

SCHOOL START TIME AND ACADEMIC ACHIEVEMENT: A LITERATURE REVIEW

Bo Yan

Mike Slagle

Blue Valley School District

Direct correspondence to:

Bo Yan

Blue Valley School District

15020 Metcalf

Overland Park, KS 66223

Phone: (913) 239-4288

Email: byan@bluevalleyk12.org

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www.bluevalleyk12.org

Abstract

Educators and parents have been concerned about insufficient sleep time among adolescents, which could seriously compromise their learning and development. Altering school schedule to a later start time has been proposed to be a viable measure to address the problem and practiced in some schools and districts. Despite its significance and high stake, not much research has been conducted to investigate the impact of altering school start time on student achievement. This study intends to strengthen our understanding of the relationship between school start time and student achievement by synthesizing findings from both medical and educational research. The review of the past research 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.

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INTRODUCTION

With the high expectation and rising demand for accountability from parents, communities, and the government, educators are leaving no stone unturned in their striving for improving students' school performance and academic achievement. In addition to technology integration, data-driven decision making, and teacher professional development, school start time has recently gained attention and aroused discussions among policy makers, researchers, and school administrators.

Critics claim the current school schedule is a major reason for insufficient sleep among adolescents, which is detrimental to their learning and development. Accordingly, altering school schedules to a later time has been proposed and practiced in some school districts. The National Sleep Foundation has published a report calling for policy changes (National Sleep Foundation, 2000). A bill has been passed by Congress ("The Z's to A's Act," 1999) asking the federal government to provide grants to local educational agencies that agree to begin school for secondary students after 9:00 in the morning. Effective in the 1997-98 school year, the Minneapolis School District became the first in the nation to adopt a later school schedule, which changed the start time of its seven high schools from 7:15 am to 8:40 am.

Changing school start time is a significant policy which will affect a broad spectrum of stakeholders. Despite its significance, not much research has been conducted to directly examine the impact of delayed school start time on students' learning (Taras & Potts-Datema, 2005). This report first summarizes findings of research on the impact of

school start time as well as the research that investigates the relationship between sleep and learning. Based upon the summary, the interpretations of findings and assumptions underlying the arguments for delayed school start time are appraised. Last, conclusions are drawn and directions for future research are suggested.

LITERATURE REVIEW

Overview of the Sleep Time Issue

Laboratory data demonstrate that adolescents probably do not have a decreased need for sleep during puberty (M. Carskadon, 1990; Carskadon, Orav, & Dement, 1983). There is also evidence suggesting that the need for sleep might increase with maturation (Mitru, Millrood, & Mateika, 2002). At the same time, children tend to go to sleep later and wake up later if given a choice as they mature into adolescents (Acebo, Davis, Herman, & Carskadon, 1991). In contrast to this sleep pattern, school days in the U.S. tend to begin progressively earlier as students move up to the next school level (Carskadon, 2002; Wolfson & Carskadon, 1998). It has been consistently reported that adolescents sleep less as they grow older (M. Carskadon, 1990; Fredriksen, Rhodes, Reddy, & N., 2004; Gau & W.T., 1995; Taras & Potts-Datema, 2005; Wolfson & Carskadon, 1996, 1998). Fredriksen and colleagues (2004) tracked three years of sleep times of 2,259 students in Illinois who began sixth grade in 1995 and found the average total sleep time on a typical school night decreased from nearly 8 hours for six graders to less than 7 ½ hours as they became eighth graders two years later. A survey of 3,120 students found that the average school night sleep time was 462 minutes for 13-14 years

old and dropped to 424 minutes for 17-19 years old (M. Carskadon, 1990). A similar pattern was also reported in Wolfson and Carskadon's study (1996) in which 3,120 students between 13 and 19 years of age were surveyed and an decrease of up to 40 minutes in sleep time was found.

According to the National Sleep Foundation (2000), 8 1/2 to 9 1/4 hours of sleep each night is considered adequate by many experts. Laboratory data from Carskadon and colleagues (1980) indicate that optimal sleep length for adolescents is 9.2 hours. The National Heart, Lung, and Blood Institute recommends that adolescents need at least 9 hours of sleep each night to do their best (National Heart, Lung, and Blood Institute, *Star Sleeper*). According to this benchmark, it is obvious that adolescents are not having enough sleep as observed in large scale surveys. In addition to the large scale surveys, students are reported in many small scale studies to have less than 8 hours of sleep time during the school week. Overall, school aged children are not having enough sleep time suggested by sleep research. This is especially true for high school students.

Impact of Insufficient Sleep on Learning and Development

There is a plethora of research exploring the impact of insufficient sleep on adolescents' development. A wide variety of developmental indexes concerning the behavioral, cognitive, and psychological dimensions of development have been investigated. As a result, a long list of problems has been found to be associated with insufficient sleep.

A direct result of insufficient sleep is drowsiness and fatigue. According to Maas (1995), twenty percent of students fall asleep in school. Among 2,201 surveyed Canadian high school students, more than 58% reported that they were "really sleepy" between 8 and 10 am (Gibson et al., 2006). In addition, less sleep time has been found to be associated with higher tendency of aggressive behavior (Wolfson et al., 1995) and increased likelihood of stimulant use (M. A. Carskadon, 1990; Giannotti F., Cortesi F., & Ottaviano S., 1997). Sleep deprivation could also lead to depressive mood (Wolfson & Carskadon, 1998), low self-esteem (Fredriksen et al., 2004), and low achievement motivation (Meijer, Habekothe, & Van Den Wittenboer, 2000).

With regard to cognitive functioning, it has been shown that sleep deprivation is associated with memory deficits and time-on task decrements (Dinges & Kribbs, 1991), inattentiveness (Fallone, Acebo, Arnedt, Seifer, & Carskadon, 2001), and slower reaction time (Sadeh, Gruber, & Raviv, 2003). At the same time, however, it is found that total sleep time is not correlated with response inhibition and sustained attention (Fallone et al., 2001). In addition, no connection has been established between insufficient sleep and concentration after controlling for psychosomatic and neurotic factors (Meijer et al., 2000). Randazzo and colleagues (1998) found significant difference between the control (11 hours in bed) and sleep-restriction (5 hours in bed) groups on three of four variables of verbal creativity, including fluency, flexibility, and average indices and Wisconsin Card Sorting Test (WCST), which may be indicative of difficulty learning new abstract

concepts; but not on measures of rote performance and less-complex cognitive functions, including measures of memory and learning and figural creativity.

Similar to the mixed results of the relationship between insufficient sleep and cognitive functioning, the research findings concerning insufficient sleep and academic achievement is inconsistent. Wolfson and Carskadon (1998) found that students who described themselves as struggling or failing school (C's, D's/F's) had about 25 min less sleep and went to bed an average of 40 min later than A and B students. A longitudinal study found that students who obtained less sleep in sixth grade exhibited lower initial grades (Fredriksen et al., 2004). However, this negative association was not found in any grade of high school students in a study conducted by Eliasson and colleague (2002), where one thousand high school students and 200 middle school students were examined.

Does Delaying School Start Time Work?

Although a solid research base concerning the relationship between sleep and learning has not been established, practitioners are not prevented from scouting for ways to ameliorate the sleep problems identified in the cumulative survey data. Despite the fact that sleep-deprivation could be caused by a wide variety of reasons such as sleep disorder, erratic sleep habit, part-time jobs, extracurricular and social activities (Carskadon, 1999; Wolfson, 2002), delaying school start time has been touted as an efficient way to address the problems (Dawson, 2005; Wahlstrom, 2000).

Two approaches have been taken to investigate the impact of a delayed school start time. One approach uses naturalistic design, which compares the outcome variables between school students who have different start times. For instance, school A and B have different start times. The sleep times of students in these two schools are compared to see whether start time makes a difference. It has been fairly consistently found that students with a later school start time sleep longer time than those with an earlier start time (Epstein, Chillag, & Lavie, 1998; Kowalski & Allen, 1995; The Center for Applied Research and Educational Improvement, 2000).

Another approach relies on experimental design, in which the outcome variables are compared between pre and post intervention. In a study where the school start time shifted from 8:25 am to 7:20 am (a backward shift) for a group of 25 high school students, the average amount of sleep on school nights fell significantly from 7 hours and 9 minutes to 6 hours and 50 minutes (Carskadon, 1999). In another study with the participation of 811 5th grade students in Israel, it is found that "early risers" who started school at 7:10 am at least 2 times a week had a shorter sleep time than "regular risers" who always started school at 8:00 am (Epstein et al., 1998). In addition, they complained significantly more about daytime fatigue and sleepiness, and about attention and concentration difficulties in school.

In contrast to the total sleep time gain consistently reported in the literature, a delayed school schedule does not necessarily lead to other improvements. Kubow and colleagues (1999) observed that teachers' responses were evenly divided among agreed

or strongly agreed, neither agreed nor disagreed, and disagreed or strongly disagreed regarding the statement “I see improved student behavior in general” after the start time was delayed. After the Minneapolis School District changed the start time of its seven high schools from 7:15 am to 8:40 am, an evaluation study conducted by the Center for Applied Research and Educational Improvement (Wahlstrom, 2001) found no significant difference between the letter grades earned by students in grades 9-12 prior to the change and the grades earned after the change.

An Appraisal of the Literature

It has been claimed that many American adolescents suffer from insufficient sleep. Regardless of whether the current school schedule is the major reason for insufficient sleep among adolescents, altering school start time has been proposed to be a viable policy measure to address the problem. It is claimed that sleep deprived students could gain sleep time from delayed school start time, which will subsequently lead to better learning and development. A review of the literature shows that some points of these claims are strongly supported by empirical research. But the evidence for other points is mixed and weak.

First, there has been a general consensus that American adolescents are not getting enough sleep. According to survey data from multiple studies, the average sleep time of American students is no more than 8 hours, which is less than what the sleep

research has suggested. The total sleep time tends to decrease as students move from elementary to middle school and from middle school to high school.

There is also evidence that students could benefit from a later school schedule by having more sleep time. Survey data have repeatedly reported that students with a later school start time have more total sleep time on school nights than those with an earlier start time. This result has been consistently observed in between-school studies where concurrent school schedules in different schools were compared and within-school studies where the pre and post schedules were contrasted for same schools. The gained sleep time ranged from 20 minutes to one hour, which was corresponding to 45 minutes to 2 hours difference in school start time. However, a longer delay does not necessarily correspond to a greater gain in sleep time. What is also noteworthy is that students still did not have enough sleep time on average even with a later school start time. None of the average sleep time reported in the studies reached 8 hours except for one conducted in Israel (See Appendix for detail).

Research has provided a fairly good answer to the question of whether a later school schedule could ameliorate the problem of insufficient sleep among adolescents. But what difference can the 20 minutes to one hour gain make is far from being well understood. On the one hand, the research findings are not consistent. On the other hand, some of the results are often inappropriately interpreted. In many studies, less sleepiness or behavioral problems among students reported by teachers was used as evidence to support the effectiveness of delayed school start time. However, it is not clear how many

students teachers were referring to when answering the question. It is possible that they were only a problem for a small number of students with the majority of students doing fine. That is, the intervention's impact is only on a rather small number of students. This is especially apparent in a widely cited study conducted by Wolfson and Carskadon (1998), in which students who self-reported high grades were found to have more sleep time than those who self-reported low grades. In their results, it is not hard to notice that most students self-reported above B level. Specifically, out of 3060 participants in their study, 2609 (85.3%) self-reported having grades of mostly A's or A's/B's and mostly B's or B's/C's, whereas only 451 (14.7%) self-reported having grades of mostly C's or C's/D's and mostly D's/F's. If A and B are considered good and acceptable grades, the results suggest that learning is not impaired by the sleep problem for most students. What is also noticeable in the results is that the sleep times of students who self-reported a lower grade had much larger standard deviations than those who self-reported a higher grade. The standard deviation of sleep time is 74 and 94 for the self-reported low performing students in contrast to 62 and 66 for the self-reported high performing students. Thus, it is possible that the shorter sleep time for students who reported low grades is largely due to the even less sleep time of a smaller number of students in that group. This pattern is also presented in the School Start Time Study conducted by the Center for Applied Research and Educational Improvement (2000).

There are also concerns with methodology. As Taras & Potts-Datema observed (2005), data collection in the existing studies is mainly based upon self-report which requires some level of validation. A study of the reliability of self-report data suggests

that self-reported grades are fairly reliable except for students near the bottom of the distribution who tend to report better grades (Crockett, Schulenberg, & Petersen, 1987). But self-reported sleepiness rating could be greatly influenced by contextual factors (Sharafkhaneh & Hirshkowitz, 2003). The fact that the reported percentage of sleepy students varies greatly across studies is an indication of such influence. Most studies did not give a detailed description of how surveys were administered. It is not clear whether the responses to sleep related questions would be dramatically different in another context, for example, when sports and extracurricular activities are concerned. Another weakness in the past research is that the majority of studies in the literature did not take into account other factors that may confound the results (Wolfson & Carskadon, 2003). A very small number of studies took SES and gender into consideration. But other factors such as employment hours, parental involvement, and motivation to learn have been largely excluded from analysis.

Recognizing the contribution of the past research efforts to our understanding of the relationship between sleep and learning, some core questions have not been seriously asked and studied. When sleep is concerned, it is still not clear what the major causes for insufficient sleep among adolescents are and what those students who sleep less engage them with when their peers are resting. A comprehensive solution to address sleep problems will not be attainable until we gain a better understanding of these questions. With regard to learning and development, how delayed school start time is reinterpreted by teachers and students and how students' learning habits and social lives change as a result have received little attention. "Published peer-reviewed studies that investigate the

benefits of such modifications are virtually absent in the literature.” (Taras & Potts-Datema, 2005) But answers to these questions are pivotal for us to understand the impact of delayed school start time. What is also unclear is the magnitude and distribution of insufficient sleep among adolescents in the sense that what percentages of students are mildly, moderately, and badly affected by the problem.

CONCLUSIONS

Overall, the literature suggests that adolescents’ learning and development could be impaired by insufficient sleep. Insufficient sleep can be ameliorated but not fully addressed by delaying school start time. It is not clear whether student academic achievement will improve along with a later school schedule. Lastly, insufficient sleep might not be as grave as what the media and some studies have depicted.

We have known much about how sleep impacts a human being’s cognitive functioning. This body of knowledge could be enriched by investigating the social aspect of sleep problems, which will help us understand why some students sleep less and how their sleep patterns are influenced by their social environment. More rigorous studies that control for confounding variables are needed to rule out alternative interpretations of research findings. Future research could also greatly benefit from more comprehensive and reliable measurement.

APPENDIX A: SCHOOL START TIME AND SLEEP TIME

Study	Grade Level	Start Time	Sample Size	Sleep Time Difference/Gain
Kubow, P. K., Wahlstrom, K. L., & Bemis, A. E. (1999)	High school	7:15 (before shifting)	N/A	1 hour
		8:40 (after shifting)		
*Carskadon, M. A. (1999)	High school	8:25 (before shifting)	25	7 hours 9 min
		7:20 (after shifting)		6 hours 50 min
*Kowalski & Allen (1995)	12th grade	9:30	119	7.5 hours
	11th & 12th grade	7:20	97	6.9 hours
*Epstein, R., N. Chillag, et al. (1998)	5 th grade	7:15	232	8.7 hours
		8:00	340	9.1 hours
*CAREI School start time study technical report, Volume II (2000)	High school	7:15	N/A	6 hours 48 min
		7:25	N/A	6 hours 47 min
		8:30	N/A	7 hours 46 min
*CAREI School start time study technical report, Volume II (2000)	Middle school	7:35	N/A	8 hours 4 min
		8:00	N/A	8 hours 21 min
		8:00	N/A	8 hours 35 min
*Wahlstrom, K. (2002)	High school	7:30	467	7 hour 53 min
		8:40	169	7 hours 7 min

* Results are significant at 0.05

APPENDIX B: SLEEP TIME BY GRADE LEVEL

Study	Grade Level	Average Total Sleep Time	Sample Size
*Fredriksen, K., J. Rhodes, et al. (2004).	6 th grade	Nearly 8 hours	2259
	7 th grade	Just over 7 ½ hours	2259
	8 th grade	Between 7 and 7 ½ hours	2259
*Wolfson, A. R., & Carskadon, M. A. (1998).	13-14 years old	462 minutes	336
	15 years old	449 minutes	858
	16 years old	435 minutes	919
	17-19 years old	424 minutes	988
*CAREI School start time study technical report, Volume II (2000)	13-14 years old	8 hours 1 min	2306
	15 years old	7 hours 27 min	1177
	16 years old	7 hours 1 min	1271
	17-19 years old	6 hours 56 min	1596

* Results are significant at 0.05

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