

# School Start Time Study

## **Technical Report, Volume II: Analysis of Student Survey Data**

*The Center for Applied Research & Educational Improvement  
University of Minnesota*

## Executive Summary

The initial purpose of this study was to discover and examine the array of factors to be considered by a school district relative to changing the start time for high schools. The study was developed in response to a request by school superintendents from two member school districts of the Center for Applied Research and Educational Improvement (CAREI) at the University of Minnesota. Ultimately, the administrative and financial support of 17 participating CAREI member districts was obtained. A sample of 7,168 students was drawn from a total student population of 66,394 in the 17 districts.

This report, the second in an anticipated series of reports, focuses primarily on data obtained from three of the 17 Minnesota school districts that responded to the School Sleep Habits Survey developed by the Bradley Hospital at Brown University School of Medicine. The main purpose of this study was to discover any differences in student responding to a sleep habits survey between a district that had changed its school start time to a later time and two districts that maintained an earlier start time. The implementation of a later high school start time by District A when compared to two similar districts that maintained an earlier start time, Districts B and C, produced significant differences in student responses to the School Sleep Habits Survey.

High school students in District A report not going to bed much later than students at the two other demographically similar schools, while they get up roughly an hour later. That is, students in District A, as a group, are getting a full hour more sleep than students at the two similar schools with earlier start times. This difference in amount of sleep was found to be related to students' reports of how they feel and perform during the school day. District A students reported less overall sleepiness, less daytime sleepiness, less erratic sleep behaviors, and less depressive feelings and behaviors when compared to students in the early start time schools. Students in District A reported getting higher grades. The observed effects appear, to some extent, to be related to simply getting more sleep.

Students in District A did not report a restriction in their participation in extracurricular activities and sports. However, District A students did report significantly less time working in a job. This may be related to the later school dismissal time or it may be a factor of some other community norm. This finding deserves more careful study.

Students in District A's middle school get a little less sleep than middle school students in Districts B and C and report slightly higher levels of sleepiness, erratic sleep behavior, and depressive feelings and behaviors than reported by students getting more sleep in Districts B and C. This result is consistent with the results obtained at the high school level. This finding also supports the contention that the student populations in the three districts are similar in terms of community norms and other variables which were not directly controlled for in this research.

This study only touched on individual differences within the student populations. The original study conducted by Bradley Hospital categorized students as either morning, in-between, or evening subjects. When examining the data from the 17 Minnesota schools, significant differences were observed between these groups. Students who are owls (naturally more alert and active in the evening) tend to report more depressive feelings and behaviors, are sleepier during the day, and have more erratic sleep behaviors than larks (naturally more alert and active in the morning). Even though owls report being sleepier during the day, they actually report getting about the same amount of sleep at night as do larks. This finding raises a host of questions related to the importance of individual differences and school start time. Later school start times may not benefit all students.

Several questions emerged from the research team which focused on employment and participation in extracurricular activities. The observed differences relative to grades and employment and/or extracurricular activities were not substantial either in a positive or negative direction. Two questions did provide significant differences. Erratic sleep/wake behaviors were related to reports of lower grades and more depressive feelings and behaviors. The report of more frequent sleepiness was related to reports of more depressive feelings and behaviors. The Minnesota sample proved to be remarkably similar to the original Rhode Island sample. As students age, the amount of reported school night sleep decreases. Students who go to bed earlier on school nights, and consequently, get more sleep report higher grades in school. Taken as a whole, the analyses in this report appear to support the contention that later school start times for high school students, as a group, is beneficial. A later school start time appeared to be related to better achievement, less sleepiness, and fewer reports of depressive feelings and behaviors.

## **Introduction**

This is the second in an anticipated series of reports to be generated from the Minnesota application of the School Sleep Habits Survey developed by the Bradley Hospital at Brown University School of Medicine. This survey was administered to a sample of 7,168 students in 17 Minneapolis/St. Paul area school districts with a total student population of 66,394. These analyses and this report are in follow-up to the School Start Time Final Report Summary (CAREI, January, 1997).

This report is organized around data tables derived from the statistical analyses which were applied to the student survey sample. This has proven to be a very rich data set and it is anticipated that other analyses will be conducted in the future. The discussion accompanying each table is prepared so as to highlight critical findings. Readers are encouraged to examine all of the data contained in the tables. These data will certainly raise other important questions deserving study.

There are four components to the current effort. Of primary interest is the comparison of student survey responses from a district that changed its high school start time to a later time with those of two similar school districts that maintained an earlier start time. All three of these school districts were similar in terms of standard demographic information such as: socioeconomic status, racial and ethnic diversity, and school population size.

In a second component of the study, survey responses from middle schools students in these same three districts are compared in an effort to control for the absence of random assignment of students to the school start time condition. These analyses allowed an examination of pre-existing differences in the three communities.

The third component is made up of a set of questions of interest derived by the research team. A separate set of analyses was completed beyond those which were reported as part of the earlier School Start Time Final Report Summary (CAREI, January, 1997). These analyses utilized the total sample of 17 school districts and provided an opportunity to pose additional questions.

Finally, results from this Minnesota sample are compared with results from the original study which used the same survey instrument with a sample of Rhode Island students.

On the following pages are the data tables for each of the four components of this study. Each table is followed by a brief discussion of key findings reported in each table. It is important to note that the data is self-report data. Self-report data is subject to responder bias. To this point the self-report data such as grades or school attendance have not been verified for this particular instrument. However, the reliability of self-report data within an adequate sample size is generally considered sufficiently reliable for statistical analysis. Ultimately, the data reported here are expected to accurately reflect the opinion of the students responding.

**School Week Sleep Patterns: Comparison of Mean Scores for Three Demographically Similar High Schools (grades 10-12)**

**Table 1: Districts and Start Times**

| <b>Items/Scales from Sleep Survey</b>                                            | <b>District A<br/>8:30am</b> | <b>District B<br/>7:25am</b> | <b>District C<br/>7:15am</b> | <b>All 17 School<br/>Districts</b> |
|----------------------------------------------------------------------------------|------------------------------|------------------------------|------------------------------|------------------------------------|
| School Day Rise Time                                                             | 7:06am <sup>1</sup>          | 6:08am <sup>2</sup>          | 5:58am <sup>3</sup>          | 6:11 am                            |
| School Night Bedtime                                                             | 11:21pm <sup>1</sup>         | 11:20pm <sup>1</sup>         | 11:09pm <sup>1</sup>         | 11:08 pm                           |
| School Night Sleep Total                                                         | 7 hrs, 46 min <sup>1</sup>   | 6 hrs, 47 min <sup>2</sup>   | 6 hrs, 48 min <sup>2</sup>   | 7 hrs, 2 min                       |
| Daytime Sleepiness                                                               | 2.10 <sup>1</sup>            | 2.45 <sup>2</sup>            | 2.97 <sup>3</sup>            | 2.50                               |
| Sleepiness Scale (#43)                                                           | 14.86 <sup>1</sup>           | 15.86 <sup>1</sup>           | 17.74 <sup>2</sup>           | 16.56                              |
| <b>Struggled to stay awake or fallen asleep (school related items from #43):</b> |                              |                              |                              |                                    |
| reading, studying, doing homework                                                | 1.95 <sup>1</sup>            | 2.12 <sup>1</sup>            | 2.61 <sup>2</sup>            | 2.23                               |
| during a test                                                                    | 1.21 <sup>1</sup>            | 1.34 <sup>1</sup>            | 1.57 <sup>2</sup>            | 1.44                               |
| in a class at school                                                             | 1.98 <sup>1</sup>            | 2.24 <sup>ns</sup>           | 2.48 <sup>2</sup>            | 2.38                               |
| while doing work on a computer or typewriter                                     | 1.17 <sup>1</sup>            | 1.32 <sup>ns</sup>           | 1.42 <sup>2</sup>            | 1.31                               |
| Sleep Behavior Scale (#45)                                                       | 19.19 <sup>1</sup>           | 21.02 <sup>2</sup>           | 22.84 <sup>3</sup>           | 21.71                              |
| <b>In the last two weeks, how often have you (#46):</b>                          |                              |                              |                              |                                    |
| arrived late to class because you overslept                                      | 1.49 <sup>1</sup>            | 1.91 <sup>2</sup>            | 2.02 <sup>2</sup>            | 1.71                               |
| fallen asleep in a morning class                                                 | 1.57 <sup>1</sup>            | 1.95 <sup>2</sup>            | 2.01 <sup>2</sup>            | 2.02                               |
| fallen asleep in an afternoon class                                              | 1.45 <sup>1</sup>            | 1.70 <sup>ns</sup>           | 1.85 <sup>2</sup>            | 1.84                               |
| Depression Scale (#46)                                                           | 9.96 <sup>1</sup>            | 10.43 <sup>1</sup>           | 11.43 <sup>2</sup>           | 10.59                              |
| Days Home Sick Over 2-weeks (#21)                                                | 0.28 <sup>1</sup>            | 0.42 <sup>1</sup>            | 0.47 <sup>1</sup>            | 0.40                               |

**NOTE:** Different superscript values indicate a statistically significant difference between row means at  $p < .05$ . "ns" superscripts indicate that this district's mean is not significantly different from either of the other two district means (e.g., for item "School Day Rise Time" each of the three means are significantly different from each other; for the sub-item "struggled to stay awake in class at school" District B was not significantly different from either District A or C, but District A is significantly different from District C).

## Discussion of Table 1: School Week Sleep Patterns

Items and scales from the Bradley Hospital School Sleep Habits Survey were analyzed using one-way ANOVA's to see if there were any statistically significant differences between the three high schools. Most notably, we were looking for differences between District A, the district that changed to a later school start time, and Districts B and C which maintained an earlier start time. Because students could not be randomly assigned to schools with different start times, this is not a true experiment. Thus, one needs to be cautious about stating that the later start time in District A caused students to be less sleepy and less depressed. Other factors, such as community norms in District A, may be a more powerful causal agent than differences in sleep and sleep habits. Despite this limitation, the observed differences in responding between students in the three districts provides a rich ground for speculation concerning the importance of sleep in relation to the self-reported performance of high school students.

High school students in District A reported going to bed at about the same time as students in Districts B and C, [ $F(2,411)=0.58$ ,  $ns$ ]. However, students in District A report getting up much later [ $F(2,434)=223.82$ ,  $p < .0001$ ]. This allows these students to get an hour more sleep each night [ $F(2,411)=15.06$ ,  $p < .0001$ ].

One of the possible benefits of this extra sleep is that students in District A report being less "sleepy." There are many different measures of "sleepiness" in the School Sleep Habits Survey. One such measure (item 37) asks students "during your daytime activities, how much of a problem do you have with sleepiness (feeling sleepy, struggling to stay awake)?" Students in District A reported less daytime sleepiness than students in the other two districts [ $F(2,434)=31.91$ ,  $p < .0001$ ]. A second measure of sleepiness in the survey is the sleepiness scale, where students respond to whether or not they have struggled to stay awake in 10 different situations (item 43). Students in Districts A and B report much less overall sleepiness than students in District C [ $F(2,380)=17.07$ ,  $p < .0001$ ]. Although students in District A report less overall sleepiness than District B, the difference was not statistically significant.

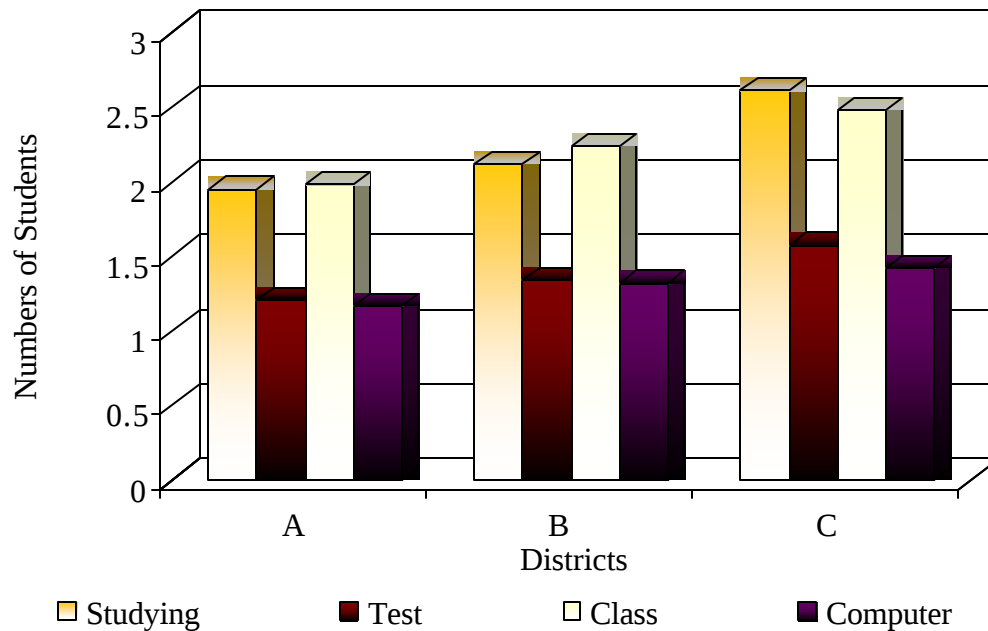
Four of the sub-items in item 43 (Sleepiness) were analyzed separately because they specifically pertained to situations occurring in an educational environment. Students in Districts A and B reported less sleepiness while studying [ $F(2,424)=17.80$ ,  $p < .0001$ ] and while taking tests [ $F(2,417)=12.01$ ,  $p < .0001$ ] than students in District C. Students in District A also were less sleepy in class [ $F(2,417)=10.55$ ,  $p < .0001$ ] and while working on a computer [ $F(2,420)=6.73$ ,  $p < .01$ ] than students in District C.

Another scale in the sleep habits survey measures students' erratic sleep behaviors (item 45). Students in District A reported less erratic sleep behaviors than students in Districts B and C [ $F(2,400)=13.22$ ,  $p < .0001$ ]. Three of the sub-items from item 45 were analyzed separately because they directly related to in-school behavior. Students from District A reported being less likely to arrive late to class because of oversleeping [ $F(2,428)=8.39$ ,  $p < .001$ ] and were less likely to fall asleep in a morning class [ $F(2,424)=6.00$ ,  $p < .005$ ] than students in Districts B and C. Students from District A also reported being less likely to fall asleep in an afternoon class than students in District C [ $F(2,422)=5.76$ ,  $p < .005$ ].

Finally, the sleep survey contains a scale that measures feelings and behaviors often associated with depression. The survey was not designed to be a diagnostic tool in terms of mental status. In the original survey the sub-items in item 46 were clustered under the heading "depression." While the responses do suggest differences between districts concerning these feelings and behaviors, there may or may not be a relation to a clinical diagnosis of depression. Caution should be used in interpreting this item. Students in Districts A and B reported less depressive feelings and behaviors than students in District C [ $F(2,412)=11.49$ ,  $p < .0001$ ].

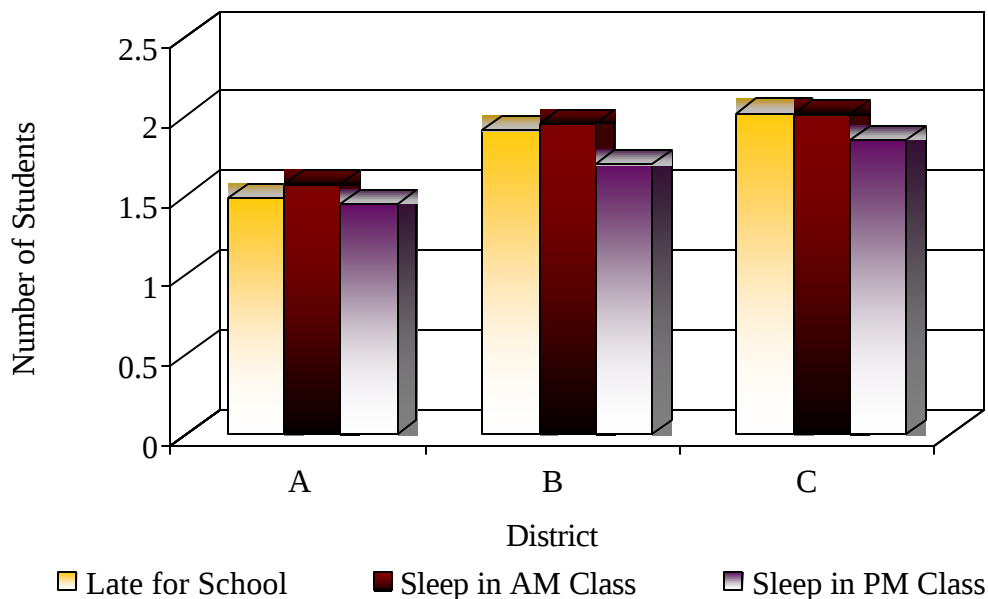
On each of the measures of sleepiness, sleep behavior, and depressive feelings and behaviors District A reported significantly less concern than District C. Only on the daytime sleepiness and erratic sleep behavior measures did District A students report significantly less difficulty than students in District B. However, of the three districts, District A always had the lowest (better) score on each measure (see Figures 1 & 2 for a graphic illustration of these trends).

**Figure 1: Student Responses to Whether They Have Fallen Asleep or Fought Sleep in 4 Educational Situations by School District**



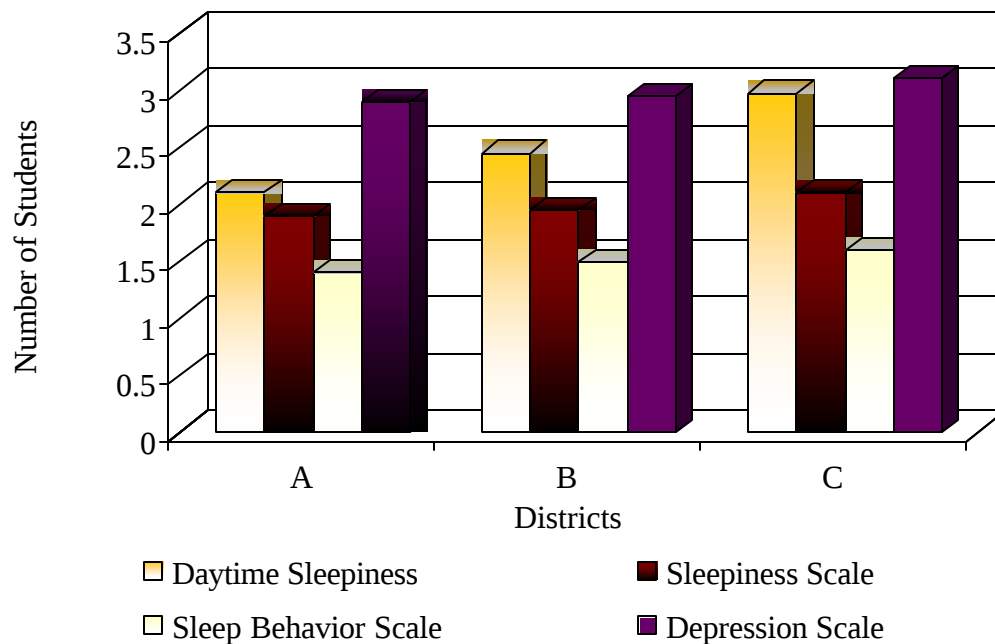
**Note:** Survey response options were given ordinal numeric values 0 to 3 for this figure.

**Figure 2: Student Responses to Selected Questions from Erratic Sleep Behavior Scale (Survey Item #45) by School District**



**Note:** Survey response options were given ordinal numeric values 0 to 3 for this figure.

**Figure 3: Student Responses to Sleepiness Items, Erratic Sleep Behavior, and Depression by School District**



**Note:** Scores on the three "scales" (sleepiness, sleep behavior, and depression) were all converted to a 5-point scale for this graph.

#### **Academic Achievement: Comparison of Mean Scores for Three Demographically Similar High Schools (grades 10-12)**

**Table 2: Districts and Start Times**

| Items/Scales from Sleep Survey     | District A<br>8:30am          | District B<br>7:25am          | District C<br>7:15am          | All 17<br>School<br>Districts |
|------------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| Hours of Homework--<br>School Week | 8 hrs, 37<br>min <sup>1</sup> | 4 hrs, 40<br>min <sup>2</sup> | 7 hrs, 15<br>min <sup>1</sup> | 5 hrs, 33 min                 |
| Hours of Homework--<br>Weekend     | 3 hrs, 5 min <sup>1</sup>     | 1 hr, 56 min <sup>2</sup>     | 2 hrs, 56<br>min <sup>1</sup> | 2 hrs, 8 min                  |
| Self-reported Grades               | 7.081                         | 6.502                         | 6.372                         | 6.12                          |

**NOTE:** Different superscript values indicate a statistically significant difference between row means at  $p < .05$ .

#### **Discussion of Table 2: Student Academic Achievement**

Students in District A report getting higher grades than did students in Districts B and C. There are many possible factors to be considered, one of which may be the extra hour of sleep. It may also be that District A has more grade inflation than the other schools. Part of the difference obtained could be due to students in District A spending more time doing homework than students at the other two schools. The observation that District A students report studying more than students in the other two district could be a result of

something within District A's community and not be related to the later start time. This seems to be the case as the middle school students at District A also study more than students in the two other districts. District A's middle school starts earlier than the middle schools in Districts B and C. Without baseline information (prior year's grades and/or standardized test results) it is difficult to determine if the increase in sleep is increasing student achievement. This is a noteworthy finding which warrants more study.

### **Weekend Sleep Patterns: Comparison of Mean Scores for Three Demographically Similar High Schools (grades 10-12)**

**Table 3: Districts and Start Times**

| <b>Items/Scales from Sleep Survey</b>                                    | <b>District A<br/>8:30am<sup>1</sup></b> | <b>District B<br/>7:25am<sup>1</sup></b> | <b>District C<br/>7:15am<sup>1</sup></b> | <b>All 17<br/>School<br/>Districts</b> |
|--------------------------------------------------------------------------|------------------------------------------|------------------------------------------|------------------------------------------|----------------------------------------|
| Weekend Rise Time                                                        | 10:00am <sup>1</sup>                     | 10:30am <sup>1</sup>                     | 10:15am <sup>1</sup>                     | 10:06 am                               |
| Weekend Bedtime                                                          | 1:07am <sup>1</sup>                      | 1:28am <sup>1</sup>                      | 1:13am <sup>1</sup>                      | 1:23 am                                |
| Weekend Sleep Total                                                      | 8 hrs, 54<br>min <sup>1</sup>            | 9 hrs, 2<br>min <sup>1</sup>             | 9 hrs, 1<br>min <sup>1</sup>             | 8 hrs, 44<br>min                       |
| Weekend Oversleep<br>(weekend total sleep -<br>school night total sleep) | 1 hr, 12<br>min <sup>1</sup>             | 2 hrs, 23<br>min <sup>2</sup>            | 2 hrs, 16<br>min <sup>2</sup>            | 1 hr, 43 min                           |
| Weekend Delay (weekend<br>bedtime - school night<br>bedtime)             | 1 hr, 47<br>min <sup>1</sup>             | 2 hrs, 6<br>min <sup>1</sup>             | 1 hr, 59<br>min <sup>1</sup>             | 2 hrs, 14<br>min                       |

**NOTE:** Different superscript values indicate a statistically significant difference between row means at  $p < .05$ .

### **Discussion of Table 3: Weekend Sleep Patterns**

Students in District A do report similar weekend sleep patterns as compared to students in the other two districts. Thus, it appears that even though students in District A are getting extra sleep during the week, they still feel the need for more sleep on the weekends. The reason why their "Weekend Oversleep" score is so much lower than students in the other two Districts [ $F(2,374)=5.72, p<.005$ ] is because they are getting more sleep during the week, not because they are sleeping in less on the weekend.

**After School Activities: Comparison of Mean Scores for Three Demographically Similar High Schools (grades 10-12)**

**Table 4: Districts and Start Times**

| <b>Items/Scales from Sleep Survey</b>               | <b>District A<br/>8:30am</b> | <b>District B<br/>7:25am</b> | <b>District C<br/>7:15am</b> | <b>All 17<br/>School<br/>Districts</b> |
|-----------------------------------------------------|------------------------------|------------------------------|------------------------------|----------------------------------------|
| Hours of Work--School Week                          | 2 hrs, 42 min <sup>1</sup>   | 5 hrs, 45 min <sup>2</sup>   | 5 hrs, 51 min <sup>2</sup>   | 6 hrs, 52 min                          |
| Hours of Work--Weekend                              | 3hrs, 34 min <sup>1</sup>    | 3 hrs, 44 min <sup>1</sup>   | 4 hrs, 42 min <sup>1</sup>   | 5 hrs, 41 min                          |
| Hours of Homework--School Week                      | 8 hrs, 37 min <sup>1</sup>   | 4 hrs, 40 min <sup>2</sup>   | 7 hrs, 15 min <sup>1</sup>   | 5 hrs, 33 min                          |
| Hours of Homework--Weekend                          | 3 hrs, 5 min <sup>1</sup>    | 1 hr, 56 min <sup>2</sup>    | 2 hrs, 56 min <sup>1</sup>   | 2 hrs, 8 min                           |
| Self-reported Grades                                | 7.081                        | 6.502                        | 6.372                        | 6.12                                   |
| Hours of Organized Sports--School Week              | 3 hrs, 16 min <sup>1</sup>   | 4 hrs, 14 min <sup>1</sup>   | 3 hrs, 10 min <sup>1</sup>   | 3 hrs, 29 min                          |
| Hours of Organized Sports--Weekend                  | 1 hr, 20 min <sup>1</sup>    | 1 hr, 25 min <sup>1</sup>    | 1 hr, 13 min <sup>1</sup>    | 1 hr, 11 min                           |
| Hours of Extra- curricular Activities-- School Week | 2 hrs, 44 min <sup>1</sup>   | 1 hr, 32 min <sup>2</sup>    | 2 hrs, 48 min <sup>1</sup>   | 1 hr, 44 min                           |
| Hours of Extra- curricular Activities-- Weekend     | 1 hr, 3 min <sup>1</sup>     | 1 hr, 11 min <sup>1</sup>    | 1 hr, 29 min <sup>1</sup>    | 1 hr, 2 min                            |

**NOTE:** Different superscript values indicate a statistically significant difference between row means at  $p < .05$ .

**Discussion of Table 4: After School Activities**

For the most part, the later start time for District A does not seem to be restricting student participation in after school activities such as organized sports and extracurricular activities. However, students in District A do report working at a job much less during the school week than do students in other school districts. This could be a result of getting out of school later in the day. But it could also be possible that the norm for students in this school district is to not work as much during the school week. Because we have no baseline on this high school and because middle school students typically do not work much during the school week, it is difficult to determine from this data set what is causing these high school students to work less.

## Comparison of Mean Scores for Three Demographically Similar Middle Schools (grades 7-8)

**Table 5: Schools and Start Times**

| Items/Scales from Sleep Survey                                                   | District A<br>7:35 am | District B<br>8:00 am | District C<br>8:00 am | All 17<br>School<br>Districts |
|----------------------------------------------------------------------------------|-----------------------|-----------------------|-----------------------|-------------------------------|
| School Day Rise Time                                                             | 6:14 am1              | 6:29 amns             | 6:37 am2              | 6:22am                        |
| School Night Bedtime                                                             | 10:10 pm1             | 10:09 pm1             | 10:02 pm1             | 10:07pm                       |
| School Night Sleep Total                                                         | 8 hrs, 4 min1         | 8 hrs, 21 minns       | 8 hrs, 36 min2        | 8 hrs, 16 min                 |
| Daytime Sleepiness (#37)                                                         | 2.281                 | 1.942                 | 2.07ns                | 2.16                          |
| Sleepiness Scale (#45)                                                           | 14.261                | 13.531                | 14.141                | 14.54                         |
| <b>Struggled to stay awake or fallen asleep (school related items from #45):</b> |                       |                       |                       |                               |
| reading, studying, doing homework                                                | 1.751                 | 1.462                 | 1.72ns                | 1.76                          |
| during a test                                                                    | 1.271                 | 1.141                 | 1.251                 | 1.31                          |
| in a class at school                                                             | 1.701                 | 1.422                 | 1.55ns                | 1.72                          |
| while doing work on a computer or typewriter                                     | 1.321                 | 1.152                 | 1.22ns                | 1.24                          |
| Sleep Behavior Scale (#43)                                                       | 19.101                | 17.072                | 17.53ns               | 19.08                         |
| Depression Scale (#46)                                                           | 9.851                 | 8.872                 | 9.34ns                | 9.65                          |
| Weekend Rise Time                                                                | 9:58 am1              | 9:19 am2              | 9:41 amns             | 9:40 am                       |
| Weekend Bedtime                                                                  | 11:50 pm1             | 11:37 pm1             | 12:17 am1             | 12:11 am                      |
| Weekend Sleep Total                                                              | 10hrs, 10min1         | 9 hrs, 43 min1        | 9 hrs, 27 min1        | 9 hr, 29 min                  |
| Weekend Oversleep                                                                | 2 hrs, 4min1          | 1 hr, 20 minns        | 53 min2               | 1 hr, 14 min                  |
| Weekend Delay                                                                    | 1 hr, 40 minns        | 1 hr, 23 min1         | 2 hrs, 19 min2        | 2 hrs, 3 min                  |
| Hours of Work--School Week                                                       | 38 min1               | 34 min1               | 29 min1               | 50 min                        |
| Hours of Work--Weekend                                                           | 44 min1               | 1 hr, 16 min1         | 59 min1               | 1 hr, 14 min                  |
| Hours of Homework-- School Week                                                  | 6 hrs, 44 min1        | 3 hrs, 20 min2        | 3 hrs, 30 min2        | 4 hrs, 16 min                 |
| Hours of Homework-- Weekend                                                      | 2 hrs, 31 min1        | 1 hr, 20 min2         | 1 hr, 30 min2         | 1 hr, 39 min                  |
| Self-reported Grades                                                             | 6.661                 | 6.911                 | 6.601                 | 6.44                          |
| Hours of Organized Sports--School Week                                           | 2 hrs, 16 min1        | 3 hrs, 13 min1        | 2 hrs, 12 min1        | 2 hrs, 49 min                 |
| Hours of Organized Sports--Weekend                                               | 1 hr, 38 min1         | 1 hr, 48 min1         | 1 hr, 14 min1         | 1 hr, 23 min                  |
| Hours of Extra- curricular Activities-- School Week                              | 1 hr, 28 min1         | 47 min1               | 53 minns              | 1 hr, 12 min                  |
| Hours of Extra- curricular Activities-- Weekend                                  | 40 min1               | 26 min1               | 38 min1               | 44 min                        |

**Note:** Different superscript values indicate a statistically significant difference between row means at  $p < .05$ . "ns" superscripts indicate that this district's mean is not significantly different from either of the other two district means (e.g., for item "Daytime Sleepiness" the mean for District A is significantly different District B as indicated by the different values in the superscript; for the item "School Day Rise Time" District B was not significantly different from either District A or C, but District A is significantly different than District C).

### Discussion of Table 5: Middle School Comparisons

Of these middle schools, students in District A, unlike at the high school level, actually started school earlier than students in Districts B and C. If middle school students in District A report less sleepiness, erratic sleep behaviors, and depressive feelings and behaviors than middle school students in Districts B and C, this finding would support that lower scores on these measures by the high school students in District A may be more a function of community norms, or some other factor than simply getting more sleep.

The middle school students in District A reported getting less sleep than middle school students in Districts B and C, and had the highest (worse) scores on measures of sleepiness, erratic sleep behaviors, and depressive feelings and behaviors. This finding lends support to the contention that the later start time for the high school students in District A, which resulted in an increased amount of reported sleep, did help reduce daytime sleepiness, erratic sleep behaviors, and depressive feelings and behaviors.

### All 17 School Districts: Effects of a Student's Degree of Morningness/Eveningness (items 47-56)

**Table 6**

| Items and Scales           | Owls                       | In Between                 | Larks                      |
|----------------------------|----------------------------|----------------------------|----------------------------|
| Depression                 | 11.281                     | 10.162                     | 9.143                      |
| Sleepiness (#43)           | 17.431                     | 15.712                     | 14.133                     |
| Sleep Behavior Scale (#45) | 23.391                     | 20.572                     | 18.053                     |
| School Night Sleep Total   | 7 hrs, 35 min <sup>1</sup> | 7 hrs, 35 min <sup>1</sup> | 7 hrs, 28 min <sup>1</sup> |
| School Day Rise Time       | 6:14 am <sup>1</sup>       | 6:16 am <sup>1</sup>       | 6:10 am <sup>2</sup>       |
| School Night Bedtime       | 10:38 pm <sup>1</sup>      | 10:41 pm <sup>1</sup>      | 10:42 pm <sup>1</sup>      |
| Weekend Night Sleep Total  | 9 hrs, 20 min <sup>1</sup> | 9 hrs, 5 min <sup>2</sup>  | 8 hrs, 41 min <sup>3</sup> |
| Weekend Rise Time          | 10:11 am <sup>1</sup>      | 9:56 am <sup>2</sup>       | 9:38 am <sup>3</sup>       |
| Weekend Bedtime            | 12:53 am <sup>1</sup>      | 12:52 am <sup>1</sup>      | 12:59 am <sup>1</sup>      |
| Weekend Oversleep          | 1 hr, 47 min <sup>1</sup>  | 1 hr, 34 min <sup>1</sup>  | 1 hr, 13 min <sup>2</sup>  |
| Weekend Delay              | 2 hrs, 12 min <sup>1</sup> | 2 hrs, 8 min <sup>1</sup>  | 2 hrs, 16 min <sup>1</sup> |

**Note:** Different superscript values indicate a statistically significant difference between row means at  $p < .05$ .

### Discussion of Table 6: Morningness/Eveningness Scale

For this analysis, all surveyed students' morningness/eveningness scores were calculated and the resulting distribution was broken into thirds: owls (evening people), in-between (students in the middle third of the distribution) and larks (morning people).

Students who are owls tend to report more depressive feelings and behaviors, are sleepier during the day, and have more erratic sleep behaviors than larks. Notice that even though owls report being sleepier during the day, they actually report getting about the same amount of sleep at night as do larks. One possible explanation for these differences between owls and larks is that the early school start times disrupts owls' circadian rhythms more, while these start times fit more naturally into the larks' circadian rhythm schedule.

### Sleep Survey: Further Analyses

Further correlational analyses were conducted on the complete Minnesota data set (all 17 participating school districts). Correlational results are provided after each question. Because the data set had such a large sample ( $N=7168$ ), many small correlations will be statistically significant. Some of the correlations are extremely small, which means they explain very little of the variation between the variables, yet they are still statistically significant. These correlations are noted below as being statistically significant, but not very meaningful. For example, the correlation between sports participation and grades is .08. By squaring this correlation one can find its true meaning, because this correlation squared tells you the amount of variance that can be explained in the students grades by knowing how much they participate in sports. In this example, only 0.64% of the variance in grades can be explained by sport participation. This is not very meaningful information.

When examining these results, one should also note that many of the correlations with students' self-reported grades are small. This is most likely due to the restriction in range present in the self-reported grades. As is shown in Table 8, most students report getting mostly A's and B's. When a distribution is skewed to one end as it is on this variable, there exists little variability and, thus, the ability of true correlations to be revealed is restricted. In other words, if one were to examine the relationship of these same variables with the students' actual grade point averages, one would probably find somewhat higher correlations.

What is the relationship between employment after school and grades? There is a statistically significant, though small, negative correlation ( $r=-.18$ ,  $p<.001$ ) between the number of hours worked during the week and grades. The more hours worked the lower the grades.

What is the relationship between employment during the weekend and grades? Again, there is a statistically significant, though small, negative correlation ( $r=-.13$ ,  $p<.001$ ) between the number of hours worked during the weekend and grades. The more hours worked the lower the grades.

What is the relationship between participation in sports and grades? There is a statistically significant, though very small, positive correlation ( $r=.08$ ,  $p<.001$ ) between the number of hours spent in organized sports during a 7-day week and grades. This is a good example of a result being statistically significant but not very meaningful. This seems to indicate that participation in organized sports does not hurt a student's academic progress.

What is the relationship between participation in extracurricular activities other than sports and grades? Similar to the sports result above, a statistically significant positive correlation exists but it is not very meaningful ( $r=.08$ ,  $p<.001$ ). Again, participation in extracurricular activities is not detrimental to academic performance.

What is the relationship between employment and participation in athletics and other extracurricular activities? Surprisingly, there is no relationship between number of hours worked and number of hours spent participating in either athletics ( $r = -.02$ , ns) or other extracurricular activities ( $r = .01$ , ns). What is the relationship between employment and depressive feelings and behaviors? Students who work more hours tend to report more depressive feelings and behaviors. This relationship is statistically significant, though small ( $r = .14$ ,  $p < .001$ ).

What is the relationship between participation in athletics and other extracurricular activities and depressive feelings and behaviors? There is no relationship between hours spent participating in athletics and depression ( $r = .02$ , ns). The relationship is statistically significant but not very meaningful between hours spent participating in extracurricular activities and depression ( $r = .08$ ,  $p < .001$ ).

What are the effects of erratic sleep/wake behaviors (e.g., staying up all night, falling asleep in class, awakened too early in the morning and couldn't get back to sleep) on student functioning? Students who report more erratic sleep/wake behaviors tend to report getting lower grades ( $r = -.27$ ,  $p < .001$ ), tend to report more depressive feelings and behaviors ( $r = .47$ ,  $p < .001$ ), and tend to report getting less sleep during a school night ( $r = -.21$ ,  $p < .001$ ).

What are the effects of sleepiness (responses to struggling to stay awake or falling asleep in various situations) on student functioning? Students who report more sleepiness tend to report getting lower grades ( $r = -.15$ ,  $p < .001$ ), tend to report more depressive feelings and behaviors ( $r = .43$ ,  $p < .001$ ), tend to report getting less sleep during a school night ( $r = -.26$ ,  $p < .001$ ), and tend to report working more hours during the week ( $r = .24$ ,  $p < .001$ ).

## Gender Differences in Sleeping Patterns and Daytime Functioning

**Table 7**

| Items and Scales           | Females       | Males         | Effect Size |
|----------------------------|---------------|---------------|-------------|
| Depression                 | 10.86         | 9.55          | .48*        |
| Sleepiness (#43)           | 16.08         | 15.49         | .14*        |
| Sleep Behavior Scale (#45) | 20.99         | 20.39         | .09*        |
| School Night Sleep Total   | 7 hrs, 27 min | 7 hrs, 40 min | .10*        |
| School Day Rise Time       | 6:07 am       | 6:20 am       | .35*        |
| School Night Bedtime       | 10:39 pm      | 10:43 pm      | .04         |
| Weekend Night Sleep Total  | 9 hrs, 0 min  | 9 hrs, 5 min  | .03         |
| Weekend Rise Time          | 9:51 am       | 10:01 am      | .07*        |
| Weekend Bedtime            | 12:53 am      | 12:58 am      | .03         |
| Weekend Oversleep          | 1 hr, 35 min  | 1 hr, 29 min  | .03         |
| Weekend Delay              | 2 hrs, 14 min | 2 hrs, 11 min | .02         |

**Note:** Because of the large sample size in this study, effect sizes were computed to allow one to properly interpret group differences. Effect sizes are computed by dividing the mean difference between the two groups by their pooled standard deviation. A '\*' after an effect size indicates that the difference between these two variables is statistically significant at  $p < .01$ . However, Cohen (1988) suggests that an effect size less than .20 is too small for the difference to be meaningful.

## **Table 7 Discussion**

The few meaningful gender differences that emerged were similar to what Wolfson and Carskadon (1996) found in their analysis of Rhode Island students' sleep/wake patterns. Female adolescents reported that they woke up 13 minutes earlier than their male peers on school mornings. This finding is consistent with many other studies (Gau & Soong, 1995; Wolfson & Carskadon, 1996). Wolfson and Carskadon speculate that adolescent girls may be getting up earlier because they require more time to prepare for school and/or family responsibilities.

Also, female adolescents in this sample report more depressive feelings and behaviors than males. This result is also consistent with numerous studies.

## Rhode Island and Minnesota Means for School-Night and Weekend Sleep Variables by Grades & Age

**Table 8: Self-Reported Grades**

| <b>Sleep/Wake Variables</b>   | <b>A's<br/>(N=1238)<br/>(N=4017)</b> | <b>B's<br/>(N=1371)<br/>(N=1988)</b> | <b>C's<br/>(N=390)<br/>(N=778)</b> | <b>D's/F's<br/>(N=61)<br/>(N=150)</b> |
|-------------------------------|--------------------------------------|--------------------------------------|------------------------------------|---------------------------------------|
| School-night Total Sleep Time |                                      |                                      |                                    |                                       |
| • Rhode Island                | 7 hrs, 35 min                        | 7 hrs, 33 min                        | 7 hrs, 18 min                      | 6 hrs, 48 min                         |
| • Minnesota                   | 7 hrs, 39 min                        | 7 hrs, 26 min                        | 7 hrs, 15 min                      | 7 hrs, 5 min                          |
| School-night Bedtime          |                                      |                                      |                                    |                                       |
| • Rhode Island                | 10:27pm                              | 10:32pm                              | 10:52pm                            | 11:22pm                               |
| • Minnesota                   | 10:34pm                              | 10:46pm                              | 10:59pm                            | 11:13pm                               |
| School-night Rise Time        |                                      |                                      |                                    |                                       |
| • Rhode Island                | 6:02am                               | 6:05am                               | 6:10am                             | 6:09am                                |
| • Minnesota                   | 6:13am                               | 6:13am                               | 6:15am                             | 6:21am                                |
| Weekend Total Sleep Time      |                                      |                                      |                                    |                                       |
| • Rhode Island                | 9 hrs, 15 min                        | 9 hrs, 14 min                        | 8 hrs, 50 min                      | 9 hrs                                 |
| • Minnesota                   | 9 hrs, 4 min                         | 9 hrs, 1 min                         | 8 hrs, 55 min                      | 9 hrs, 22 min                         |
| Weekend Bedtime               |                                      |                                      |                                    |                                       |
| • Rhode Island                | 12:06am                              | 12:29am                              | 1:09am                             | 1:33am                                |
| • Minnesota                   | 12:41am                              | 1:04am                               | 1:36am                             | 1:47am                                |
| Weekend Rise Time             |                                      |                                      |                                    |                                       |
| • Rhode Island                | 9:21am                               | 9:43am                               | 9:59am                             | 10:33am                               |
| • Minnesota                   | 9:44am                               | 10:04am                              | 10:26am                            | 11:00am                               |
| Weekend Oversleep             |                                      |                                      |                                    |                                       |

|                |              |               |               |               |
|----------------|--------------|---------------|---------------|---------------|
| • Rhode Island | 1 hr, 45 min | 1 hr, 48 min  | 1 hr, 49 min  | 2 hrs, 17 min |
| • Minnesota    | 1 hr, 27 min | 1 hr, 37 min  | 1 hr, 43 min  | 2 hrs, 9 min  |
| Weekend Delay  |              |               |               |               |
| • Rhode Island | 1 hr, 39 min | 1 hr, 57 min  | 2 hrs, 17 min | 2 hrs, 13 min |
| • Minnesota    | 2 hrs, 5 min | 2 hrs, 16 min | 2 hrs, 33 min | 2 hrs, 45 min |

Note: Weekend Oversleep is the difference between weekend and school-night total sleep times and Weekend Delay is the difference between weekend and school-night bedtimes.

### Table 8 Discussion

Students who get better grades tend to go to bed earlier on school nights and, consequently, get more sleep on school nights. Most students get over an hour and a half more sleep on weekend nights as compared to school nights. The Minnesota results are remarkably similar to the Rhode Island study results in this respect. However, Minnesota students tend to go to bed later and get up later (more so on the weekends) than the Rhode Island students. As an aside, another interesting finding was that Minnesota students (58%) report getting more A's as compared to the Rhode Island students (40%). This may mean that Minnesota schools suffer more from grade inflation.

**Table 9: Age**

| <b>Sleep/Wake Variables</b>   | <b>13-14<br/>(N=336)<br/>(N=2306)</b> | <b>15<br/>(N=858)<br/>(N=1177)</b> | <b>16<br/>(N=918)<br/>(N=1271)</b> | <b>17-19<br/>(N=988)<br/>(N=1596)</b> |
|-------------------------------|---------------------------------------|------------------------------------|------------------------------------|---------------------------------------|
| School-night Total Sleep Time |                                       |                                    |                                    |                                       |
| • Rhode Island                | 7 hrs, 54 min                         | 7 hrs, 40 min                      | 7 hrs, 28 min                      | 7 hrs, 19 min                         |
| • Minnesota                   | 8 hrs, 1 min                          | 7 hrs, 27 min                      | 7 hrs, 1 min                       | 6 hrs, 56 min                         |
| School-night Bedtime          |                                       |                                    |                                    |                                       |
| • Rhode Island                | 10:05pm                               | 10:20pm                            | 10:37pm                            | 10:51pm                               |
| • Minnesota                   | 10:14pm                               | 10:36pm                            | 11:08pm                            | 11:20pm                               |
| School-night Rise Time        |                                       |                                    |                                    |                                       |
| • Rhode Island                | 5:59am                                | 6:00am                             | 6:05am                             | 6:10am                                |
| • Minnesota                   | 6:16am                                | 6:03am                             | 6:08am                             | 6:17am                                |
| Weekend Total Sleep Time      |                                       |                                    |                                    |                                       |
| • Rhode Island                | 9 hrs, 30 min                         | 9 hrs, 36 min                      | 9 hrs, 9 min                       | 8 hrs, 40 min                         |
| • Minnesota                   | 9 hrs, 23 min                         | 8 hrs, 57 min                      | 8 hrs, 49 min                      | 8 hrs, 36 min                         |
| Weekend Bedtime               |                                       |                                    |                                    |                                       |
| • Rhode Island                | 11:54pm                               | 12:06am                            | 12:30am                            | 12:49am                               |
| • Minnesota                   | 12:25am                               | 1:13am                             | 1:16am                             | 1:32am                                |
| Weekend Rise Time             |                                       |                                    |                                    |                                       |
| • Rhode Island                | 9:22am                                | 9:40am                             | 9:46am                             | 9:32am                                |
| • Minnesota                   | 9:48am                                | 10:08am                            | 10:04am                            | 10:08am                               |
| Weekend Oversleep             |                                       |                                    |                                    |                                       |
| • Rhode Island                | 1 hr, 46 min                          | 1 hr, 56 min                       | 1 hr, 53 min                       | 1 hr, 34 min                          |
| • Minnesota                   | 1 hr, 23 min                          | 1 hr, 34 min                       | 1 hr, 50 min                       | 1 hr, 40 min                          |

| Weekend Delay  |              |               |              |               |
|----------------|--------------|---------------|--------------|---------------|
| • Rhode Island | 1 hr, 49 min | 1 hr 46 min   | 1 hr, 53 min | 1 hr 58 min   |
| • Minnesota    | 2 hrs, 9 min | 2 hrs, 35 min | 2 hrs, 8 min | 2 hrs, 11 min |

Note: Weekend Oversleep is the difference between weekend and school-night total sleep times and Weekend Delay is the difference between weekend and school-night bedtimes.

## Table 9 Discussion

Again, these findings are similar to the Rhode Island findings. The older students get, the later they go to bed, and consequently, the less sleep they get. The Minnesota 17-19 year olds are averaging 6 hours and 43 minutes of sleep on a school night. Carskadon hypothesizes that these later bed times for older adolescents are due to a change in their circadian rhythms. For the most part, the results from Tables 7 and 8 replicate Wolfson and Carskadon's (1996) findings. Their findings caused them to appeal to schools to start schools later in the morning.

## Conclusions

While there were substantial limitations to the present study, significant differences in the students responses relative to attendance at an early start versus late start school suggest that school start time does have an effect on student's behavior and performance. Preliminary evidence supports the notion that a later school start time for high school students has at least some self-perceived benefit. Further study is needed in order to better understand the actual effect of school start time. In particular, student survey data needs to be verified through other data collection means such as observation or follow-alone recording. This may be most important in terms of student achievement.

Not all students may experience the same benefit from late school start times. Districts may wish to consider offering alternative start times such as "zero hour" courses and late afternoon courses. How students would choose early or late start times should be examined in terms of the desired outcome. If student achievement is the goal, the schedule selection procedure will need to provide guidance so as to assure that students are making choices with that end in mind. Subsequent data collection on this project, as well as continued analysis of the existing data set, will likely provide stronger evidence concerning the impact of school start time. There is clear evidence of an effect from changing the school start time. There certainly exist a host of related factors that also interact with sleep and start times to impact student performance and behavior. Just what the effects are and how individual students benefit remains somewhat speculative.

Physiological and psychological measures have not been a part of the current study. This type of information will be necessary in order to fully understand the individual effects of schedule changes. Group data, while very powerful, does not account for individual differences. There exists strong evidence that individual differences are a critical factor relative to sleep and human performance. This will likely be especially important for special populations within the school environment.

In summary, the present project has created a very rich data base that has yielded a number of key findings relative to school start time and its impact on student performance and behavior. At a minimum, the current study supports the contention that this is an area that deserves greater attention from the educational community.

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