Wahlstrom, and Bemis, “Starting Time and School Life: Reflections from Educators and Students,” 367.

The majority of suburban students who participated in focus groups indicated their approval of the changes, noting that they were not as tired at the end of the day when doing homework and that the later dismissal had not impeded their ability to participate in after-school activities. Nearly all the students indicated that they were feeling “more rested and alert for the first hour of class and that they were generally going to bed at the same time.”⁵⁰

⁵⁰ Ibid.

Relationship between Sleep Deprivation and Depression

As discussed in the second section, sleep loss has a detrimental effect on adolescents' ability to regulate their emotions. The 2000 Adolescent Sleep Needs and Patterns report produced by the National Sleep Foundation suggests that too little sleep is associated with the following:⁵¹

- ❖ **Negative moods.**
- ❖ **A decreased ability to control, inhibit or change emotional responses.** Dahl, mentioned above, found that “the primary emotional changes following sleep loss suggest a decrease in the ability to control, inhibit, or modify emotional responses to bring them into line with long-term goals, social rules or other learned principles.”⁵²
- ❖ **Increased likelihood of stimulant use,** including caffeine and nicotine, alcohol and similar substances.

In the relationship between lack of sleep and depression, causality is difficult to determine. For instance, the National Sleep Foundation cites one study in which “female high school students who went to sleep on the weekend two or more hours later than their typical weeknight bedtime reported feeling more depressed than those who did not stay up late on the weekends.”⁵³ But did these female students go to bed later because they were depressed or did they feel depressed because they went to bed later? A similar question can be asked concerning a study of sleep patterns on trajectories of depressive symptoms and self-esteem that was conducted from 1995 to 1997 on 2,259 students in Chicago, aged 11 to 14. Researchers found that “students who obtained less sleep over time reported heightened levels of depressive symptoms and decreased self-esteem.”⁵⁴ But again, was the increase in depression responsible for decreases in sleep or vice versa?

While it is commonly thought that loss of sleep is a symptom of depression, a very recent study suggests that sleep deprivation may be a *risk factor* for depression. Taking a nationally representative sample of 15,659 children and teens in grades 7 through 12 who participated in the National Longitudinal Study of Adolescent Health,⁵⁵ Gangwisch and his colleagues explored the relationship between parent-set bedtimes, sleep duration, and depression. After controlling for several factors, these researchers found that later average bedtimes set by the parents were associated with shorter sleep duration, and that adolescents who had a set bedtime of midnight or later were at increased risks of depression and suicidal ideation compared with those with a

⁵¹ *Adolescent Sleep Needs and Patterns: Research Report and Resource Guide*, 4.

⁵² Dahl, “The Consequences of Insufficient Sleep for Adolescents,” 357.

⁵³ *Adolescent Sleep Needs and Patterns: Research Report and Resource Guide*, 4.

⁵⁴ Fredriksen et al., “Sleepless in Chicago,” 84.

⁵⁵ Which involved in-home interviews with adolescents and their parents.

bedtime of 10 p.m. or earlier.⁵⁶ Yet these associations were no longer significant when adjustments for sleep duration and the perception of getting enough sleep were made. In other words, “those who said they thought they were getting enough sleep at night were less likely to suffer from and to have suicidal thoughts.”⁵⁷

Researchers involved with this study suggest that lack of sleep can lead to depression in three different ways:⁵⁸

- ❖ First, too little sleep could result in inappropriate modulation of the emotional brain responses to aversive stimuli.
- ❖ Second, moodiness resulting from not getting enough sleep could interfere with teens’ ability to cope with daily stresses and impair interpersonal relationships, eventually leading to depression.
- ❖ Finally, lack of sleep could cause suicidal ideation by impairing judgment, concentration, and impulse control.

Importantly, Gangwisch and his colleagues noted that school start times likely contribute to adolescents getting less than the nine hours of sleep that researchers have estimated they need by limiting how long the participants could sleep in the morning.⁵⁹

⁵⁶ J. Gangwisch et al., “Earlier Parental Set Bedtimes as a Protective Factor against Depression and Suicidal Ideation,” *Sleep* 33, no. 1 (2010): 97-106.

⁵⁷ T. Neale, “Lack of Sleep Linked to Depression in Adolescents,” *MedPage Today*, January 1, 2010, http://www.medpagetoday.com/Psychiatry/SleepDisorders/17766?utm_content=GroupC&utm_medium=email&impressionId=1262582527528&utm_campaign=DailyHeadlines&utm_source=mSpoke&userid=194823.

⁵⁸ Ibid.

⁵⁹ Taken verbatim from Ibid.

Conclusion

Our review of the literature suggests that self-reported shortened sleep time, erratic sleep/wake schedules, late bed and rise times, and poor sleep quality are negatively associated with adolescents' academic performance. Although the ideal start time for younger and older adolescents has not been determined, a 2008 review conducted by O'Malley and O'Malley suggest that "available data so far point to 8:30 a.m. being the earliest time for effective learning in older adolescents."⁶⁰

Below, we include the results of a survey of Minneapolis high school teachers' opinion as to the ideal high school start time. The bulk of responses are concentrated in the 8:00 a.m. to 8:30 a.m. range.

Figure 3: High School Teacher Opinions of Optimal Start Time of First Class for Majority of Students

Time	N	Percentage
6:30	2	0.35%
7:00	6	1.04%
7:15	12	2.08%
7:30	98	16.96%
7:45	35	6.06%
8:00	183	31.66%
8:15	53	9.17%
8:30	132	22.84%
8:45	9	1.56%
9:00	26	4.50%
9:15	0	0.00%
9:30	4	0.69%
9:45	1	0.17%
10:00	7	1.21%
Other	1	0.17%
No Opinion	9	1.56%
Total	578	100

Source: Wahlstrom (2001)

It is important, however, to place emphasis on the fact that our review can only be said to *suggest* a positive relationship between later school start times and academic performance. Future research designs must go beyond subjective feelings of sleepiness to measure academic performance. Studies with experimental designs – including control groups and randomization – are necessary to validate this relationship.⁶¹

Related research reflects positively the potential of later start times. Later start times have been found to increase the quantity of sleep students get during the week. This

⁶⁰ E. O'Malley and B. O'Malley, "School Start Time and Its Impact on Learning and Behavior," 86.

⁶¹ Taras and Potts-Datema, "Sleep and Student Performance at School," 354.

is significant, given that research on the effect of sleep deprivation on learning does demonstrate that sleepiness negatively affects the capacities and skills necessary to perform well in an academic setting. Further, later start times were found to improve attendance and rates of continuous enrollment, decrease tardiness and improve behavior and school morale. Finally, recent research suggests that sleepiness can be a risk factor in depression, implying that increased sleep may lead to a decreased incidence of depression in teenagers.

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