

# Sleep, Sleepiness and School Start Times: A Preliminary Study

Donn Dexter, MD; Jagdeep Bijwadia, MD; Dana Schilling; Gwendolyn Applebaugh, PhD

## ABSTRACT

*Background:* High school students are reported to be excessively sleepy, resulting in decreased academic performance, increased psycho-social problems and increased risk of morbidity and mortality from accidents. Early school start times have been noted to contribute to this problem. This report attempts to confirm the relationship of early school start times with decreased sleep and increased sleepiness.

*Methods:* We examined sophomore and junior students in 2 local high schools with different start times and measured the amount of time slept and sleepiness.

*Results:* We found that students at the early start school reported reduced sleep time and more sleepiness than their counterparts at the later starting school.

*Conclusion:* Early school start times are associated with student reports of less sleep and increased sleepiness. Further studies in larger groups are recommended in view of the potential significant impact of sleep deprivation in this age group.

## INTRODUCTION

Excessive sleepiness is a common symptom in adults seen at sleep disorders centers. The cause is typically a medical condition such as obstructive sleep apnea, periodic limb movement disorder, restless legs syndrome or a parasomnia. In adolescents, however, the cause of excessive sleepiness is often sleep deprivation. One important cause of sleep deprivation in young adults may be the early start time for high school students.

In our area we have 2 high schools in like communities with a similar ethnic and racial background. The

start time for the high schools varies by 45 minutes. We believed this difference in the start times, with other variables for the students being very similar, would allow us to investigate the effect of early school start on time slept and sleepiness.

## METHODS

We surveyed all sophomore and junior students at Altoona and Chippewa Falls High Schools. Both are public high schools in communities bordering Eau Claire, Wis. High school students begin classes at 7:50 AM in Altoona and at 8:35 AM in Chippewa Falls. The city population is approximately 6300 in Altoona and 13,000 in Chippewa Falls. The class size was approximately 3 times larger in Chippewa Falls. The sophomore and junior classes were chosen for the ability to survey all class members on a single day. (This was not possible for the senior class.) The students were surveyed on a single day in the spring of the 2001-2002 school year. Surveys were distributed and collected by 2 students from Altoona High School. A questionnaire was used to assess the average amount of time slept each night and the degree of sleepiness experienced during the day. The average time slept was based on the response to the question, "On average, how many hours of sleep do you get on a weeknight?" The range was 4 to 9 hours with half-hour increments. The degree of sleepiness was based on the Epworth Sleepiness Scale (ESS), a standardized, 8-question survey that has a minimum score of 0 and a maximum score of 24. ESS scores above 10 indicate a pathologic level of sleepiness. We did not do subgroup analysis based on class, sex, or race.

## RESULTS

The sample size was 242 students in Altoona and 774 in Chippewa Falls. The responses were incomplete, missing or illegible for 20% of Altoona students and 24% of Chippewa Falls students. The results are based on the remaining 193 Altoona students and 587 Chippewa Falls students. The mean hours of sleep for Altoona

---

Doctors Dexter and Bijwadia are Co-Directors, Sleep Disorders Center, Luther/Midelfort, Mayo Health System, Eau Claire, Wis. Doctor Dexter is with the Department of Neurosciences. Doctor Bijwadia is with the Department of Pulmonology. Ms. Schilling is a student at the University of Wisconsin-Eau Claire. Dr. Applebaugh is with the Department of Mathematics, University of Wisconsin-Eau Claire.

were 6.88 (standard deviation 1.09, SE mean 0.079) and for Chippewa Falls were 7.07 (standard deviation 1.13, SE mean 0.047). After determining each category of data to be normally distributed, a 2-sample T test was done on the data to compare the scores and hours of sleep and determine statistical significance. The difference of 11.4 minutes was statistically significant with a p value of 0.039.

The ESS score average was 10.06 for Altoona and 9.57 for Chippewa Falls. This result was not statistically significant. It should be noted, however, that the results in the early start school (Altoona) were in the pathologically sleepy range on average and the late start school was in the normal range, although just barely.

## DISCUSSION

Sleep problems in adolescents have been clearly identified as an area of concern by lay persons,<sup>1</sup> educators,<sup>2</sup> researchers,<sup>3</sup> and government agencies.<sup>4</sup> One of the most significant sleep problems in adolescents is sleep deprivation. Sleep deprivation in adolescents has multiple causes including the demands of school, extra-curricular activities, social activities, and work outside the home.

Another important factor affecting the sleep of adolescents is the tendency towards sleep delay. The delayed sleep phase syndrome is characterized by difficulty falling asleep at a reasonable bedtime and difficulty rising from sleep in the morning.<sup>5</sup> The early start times seen in many school systems directly conflict with teenagers' internal biologic rhythm and adversely contribute to the trend towards significant sleep deprivation in adolescents.

There are multiple adverse outcomes associated with sleep deprivation in high school students. Impaired academic performance has been attributed to insufficient sleep.<sup>6</sup> The causal relationship remains controversial as one study failed to show a relationship between academic performance and sleep time.<sup>7</sup> Difficulties with mood disturbance and behavioral problems have been associated with decreased sleep times.<sup>6</sup> Impulsivity, difficulty with attention and problems completing tasks are signs of excessive sleepiness seen in teens that can be mistaken for Attention Deficit Disorder.<sup>8</sup> The most drastic complication of sleep deprivation is the morbidity and mortality due to accidents. There is clearly an increased risk of injury and death in teens that fall asleep at the wheel.<sup>9,10</sup> Delaying the high school start time by 1 hour has been shown to significantly reduce the motor vehicle crash rate.<sup>11</sup>

In our study we relied on student surveys for data.

This is cost effective and easy to accomplish. Self-report surveys have been shown to be accurate in determining sleep times in adolescents, even when compared to more objective actigraph recordings.<sup>12</sup>

The ESS was used to assess daytime sleepiness. This scale was developed as a subjective measure of daytime sleepiness and mean scores in normal sleepers range from 4.6 to 7.7. A recent study has shown no significant age or gender variations, but this study only looked at a population from 20 to 98 years of age.<sup>13</sup> Our sleep disorders center uses a cutoff of 10 as the upper limit of normal, with scores above this level being pathologically sleepy. The students in our study were, on average, near or above this value.

Moving the start times for high school students to later in the day may improve these problems significantly. However, a number of other problems have been raised with moving the start time for high school students until later in the day. Later start times for high school students may mean earlier start times for younger students, which may be associated with another set of problems such as youngsters waiting for the bus on dark mornings and spending more time in an empty house when coming home in the early afternoon. There may be scheduling difficulties for extracurricular activities and sports.

Our study had several limitations. The study groups in the 2 schools were not balanced, leading to difficulty in assessing statistical significance. Although questionnaire surveys have been validated in some studies, they have the inherent weakness of a subjective report, and in our study we did not include actigraphic records, which could have potentially supplied more objective and measurable data. Our study population comprises a small town, mainly rural population, and the findings may not easily translate to a larger, more urban, population. Lastly the ESS tries to numerically assess sleepiness, which spans across a continuum of severity. While the students with the earlier school start times had Epworth scores in the "pathologically sleepy" range, they were statistically similar to the school with later start times. It was interesting that students in this age group were all fairly sleepy, a commentary on the demands and stresses of being in school in current times.

Despite the above limitations there was a definite trend in our pilot study towards increasing sleepiness with earlier school start times. Later school start times have been instituted in several localities, including the Minneapolis school district. The results in Minneapolis have been very positive and well received by students, parents and staff.<sup>14</sup>

## CONCLUSION

Early school start time in our community is associated with a trend towards reduction in sleep time and reports of increased sleepiness. We believe, given the numerous prior reports of the detrimental effects of sleep deprivation in this age group, that further studies with larger populations of students and more objective assessments should be done to assess the impact of early school start times.

## ACKNOWLEDGEMENTS

The authors wish to thank Jan Engelsjerd of the Altoona Schools Gifted and Talented education program, high school students Mai Vue Xiong and Rachel Johnson, and Tom Tysver from University of Wisconsin-Eau Claire for their assistance.

## REFERENCES

1. Brownlee, Shannon. Why teens need more sleep time. *U.S. News and World Report*. Aug 9, 1999: v127 i6, 54.
2. Reiss, Tammy. Wake up call on kids' biological clocks. *NEA Today*. Feb 1998; v16, n6:19(1).
3. National Sleep Foundation. Adolescent Sleep Needs and Patterns. 2000.
4. National Institutes of Health, National Center on Sleep Disorders Research and Office of Prevention, Education and Control. Problem sleepiness in your patient. Sept, 1997, NIH Publication No. 97-4073.
5. Thorpy MJ, Korman E, et al. Delayed sleep phase syndrome in adolescents. *J Adolesc Health Care*. 1988 Jan;9(1):22-27.
6. Wolfson AR, Carskadon MA. Sleep schedules and daytime functioning in adolescents. *Child Development*. 1998;69:875-877.
7. Eliasson A, King J, et al. Association of sleep and academic performance. *Sleep Breath*. 2002. Mar;6(1):445-458.
8. Dahl RE. The impact of inadequate sleep on children's daytime cognitive function. *Seminars in Pediatric Neurology*. 1996;3(1):44-50.
9. Pack A, Rogman E, et al. Characteristics of crashes attributed to the driver having fallen asleep. *Accident Analysis and Prevention*. 1995;27:769-775.
10. McCartt A, Ribbner S, et al. The scope and nature of the drowsy driving problem in New York State. *Accident Analysis and Prevention*. 1996;28:511-517.
11. Danner FW. High school start times and teen auto accidents. *Sleep*. 2002;25(Abstract suppl):A86.
12. Wolfson AR, Fallone G, et al. Do surveys produce accurate data regarding high school students' sleep patterns? *Sleep*. 2002;25(Abstract Suppl):A96.
13. Sanford SD, Lichstein KL, et al. Epworth Sleepiness Scale scores among normal sleepers: An analysis from a random sample. *Sleep*. 2002;25(Abstract suppl):A511.
14. Wahlstrom KL, Freeman CM. School start times study: Report summary. The Center for Applied Research and Educational Improvement, College of Education and Human Development, University of Minnesota. 1997.



The mission of the *Wisconsin Medical Journal* is to provide a vehicle for professional communication and continuing education of Wisconsin physicians.

The *WMJ* (ISSN 1098-1861) is the official publication of the Wisconsin Medical Society and is devoted to the interests of the medical profession and health care in Wisconsin. The managing editor is responsible for overseeing the production, business operation and contents of *WMJ*. The editorial board, chaired by the medical editor, solicits and peer reviews all scientific articles; it does not screen public health, socioeconomic or organizational articles. Although letters to the editor are reviewed by the medical editor, all signed expressions of opinion belong to the author(s) for which neither the *WMJ* nor the Society take responsibility. The *WMJ* is indexed in Index Medicus, Hospital Literature Index and Cambridge Scientific Abstracts.

For reprints of this article contact the *WMJ* Managing Editor at 866.442.3800 or e-mail [wmj@wismed.org](mailto:wmj@wismed.org).

© 2003 Wisconsin Medical Society