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The Effect of School Start Times on Students' Sleep Quality

Tayeeba Ahmed

The insufficient amount of sleep adolescents are obtaining has been seen to have various negative effects on their academic performance and social wellbeing. Through a two-part, mixed method approach, a survey based upon the comprehensive sleep quality assessment—The Pittsburgh Sleep Quality Index—along with a voluntary interview, was provided to participants from two public high schools in the northeastern region of the United States. Each of the schools with differing starting times in order to determine the effects a delayed school start time has on high school students' sleep quality. Upon calculating the sleep scores of the participants of each school, it was found that students attending school with a later start time do have significantly better sleep quality than that of their peers from the earlier starting high school ($p < 0.05$). This study demonstrates that sleep is critical for student success. Among broader implications, a policy change accommodating the wellbeing of students could be highly impactful.

Keywords: Sleep quality, adolescents, school start time

Introduction

The sleep patterns of high school students in the United States is a significant topic that affects the entirety of the country. Currently, the American Academy of Sleep Medicine recommends that middle school and high school start later than 8:30 a.m. so that adolescents are able to obtain a healthy amount of sleep each night (Brown and Caterino, 2013). Contrary to this, schools in the United States are most commonly seen to start earlier than this suggested time, most often before 8:00 a.m. A lack of sleep and improper circadian schedule is harmful to adolescents especially as they are still not biologically developed; students who lack sleep tend to perform worse in school, experience numerous health issues spanning weight gain and acne, and are significantly more likely to get into car accidents (Wahlstrom, 2016). The clear issue with adolescents not obtaining enough sleep due to their innate biological rhythms has negatively impacted their academic performance at school and their everyday social lives, making the subject of students' sleep a topic of great concern.

To carry out this research, a survey and corresponding optional interview were created and distributed to two suburban public high schools located in Long Island, New York. Each school had a different school starting time—the earlier starting school began at 7:50 a.m. and the delayed school at approximately 8:59 a.m. The survey provided to the participants was a pre-existing survey, The Pittsburgh Sleep Quality Index (PSQI), an effective public survey in which the sleep patterns and overall sleep quality of an individual are able to be measured (Buysse, 1989). In addition to questions from The Pittsburgh Sleep Quality Index (PSQI), other basic questions were asked regarding the student's grade and age. Students from each school were provided with the same survey, and upon completing the anonymous survey, had the option to volunteer for an interview regarding sleep and sleep habits. The collection and evaluation of data from various school starting times was essential in assessing the overall sleep quality of high school students in order to better aid teenagers.

Review of Literature

It has been established that many adolescents, specifically at the high school level, suffer from sleep deprivation. According to the 2013 Youth Risk Behavior Survey (YRBS), a national survey given to high school students in the United States, 68 percent of students have admitted to sleeping fewer than seven hours on a school night. In contrast, the American Academy of Sleep Medicine (AASM) recommends that adolescents (13 to 18 years old) sleep between 8 to 10 hours per day (Paruthi, S. et al, 2016). Various research journals, such as the American Journal of Pediatrics, state that a later school start time needs to be implemented to truly assist teenagers academically and physiologically. As reviewed below, many studies in this field of research have already examined the impact of delayed school start times on various aspects of a student's academic performance and various aspects of sleep quality. However, no study has yet linked the connection between the sleep quality of those in delayed school start times as opposed to normal start times, which my study does.

School Start Times

An experimental research study published in the *Journal of Pediatric Adolescence* concluded that a delayed school start time positively impacted students sleep, mood, and behavior in a public high school in Rhode Island in which the researchers obtained permission to delay the school start time by 30 minutes. It was found that by starting school at 8:30 instead of 8:00 am, students were found to be less depressed, had an average of 45 more minutes of sleep a night, and had fewer tardies compared to prior to the change in start time (Owens, Belon, and Moss, 2010). The findings presented in this research agree with a similar experiment that not only had a much greater, more diverse sample size, approximately 9000 students, but also spanned three years. The results of the research indicated that at least 60 percent of the students who attended Jackson Hill High School were found to have obtained a mean of 8.2 hours of sleep per school night compared to a mean of 7.5 hours they obtained prior to the change (Wahlstrom, et al., 2014). Although this is not the ideal amount of time adolescents require to maintain a healthy lifestyle, it is much better than the

amounts teenagers usually get (Wolfson and Carskadon, 1998). Students in schools with later start times have seen better grades in their core subjects, higher GPAs, better performance on standardized tests, improved attendance, and fewer tardies (Wahlstrom, 2016). It is clear that later school start times improve students' academics in varied measures and behaviors, advantages that they would not have attained with the regular starting time for schools. Overall, one could generalize, based upon the previous studies, that delayed school start times have a positive impact on one's academic position, disregarding socioeconomic standing, race, or other dividing factors.

Sleep Quality

Along with improving one's academic performance, a delayed school start time also positively affects various aspects of sleep such, as sleep duration. For the purposes of this study, sleep quality will be defined as a measure of seven components: "subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction over the last month" (Buysse, 1989). Many previous studies have attempted to measure the construct of sleep quality holistically. However, few have managed to cover all seven dimensions put forth by Buysse. Most researchers studying this field have only focused on one component—primarily sleep duration—by implementing their own research method into the research design. Additionally, when measuring factors involving students' academic performance and their home life, most researchers use the Teen Sleep Habits Survey. This is not an effective method to research a student's behavior, especially when it involves sleep quality as the survey mainly focuses on school-related activities as opposed to questions inquiring about the various aspects of sleep quality (Boergers, 2014). As I have mentioned before, most studies completed regarding this topic have found a correlation between a later school time and an increase in sleep (Owens et al., 2010). Individually, most of the components of sleep quality have been researched when tested among adults, by combining all of the components and implementing them through an accurate survey, experimental errors that may have occurred for other researchers may not happen.

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Therefore, the only medically approved practice of assessing individuals' overall sleep quality is by administering the Pittsburgh Sleep Quality Index (PSQI) as it is the only survey that measures all seven components of sleep (Buysse et al, 1989). The Pittsburgh Sleep Quality Index (PSQI) is rated on a scale of 0 to 21; 21 indicating the poorest quality of sleep and 0 indicates the best quality of sleep (Buysse et al, 1989). A score of 5 or more is a general indicator of poor sleep quality; individuals with scores greater than or equal to 5 are urged to see a licensed medical expert (Buysse et al, 1989). As mentioned above, changing even one component of sleep quality—such as the amount of sleep students are able to get with a delayed school start time—has been shown to benefit students in a multitude of ways. Completing a comprehensive study on the differences in sleep quality between various schools, each with different starting times, is significant in assessing the perspectives on student productiveness.

Circadian Rhythm

Biologically, teenagers are not able to go to sleep at the same time as adults (Wolfson and Carskadon, 1998). During adolescence, a teenager's circadian rhythm—which is essentially an internal body clock—is pushed back approximately a few hours, which mean that teenagers physically want to go to sleep later and wake up later (Wolfson and Carskadon, 1998). According to Mary Carskadon, director of Chronobiology at the E.P. Bradley Hospital and Professor of Psychiatry and Human Behavior at Brown, “Psychosocial influences and changes in bioregulatory systems controlling sleep may limit teenagers' capacities to make adequate adjustments to an early school schedule” (Carskadon, 2007). This implies that many students do not perform as well academically as they could due to their age.

Furthermore, the sleeping schedule of adolescents can cause something known as circadian misalignment. It can be defined as having an irregular sleep and wake schedule, and bad sleeping habits (Crowley, 2007). These aspects are, once again, encompassed in one of the seven aspects of sleep quality: habitual sleep efficiency. The fact that students' sleep schedules are not aligned with their school start times indicates that most students currently suffer from circadian mis-

alignment. However, misalignment of the circadian rhythm has shown to be easily remedied. By setting a proper sleep schedule and abstaining from activities that may harm one's sleep schedule (such as avoiding one's phone, avoiding the usage of technology, and staying awake at times that go against the natural circadian rhythm), circadian misalignment can be easily readjusted (Crowley, 2007). In the case that circadian misalignment is not addressed, long term problems regarding an individual's health such as cardiovascular disease may occur (Wolfson and Carskadon, 1998). Factoring in the other biological changes that occur during adolescence such as hormonal changes during puberty, stress, and social dilemmas, teenagers are getting far less sleep than they require.

Call to research

After examining the research surrounding the effects of later school start times on students performance, there was a clear gap in the discussion of students' sleep quality as opposed to academic performance. The problem of a low duration of sleep present in high schools raises the question: To what extent does a delayed school start time impact the overall sleep quality of public high school students in the United States? As I have discussed above, studies have examined delayed school start times' effects from various perspectives; academic performance and the different aspects of sleep quality. For example, it has been established that a later school starting time leads to longer durations of sleep, as “each half-hour increase in start time [...] was associated with 11.36 more minutes of weeknight sleep” (Paksarian et al., 2015). However, there has not been a study that links all of the aspects of sleep quality and public school start times. In other words, the topic of sleep and its effects, especially when it concerns teenagers, is a complex issue that lacks more longitudinal data. Essentially, the cross-sectional study mentioned above is just a snippet in time, but does not assess long term efficacies of change in school start times. It only measures the immediate impact of the length of sleep that students obtain following a change in school start time. Thus, the research regarding these two subjects is incomplete, leaving a gap in knowledge concerning how school start times truly affect high school public students' sleep quality.

Methods

To examine the relationship between high school start times and a teenager's sleep quality, a descriptive research procedure was used through a two-part, mixed method approach. Initially, the Pittsburgh Sleep Quality Index was provided to two public high schools located in the northeastern United States, followed by interviews conducted on volunteering participants. It is significant to note that although the research centers on examining a connection between school start times in the United States and students' resulting sleep quality, only two different schools in the northeastern region of the country were able to be surveyed and interviewed. Also, the survey groups could only be selected through the implementation of convenience sampling as there are currently a limited amount of high schools in the United States that implement a later school starting time. Only approximately 7% of high schools implement a starting time after 8:30 A.M. in the United States (CDC, 2015). Therefore, in order to get an appropriate sample size, I had to utilize convenience sampling.

The survey, which was distributed via Google Forms, was used in this research design as it would be able to effectively measure students' sleep quality quantitatively and effectively connect it with their school start time. Along with asking questions directly from the Pittsburgh Sleep Quality Index, questions identifying the population's demographics, such as age and gender, were also included. Both the survey and interview were reviewed by the Institutional Review Board (IRB) in order to ensure the participants' safety and overall ethicality of the research.

By implementing a survey, the research becomes more applicable when comparing students' sleep quality throughout the country. In order to get the most accurate data regarding school start times effects on sleep quality, the survey (see Appendix A) was given to two schools in the northeastern region of the United States, each starting at a different time. The schools that were chosen to be a part of the research were selected based upon when their first class started. Therefore, the schools that were chosen had a one hour difference in their school start times—8:59 a.m. and 7:50 a.m. This research can best be replicated in a residential area located in the northeastern region of the United States.

Considering the current body of knowledge, the only survey given to teenagers in high school when attempting to measure sleep habits is the Teen Sleep Habits Survey, which I have acknowledged in the literature review. The purpose of this pre-existing survey in a research study has been to measure the correlation between academic performance and sleep habits (Boergers, 2014). This method of distributing a survey that is already public and known to be credible assists the researcher in focusing on the results of their data more so than having to spend time formulating the questions. Completing studies using pre-existing surveys, such as the study completed using the Teen Sleep Habits Survey, was beneficial to the scope of the research. However, my current research design would not allow me to use the Teen Sleep Habits Survey as it does not measure sleep quality only. This is why I chose to implement the PSQI, although it has not been applied to teenagers in a formal study regarding school start times and students sleep quality, it has been shown to effectively examine the sleep quality of all age groups (Taras, 2005). The process of utilizing the research method with a different concept is proven to allow me to effectively research and analyze the effect school start times have on the sleep quality of high school students.

The survey itself (see Appendix A) was created primarily using questions from The Pittsburgh Sleep Quality Index (PSQI), a pre-existing public survey that effectively assesses sleep quality over the course of a month (Buysse, 1989). As I have defined above, sleep quality encompasses seven different components, and the PSQI is able to quantify and measure those components. Questions in the PSQI were given a four-point answer scale and asked the respondents questions about their sleep habits, such as if they wake up during the middle of the night, to assess sleep quality. Following the PSQI section of the survey, a free response section was created focusing on sleep quality in relation to school start times. The participants were asked about their perceptions on later school start time, how it would affect them (or how it already affects them in the case of students who already attend schools with late school start times) and various other questions regarding school start times effects on sleep quality. The survey was implemented anonymously, though if the student wanted to participate in the interview, they were asked to leave an email with which I may contact them. All of the students who participated in the survey did

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so anonymously and voluntarily, which is significant regarding the ethical aspect of implementing a survey on students and interviewing individuals.

The second part of the mixed method approach encompassed an interview (see Appendix B). After taking the survey, the participant was able to choose if they would like to participate in an interview in which I asked them questions about school start time and sleep quality more in depth. The interviews were structured and all participants were asked the exact same questions in the same order listed in Appendix B. Applying interviews was beneficial as it allowed me to put together qualitatively the different aspects of this research. Although the school start times were controlled (the survey was given to only two schools, each with varying school start times), the topic of sleep quality is dependent on the person. Therefore, with interviews, I was able to connect the quantitative data found from the mainly multiple choice questions in the survey to the mainly qualitative and anecdotal responses from the interviews.

Questions in the interview spanned from the participant's daily schedule to a discussion on their circadian rhythm. These questions asked about students' variations in sleep habits on weekends and weekdays, their methods of waking up and going to bed, and their perceptions of their sleep quality as well as of their peers. The questions were worded in a way in which the researcher would be able to see connections between the PSQI, sleep quality, and the interview questions, which spanned teenagers and school start times. An example of this can be seen in a question in the survey asking, "During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?" and various other questions regarding academic performance and engagement students as a result of the amount of sleep they are currently getting. Again, the survey, which uses multiple choice questions, is best used in addition to free answer responses from a smaller population to best examine the connection between school start time and sleep quality of students in the United States.

Following the collection of the data, each participants' survey response was calculated in order to find a representative PSQI score for the participants. The individual PSQI score for each participant will then be averaged to find a representative score for each school. The interview questions will be compared to the PSQI

scores to see if the responses correlate with the quantitative data. In terms of analytical strategy, the data will be analyzed using descriptive statistics. A t-test will be performed in order to test the validity of the quantitative data while the qualitative data—the responses—will be validated depending upon the conclusion of the data analysis.

Results

The surveys yielded results from high school students from over 2 different starting high schools across located in the northeastern United States. There were a total of 240 respondents to each survey, 115 participants from the 7:50 a.m. starting school (47.9%), and 125 students from the 8:59 a.m. starting school. A total of six students, three randomly selected from volunteering participants of each school, were chosen to partake in the follow-up interview. The questions, as mentioned in the previous section, primarily centered around one's sleep quality and opinions about one's school start time, while the interviews discussed the qualitative reasoning behind the average calculated sleep score. Once again, the research was carried out with the intent of finding a possible correlation between school start times and students sleep quality.

Prior to calculating the sleep scores of students from their respective school, the responses had to undergo a process of data correction. Exclusion criteria was applied to responses consisting of unrealistic numbers or responses that were incomplete. Inclusion criteria accounted for all responses that were completed and "normal." For example, an individual who purposely slept during the day and was awake throughout the night was excluded as their response was not ideal for the purpose of the research. Overall, only four participants were excluded from the data integration. These participants were excluded as they had abnormal sleep schedules. The other excluded participants had responses that were physically impossible (i.e., one participant claimed they got more hours of sleep than the total amount of time they were in their bed while the other participant stated they did not sleep). Below are the calculated average PSQI scores of each school as a whole. Once again, the PSQI scale goes from 0 to 24, a score of 5 or above indicates poor sleep and a score of anything below 5 indicates good sleep quality.

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Table 1.

<i>Total PSQI - 8:59 A.M.</i>		<i>Total PSQI - 7:50 A.M.</i>	
Mean	9.5	Mean	12
Standard Error	0.4	Standard Error	0.49
Median	9	Median	11
Mode	8	Mode	10
Standard Deviation	4.45	Standard Deviation	5.21
Minimum	1	Minimum	0
Maximum	24	Maximum	23
Count	121	Count	114

Figures 1a and 1b (pictured below) represent the average amount of times students felt that they could not get to sleep within 30 minutes over the course of a one month period. As seen in the data, a larger percentage of students from both schools felt that they could not fall asleep within 30 minutes. This data was cross-referenced with the free response question asking the participants how long it took, on average, for them to fall asleep which suggested students' inclination to fall asleep later due to their naturally delayed circadian rhythms.

Figure 1a. 8:59 starting school

...Cannot get to sleep within 30 minutes

125 responses

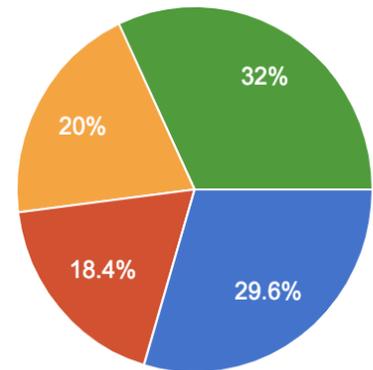
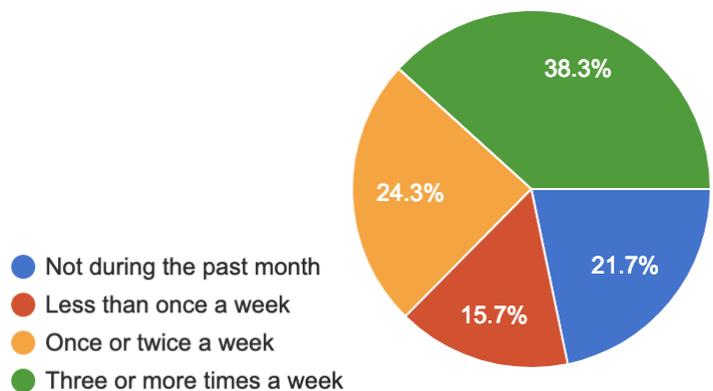


Figure 1b. 7:50 starting school

...Cannot get to sleep within 30 minutes

115 responses



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Another significant question regarding the scope of the research and overall data can be seen in the question asked in Figure 2a and Figure 2b (pictured below). It asked, "During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?". This question has significant implications on the social

and functional life of adolescents, based on their social habits and nutritional wellbeing. As seen in the responses, both schools are seen to have a variety of different responses suggesting that school start time is correlated with these behaviors as they are directly influenced by students' sleep habits.

Figure 2a. 8:59 starting school

During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

125 responses

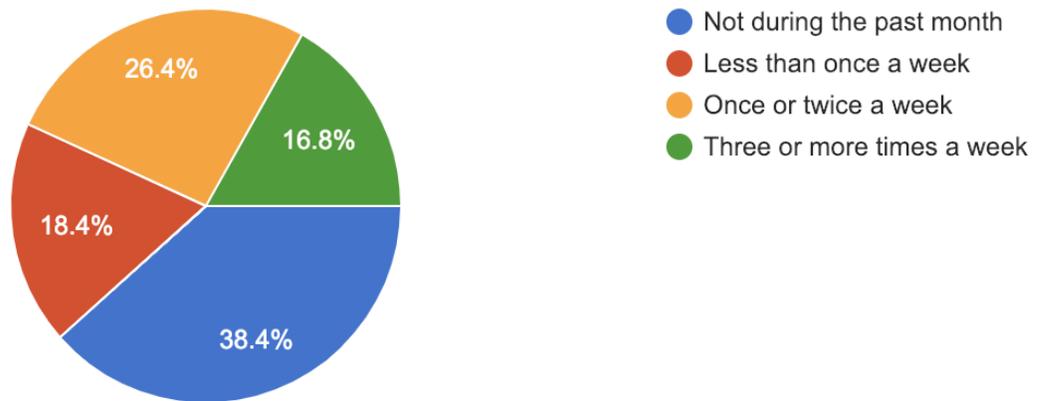
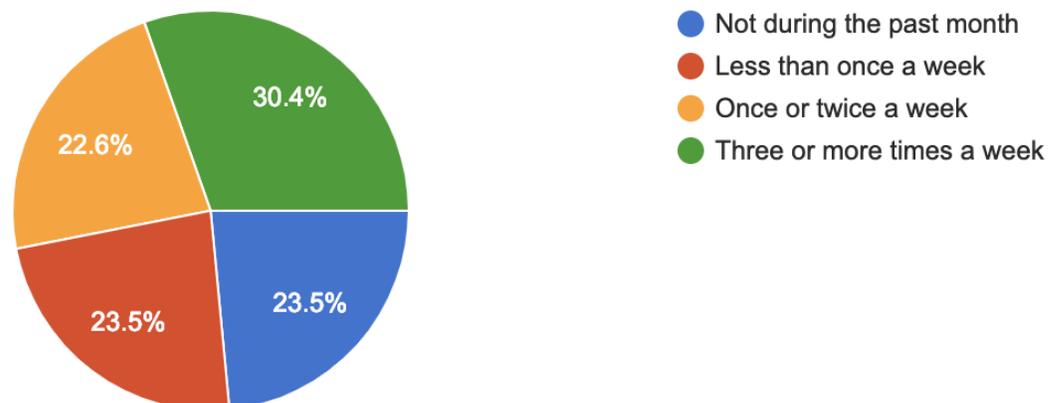


Figure 2b. 7:50 starting school

During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

115 responses



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Once again, Figures 3a and 3b ask similar questions regarding the influences that one's sleep may have on their productivity and social life. Both schools had the majority of responses leaning to experiencing a lack of enthusiasm more than once or twice a week. As seen in the interviews (Appendix B), the data suggests that

students from both schools suffer from some degree of depression, which will be further discussed.

Figure 3a. 8:59 starting school

During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?

125 responses

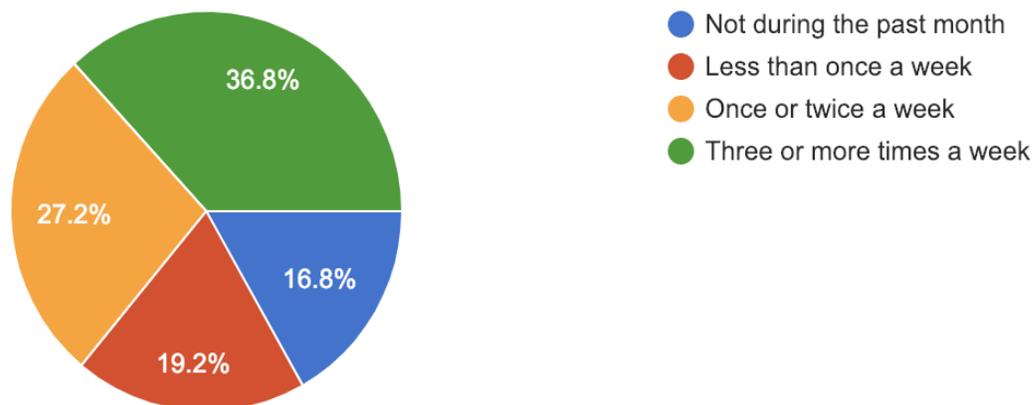
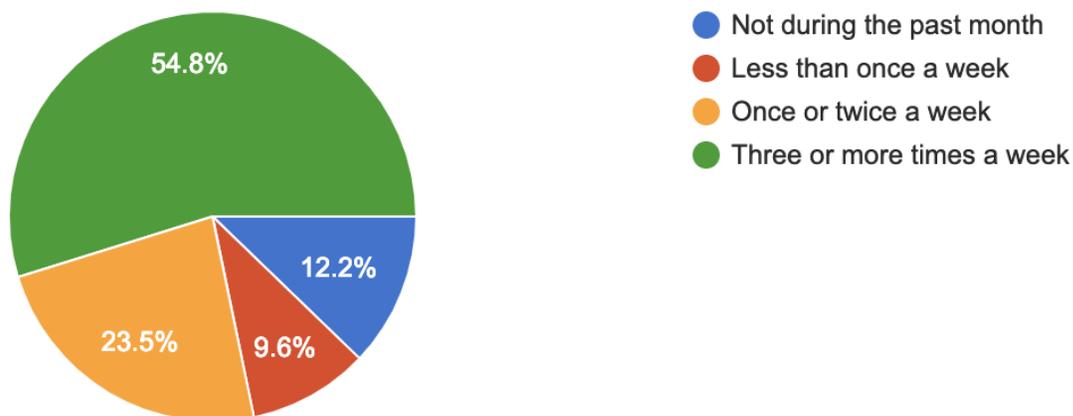


Figure 3b. 7:50 starting school

During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?

115 responses



Analysis

Currently, the research indicates that a delayed school start time indicates a greater sleep quality than attending a school that did not implement a late school starting time. It can be seen that the mean PSQI score of the later school starting time is 9 while the earlier starting school has a mean sleep score of 12. As I have mentioned prior, a score of 5 or above indicates poor sleep quality. Interestingly, it is found that a later school start time does not correlate with adequate sleep quality, it only suggests that students from later school start times have *better* sleep quality than their peers at the different schools. Also, as seen in the mean score of each sleep component, the 8:59 A.M. school had an overall better score for each individual aspect of sleep quality. The previously established research conducted regarding sleep habits and various isolated components of sleep quality further validated the findings present in the data.

Naturally, with the established data, it was significant to continue by implementing descriptive statistics in order to prove the validity of the research. An F-Test Two-Sample for variances was implemented followed by a two-variable t-test assuming unequal variances (see Table 2, Table 3, Appendix C). The data was proven to be statistically significant with the p-value derived from the t-test being 0.000105, smaller than the threshold alpha reference value of $p=0.05$ when determining the accuracy of data. This indicates that the null hypothesis, school start time has no relation with sleep quality was rejected. The alternative hypothesis, that school start time does make a difference in students' sleep quality was true as seen in the different mean values. Due to the fact that the two research groups were isolated primarily by their difference in school start time, it can be said that a later school start time is the reason for the differences in sleep quality.

Interestingly, it is found that a later school start time does not correlate with adequate sleep quality, it only suggests that students from later school start times have better sleep quality than their peers at the different school. It was found that the 8:59 school had an average of 6.1 hours of sleep, while the 7:50 school had an average of 5.7 hours of actual sleep. This is nowhere close to the recommended amount of time of 8 to 9.5 hours of actual sleep that teenag-

ers are supposed to obtain a night. A possible cause of these factors may due to the fact that most of my participants stated that they were—or still are—in accelerated classes, 90% for both participating schools. This suggests that these students take on a heavier workload with various Advanced Placement courses or partake in gifted programs which naturally indicates more work needed to be completed after the school day. This data leads one to ask how the sleep quality of students in honors programs compares to that of students in normal/regents programs? When analyzing one component of sleep quality, sleep duration, it is clear that the 7:50 schools are lacking in the amount of time they spend in bed and the amount of time they actually get to sleep in comparison with the 8:59 school.

Alarming, many of the participants, when asked what prevents them from sleeping, stated that technology and social media was a main factor in their lack of ability to sleep. Additionally, many participants stated that mental issues, the most common being stress, anxiety, and depression was another reason as to why they could not fall asleep. Various PSQI questions, such as those asked in Figures 2a and 2b above, ask about social interactions with friends and enthusiasm levels throughout the day correlate with the free response questions regarding reasons as to why students could not focus and sleep as well. For example, as seen in the Figures above, a large percentage of students stated that they were affected by a lack of sleep socially three or more times a week. Distributing this survey not only unveiled a previously unknown correlation between sleep quality and school start times, but seemingly has created a connection between teenagers and an increase in mental disorders that will require further research.

Interview Analysis

The interview responses, collected from a total of six individuals, further discussed the overall sleep habits of students. With the intent of maintaining anonymity, the 7:50 interview participants will be referred to as Participants A, B, and C while the 8:59 interview participants will be referred to as Participants D, E, and F. Nearly all of the participants, excluding E, believed that a later school starting time would be beneficial to overall performance academically, socially, and physically. E stated that although they personally are not affected by their later school

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starting time, they know their friends greatly benefit from it in regards to the amount of sleep they get. Participants A, B, and C stated that if they had a later school starting time, they would benefit by getting more sleep, be able to have more time to prepare for school and do homework, and be less stressed due to school. Overall, every interview participant came to a general consensus that a later school start time would benefit the overall success of students. When asked why they thought this, they responded with thought-out responses spanning mental health, more time to study/complete schoolwork, and obtaining better sleep quality.

It is important to note that the students seemed to be aware of the fact that using technology would be harmful to one's circadian rhythm. The participants all stated, however, that they still needed technology to complete their schoolwork as required by the school. Most students were aware of the fact that they had disrupted sleep schedules but that they could not do anything about it due to their workload and responsibilities outside of school. However, students from the 8:59 a.m. starting school were significantly less aware of the amount of technology that they used prior to when they start feeling tired due to the fact that they were aware that their school start time allowed them to adjust to their natural circadian rhythms more efficiently.

Discussion

Limitations

Moreover, the survey distribution was distributed online using Google's online service, Google Forms. This suggests that low-income students or students without access to technology did not have access to the survey. However, both high schools have resources and technology at the students' respective schools that allowed them to participate in the survey thus minimizing this potentially limiting factor. Additionally, the sample size of each school was quite large and the interview data was extensively compared with the survey data, which indicates a high quality of accurate responses. Furthermore, one has to realize how personal sleep is to each individual, no one will have the same sleep patterns or sleep caused side effects.

This means that sleep quality may not be affected for certain individuals because they are accustomed to their current sleep schedule. This research design was created with the intent to minimize the number of outliers by allowing for a greater sample size and conducting interviews on a large number of students.

Implications

The results of the research further adds to the preexisting body of knowledge centering around the sleep habits of teenagers. With the results of this paper showing that a later school start time suggests better sleep quality among high school students when compared to students of an earlier school starting time, it makes one ask why school start times of later than 8:30 a.m. are not implemented throughout the United States? By implementing changes into seemingly insignificant factors of the high school education system, such as school start times, students will be able to see a greater change in not only their academic performance, but also their social lives. Maximizing students' success while in school suggests a greater potential for further success and better control of their circadian cycle in the future. A productive workforce, which education is intended to create, is imperative in furthering the success of the country as a whole. With further implementation of later school start times across the United States, students are expected to exponentially obtain better levels of sleep quality that actually align with their circadian rhythm and further benefit all stakeholders involved.

Conclusions

A multifaceted issue, the topic of high school starting times has been widely debated on both the local and even the federal level. With this new conclusion, the evidence further suggests that a later school starting time is greatly beneficial to students. Although some research has stated that a later school starting time would be inconvenient for transportation reasons and after-school activities, in the case of the later starting schools, students there have been able to cope with the differences in scheduling. A minor adjustment period for transportation will surely benefit the overarching challenge of getting students and parents

adjusted to a newer method of transport.

For further research, which cannot be collected currently without extensive district permission, it is suggested to conduct the same experiment with only one school. Collecting the sleep qualities of students of an early starting school and then implementing a later school start time to the same school followed by distributing the same survey again would allow researchers to study the effect of a changed school start time on the sleep quality of the same population and sample group. Also, although this research was carried out in the northeastern region of the United States in two schools that were located in residential areas with the presupposition that the results would be the same throughout the country, it would be greatly beneficial to repeat the same procedures in various other areas in America. Completing this research as well would further add to the pre-existing body of knowledge centering on the sleep patterns of high schoolers.

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Appendix A

Survey Questions

- I agree that taking this anonymous survey is voluntary and that the participant (you) has the right to withdraw at any time. (If you are below 18 years of age, you are agreeing that you have parental consent to take this survey.)
 - What is your gender?
 - Are you in an accelerated/honors program?
 - What grade are you in?
 - What time does your school start every morning?
1. When have you usually gone to bed?
 2. How long (in minutes) has it taken you to fall asleep each night?
 3. What time have you usually gotten up in the morning?
 4. A. How many hours of actual sleep did you get at night?
B. How many hours were you in bed?
 5. During the past month, how often have you had trouble sleeping because you..... (choices included, "not during the past month," "less than once a week," "once or twice a week," and "three or more times a week")
 - A. Cannot get to sleep within 30 minutes
 - B. Wake up in the middle of the night or early morning
 - C. Have to get up to use the bathroom
 - D. Cannot breathe comfortably
 - E. Cough or snore loudly
 - F. Feel too cold
 - G. Feel too hot
 - H. Have bad dreams
 - I. Have pain
 - J. Other reason(s), please describe, including how often you have had trouble sleeping because of this reason(s):
 6. During the past month, how often have you taken medicine (prescribed or "over the counter") to help you sleep? (choices included: "very good," "fairly good," "fairly bad," or "very bad")
 7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity? (choices included: "very good," "fairly good," "fairly bad," or "very bad")
 8. During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done? (choices included: "very good," "fairly good," "fairly bad," or "very bad")
 9. During the past month, how would you rate your sleep quality overall?(choices included: "very good," "fairly good," "fairly bad," or "very bad")

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Free Response Questions

- Do you believe your schools start time has an effect on your sleep quality?
- What are your opinions on later school start times (when school starts on or after 8:30 am)?
- Do you believe that a delayed school start time positively affects students? If so, in what ways?

Note: Bullets indicate questions NOT a part of the PSQI

Appendix B

Interview Questions/Responses

Before we begin, I'd like to state that partaking in this survey is voluntary and that the participant (you) has the right to withdraw at any time (If you are below 18 years of age, you are agreeing that you have parental consent to take this survey). If you do not feel comfortable answering any of the questions below, feel free to disregard it. If you do not feel comfortable taking the survey anymore, you are able to stop.

Please answer each question in as detailed a response as possible. Thank you for your cooperation.

Describe your daily routine, from when you get up to when you go to bed. (morning routine, school day, extra curricular activities, sports, jobs, etc)

A: In the morning, I wake up from my alarm at 6:30, brush teeth, put contacts in, wash my face by 6:45, eat breakfast at 7 and leave for school at 7:45. After school I usually tutor until 3:15 and then head home if it's not spring sports season or if I don't have a club or honor society meeting. Recently, I started SAT prep, which ends at 9:30.

B: I wake up around 6 am-- depending on how much homework I need to do in the morning (this can range from 4:30- 7:00 am). On the average day I spend periods 2-4 in school, take a period of lunch during which I either do more homework or patron our local businesses. I return to school for periods 6-9, then either participate in a

club or go to work as a receptionist for a hair salon. After work or extracurriculars, I either go for a run (in warmer weather) or go to the gym (in the bitter cold). After that I either go home or hang out with my loved ones.

C: Wake-up time varies depending on the day, no later than 6:15 a.m. I typically arrive at school around 7:30, except for on Wednesdays and Thursdays when I arrive at 7:00. I have lunch every other day, and aside from that have no free periods. I'm an active member of cultural society and up until this past week had been staying at school almost every day until at least 5:30. I don't play any sports, but other extracurriculars tend to keep me in school until approximately the same time year-round. I get home around 6:00 and do my school work, eat dinner, and sleep, which also varies depending on the day. I typically get between 4-6 hours of sleep.

D: I wake up around 6:00 a.m. and get to school early to hang out with my friends. After school is over, I go to musical rehearsal and stay usually until 6:00 p.m. I fall asleep between 9:00 p.m. and 10:00 p.m.

E: I usually get up at 6:30, then classes after school 4 days a week for 1.5 hours. I go to sleep at about 11:30.

F: I wake up from 6:45AM to 7:30AM and go to school after having breakfast. I return home from 4 to 6. When I get home, I first have a snack and then do homework. I play piano and finish homework. Sometimes, I draw or write. I usually sleep at around 12.

What are your opinions on a later school start time?

A: I think a later school start time is in the best interests of everyone, considering past research. Sleep is extremely necessary and beneficial especially for teenagers but current scheduling makes it difficult and almost discourages proper sleep. I'm not sure how accurate this is, but I've read somewhere that teenagers are naturally more inclined to go to sleep at later times (Those winter track meets).

B: I think it's silly we don't start later.

C: A later school start time would be extremely beneficial to most teens, as the biological clock is at its latest during this time. However, with sports and extracurriculars, I understand why this may be difficult to implement.

D: I think it's a great idea, since it gives us time to sleep in if needed or just hang out with friends in the morning if you don't have clubs or extra help.

E: Right now I think it's not necessary for a later school start time (high school). The current start time in Jericho is reasonable, also prepares us for college or jobs later on.

F: I think that having a later start time has been extremely beneficial for me in terms of getting work done and being able to make it to school on time every day.

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Do you think it is beneficial for you in terms of getting the amount of sleep necessary for teenagers?

- A: Yes, this would allow more teenagers to achieve better quality of sleep by giving them a more optimal schedule for adolescent sleep habits
- B: Yes, it would be highly beneficial if that time was truly used for sleeping.
- C: I think that getting proper amounts of sleep is imperative, as teenagers are still growing. Getting sleep is necessary for proper growth development, and much of the necessary growth happens during adolescence.
- D: A proper sleep schedule is important for teenagers since I believe your body functions better on a solid routine and a good amount of hours spent sleeping is beneficial for one's physical and mental health.
- E: Yes, sleeping is overall more important than staying up late for school, we would get overstressed and essentially mental illness etc.
- F: Yes.

What do you think sleep quality is, in your own words?

- A: I feel that sleep quality is the benefit one gets from the conditions of their sleep.
- B: Sleep quality is a measure of how long you remain at rest, without interruption. If you wake up a lot during the night, are restless, or have a lot of trouble falling or staying asleep, your sleep quality is poor.
- C: Sleep quality not only entails getting the right amount of sleep, but sleeping at proper times and being able to sleep without feeling stressed or anxious beforehand. Having burdens on your mind prior to falling asleep makes the task difficult and could decrease your quality of sleep, causing frequent interruptions to your sleep as well as a difficulty being able to sleep in the first place.
- D: (Not answered)
- E: How one's sleeping status is, in terms of deepness, and if one's resting well or feeling good.
- F: Sleep quality is how well someone sleeps, measured by the level of benefits they receive from their sleep.

Do you believe that the quantity of sleep you get is correlated with the quality of sleep you get? How so?

- A: Yes, but this is probably different for everyone because different people need different levels of sleep. When I sleep too much, like on a vacation, I don't feel as good as if I get an ideal amount of sleep like 9 hours.
- B: Well, the more time you spend trying to sleep, the more sleep you are likely to get and therefore the quality of your sleep will likely be better.
- C: Yes; to an extent, sleep quality and sleep quantity

correlate. As someone who frequently functions on little amounts of sleep, I can easily say that though you may feel rested to an extent, there is a significant lack in one's ability to function properly for extended periods of time without getting adequate amounts of sleep.

- D: (Not answered)
- E: Not really. I think sleeping too long even has a negative impact, but having the right sleeping hour is right.
- F: I think that I sleep best in specific time intervals, such as 30 minutes to 2 hours and 6 or 8 to 10 hours. I think it's just because I am used to sleeping for that interval of time. Somehow, I always feel tired after sleeping 7 hours, though.

Do you believe that a later school start time leads to better sleep quality? Why?

- A: Yes, because it would align better with the schedules of teenagers, which ideally should be the people schools are designed for
- B: Yes, there is more time to sleep and less stressors.
- C: Yes; having a later school start would allow for students to sleep later according to their biological clocks while still getting the rest necessary for them to complete tasks and focus properly. By starting later, teenagers can sleep in a bit more, giving them more of the rest they require.
- D: I cannot speak for myself on this matter, however there isn't much difference between the sleep schedules of my friends in the middle school and those in the high school.
- E: No. It may even cause students to sleep later which doesn't help with anything.
- F: I think that since most teens sleep later at night regardless of school start times, having a later start time will help them receive more sleep and therefore better sleep quality.

How do you feel when you wake up for a normal school day?

- A: Pretty good every day, it might take some time to get out of bed but not too often
- B: Terrible. Anxious. Bitter. Sleep deprived.
- C: It is an extremely difficult task to make me wake up in the morning before school. I have many, many alarms set to wake myself up early, which often makes me more tired due to frequent interruptions to my sleep. I don't enjoy the process of waking up, and it is easily one of my least favorite things to do, though I actually work better in the early morning than at night.
- D: Mostly energized and prepared to seize the day ahead.
- E: Depends on when I slept and woke up, if later I would

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feel okay but still tired. Sometimes it's even hard for me to get up at 6:30.

F: I feel tired.

Does the weekend bring any changes in your sleep quality?

A: Yes, I tend to feel more well rested on weekends.

B: The only day I get to sleep in is Saturday and it is a blessing. I usually stay up late Friday night and sleep like a baby through Saturday morning.

C: Absolutely; On Saturdays, I sleep in as long as possible and feel more well-rested than any other day of the week. On Sundays I wake up at 7 to go to church, but even then I feel more refreshed than I do waking up to go to school.

D: I have more freedom on the weekends to hang out with friends, so I usually end up going to bed slightly later, but not by much.

E: No. I sleep pretty late on weekends also due to homework and other activities. But I have the mindset that since it's weekend so it's fine, that's also why I sleep late on weekends.

F: I sleep longer and deeper. I usually have dreams during the weekends.

Do you wake up naturally on the weekends as opposed to on school days?

A: Only on Sundays, and I tend to wake up around 9 or 10

B: Yes, I wake up naturally and feel less groggy. I don't feel jolted awake.

C: I still need an alarm to wake up on Sunday mornings, but only one or two as opposed to fifteen for school days. On Saturdays I almost never use an alarm, waking up only when my body feels I've gotten an adequate amount of rest.

D: I wake up naturally every day.

E: On Saturdays no, but on Sundays yes. I would wake up pretty late because I sleep late.

F: I always use an alarm clock. On weekends, I sometimes can turn it off in the morning (if I don't have anywhere to go) and I go back to sleep. If that happens, I usually wake up at around 9:30.

Does the presence of an alarm clock affect your perception of your sleep quality?

A: Yes, I always feel better when waking up without one

B: Knowing an alarm will eventually blare in my ear makes me dread the morning. So, yes but not too much.

C: To an extent, it does. If I require many alarms to wake up, I wake up feeling more exhausted than I would waking up to a single alarm. Of course, the presence of multiple

alarms only exists because of inadequate amounts of sleep, which is also a symbol of decreased sleep quality in my opinion.

D: I don't use an alarm clock.

E: Not really, I don't usually use alarm clock but sometimes it's more effective for me.

F: I'm not sure at this point because I always use an alarm clock. I think that if I don't use one though, I'll end up sleeping for an extremely long time, like 10-12 hours.

(FOR STUDENT IN A LATER STARTING SCHOOL) Do you believe that attending a school in which you have a later start time is beneficial to you, specifically your sleep quality? How about your peers?

D: The difference is so clear with my peers, however I prefer the later start time and gives me more time to sleep in the morning.

E: In some extensions yes, I think then we can have a longer sleeping schedule without worrying about getting up late. But usually sleeping quality depends on your stress level.

F: Yes and yes.

(FOR STUDENT IN A NORMAL STARTING SCHOOL)

Would implementing a later school start time at your school benefit you, specifically your sleep quality? How so? How would it benefit your peers?

A: Yes it would, because it'd be more aligned to my schedule and allow me to get 8-9 hours of sleep more consistently and thus improve my quality of life consequently. My peers would also receive similar benefits considering many of us have very busy schedules and a significant amount of work to complete daily.

B: Yes, I would have more time to sleep, to prepare for the day, and more time to socialize and do things I want to do without having to sacrifice so much of my sleep time! The same goes for my peers. For the ones who work more than 20 hours a week I am sure the extra sleep is not only beneficial but crucial to their ability to function on a day to day basis.

C: Of course, it would benefit myself and my peers. If I could wake up later, naturally, as opposed to using multiple alarms to force myself awake, my levels of focus would be much higher than they are now, and I'm sure my grades would be better as well. A large problem I find common amongst myself and my peers is distraction during classes due to a lack of sleep. I have friends who sleep no earlier than 3 in the morning naturally, nearly every night.

Are there any reasons why you, or anyone, should be

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opposed to a later starting school time?

- A: These times are what people are used to, they might align better with the job schedules of parents and their kids at other schools, and pushing back school start times would push back extracurricular times
- B: Some may argue that teenagers will only procrastinate more and ultimately not use the extra time for sleep.
- C: Personally, a later start time wouldn't harm me very much, aside from during tech week before a show, but to students who are active in sports such as track, who sometimes arrive home around midnight, a later start time would do more harm than good.
- D: Some people might argue that they may have more time to sleep in the morning, but less time at night to complete homework assignments and end up going to bed late either way.
- E: Yes, I think if then it's going to be really hard for me to adjust my sleeping schedule later on for jobs or college.
- F: I think the most popular reason is that we get home later in the day, but I still don't think it has a big impact on our life. If we have sports, we get home later anyway. In addition, teenagers tend to procrastinate and communicate a lot through social media at night so they usually don't sleep early anyway.

In a normal school day, do you ever feel tired enough that it affects your social life? How?

- A: Yes, but not often. Sometimes, I lose focus for a few minutes or just feel sluggish and unmotivated.
- B: YES. I am more irritable and have less desire to interact with my peers and teachers.
- C: During my lunch period, which only falls every other day and is sometimes the most socialization time I will have during a day of classes, you can often find me asleep at one of the tables rather than chatting with my friends. After long tech weeks, I sometimes fall asleep rather early from sheer exhaustion, meaning my friends who try to communicate with me over social media won't receive a response until early hours of the morning when they've been long asleep.
- D: No.
- E: Yes. There's one time I was really exhausted that I didn't want to talk to anyone, but one of my friends kept talking and I think I was being cold or a little mean, which I didn't mean to.
- F: Sometimes I don't feel like talking or joking around with my friends because I am tired.

Have you ever fallen asleep in class?

- A: Yes, 2 years ago

B: This year not so much, last year at least twice a day.

C: Frequently, yes. I take my academics very seriously, and I'm in the top 5 of my grade, but I get such little amounts of sleep at night that I find myself dozing off during classes, which is counterproductive as I have to then catch up at night when I get home, thus causing a cycle of sleeplessness.

D: Never.

E: Yes, I slept at 3 one time and woke up at 6:30. I was super tired to open my eyes and fell asleep for only a few minutes.

F: No, but I have come close to :) I've been called out by a teacher for "having a good nap"

Do you feel tired throughout the school day?

A: Yes, typically around 12 p.m.

B: This year not so much, last year at least twice a day.

C: On occasion; certain classes are less dynamic than others, and as a result it's much easier to feel tired during those, but I usually only feel physically tired after extracurriculars.

D: On very rare occasions.

E: Yes, even among peers I would say most people are tired all days.

F: Yes, but only during specific classes that I don't have to pay a lot of attention in or aren't very interesting to me.

Do you think that your grades in your first period class suffer as a result of any tiredness you may have due to lack of sleep? Do you believe that any tiredness you have, if you have any, affects your whole school day?

A: I don't believe my grades in any class suffered but they could likely improve if I was getting good sleep consistently. I do believe tiredness interferes with my ability to focus, but not often.

B: My first class of the day is second period and that has been a blessing. That period I usually do not feel tired, the weariness comes out during the day.

C: Actually, my first period class is usually quite energetic, so although I feel tired on occasion, I typically make it through that class just fine. Other classes don't always fare the same - last year, I frequently slept during my sixth period class, and this year the same is true of fourth.

D: Not necessarily, no.

E: For my first period I think doesn't bother much, but around 10 to 12 I'm really tired to listen and eventually miss a lot of stuff.

F: Not really because my first period class is important to

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me, and I always have to pay a lot of attention to what is going on. Yes.

The circadian rhythm is essentially a regulating internal body clock. Partaking in certain activities, such as using electronics late, staying up late, etc, are said to affect one's circadian rhythm. Do you partake in any of the activities?

- A: Yes, I often use my computer when I have to do homework late, but whenever I finish work early I turn everything off by 10. When I have more work to do, I often stay up until around 12:30.
- B: I stay up late and use electronics all the way up until I am literally sleeping.
- C: Much of my schoolwork is centered around electronics, so of course I'm typically on a computer until my work is done. My breaks are usually during meal times, but even then I'm directly in front of my computer. I don't have a habit of using my phone while trying to get to bed like some others do, but I tend to be active on my computer until I shower before bed.
- D: No.
- E: Yes, especially on school days, due to works or procrastination I would stay up really late sometimes.
- F: I use my phone and laptop right before I go to bed. I have stayed up until 3 working, reading, or watching shows.

Do you know that these activities may negatively affect your sleep quality?

A: Yes, but I understand it's mostly just a result of bad time management

B: I did, but didn't give too much thought to it.

C: I've heard just as much, yes, but I really don't have much of a choice in this day and age, where everything we do is completely based on electronics. I'm always either working or helping others with their work via social media, which means I can't sacrifice the use of electronics for better sleep quality.

D: Absolutely, which is why I avoid them as best as I can.

E: Yes, even though it's aware that it can negatively affect sleep quality, but most of the times you really can't avoid that.

F: Yes. I rarely have time to do those things at other points throughout my week, though.

Are there any comments that you would like to make about school start times and the sleep quality of your peers?

A: I feel that in the long run a delay in at least 30 minutes would be more than worth initial issues because a high school should have conditions that are ideal for students.

B: SLEEP IS CRUCIAL. GIVE US THE MOST VALUABLE RESOURCE AND WATCH HOW OUR MOODS, MOTIVATION, AND GRADES BETTER!!

C: If I'm being honest, school is already early enough. Even if we can't make start

times later, I think it's about time we cut out the ridiculous zero-hour extracurriculars and meetings. Being at school for twelve hour increments is complete and utter madness, if I must be in school until 7:00 p.m., then the least a school could do for me is guarantee that I need not be in school until 7:50 a.m., not 7:00 a.m.

D: (Not answered)

Table 1

<i>Total PSQI - 8:59 A.M.</i>		<i>Total PSQI - 7:50 A.M.</i>	
Mean	9.5	Mean	12
Standard Error	0.4	Standard Error	0.49
Median	9	Median	11
Mode	8	Mode	10
Standard Deviation	4.45	Standard Deviation	5.21
Minimum	1	Minimum	0
Maximum	24	Maximum	23
Count	121	Count	114

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E: I am really satisfied in Jericho High School start time, but still most of the students have bad sleep quality, and I think you can't change it just through changing the school start time.

F: My school starts at 9AM and ends at 3:30PM, and I think that it is an excellent system. I would tell my peers to try to keep their sleep patterns similar, even if they have to just wake up early to finish work. I'd rather sleep get home later, sleep at 12AM, and wake up at 6:45AM to finish things instead of getting home earlier, potentially sleeping at 11:30 (I'd probably still sleep at 12 :-;) and wake up at 6 to get to school.

Note: Responses A, B, and C, are from students who attended the 7:50 A.M. starting school while responses from D, E, and F, are from the 8:59 A.M. starting school. The responses have not been edited.

Appendix C

Tables 1-3

Table 2

F-Test Two-Sample for Variances		
	<i>PSQI - 7:50 A.M.</i>	<i>PSQI - 8:59 A.M.</i>
Mean	12	9.5
Variance	27.19	19.79
Observations	114	121
df	113	120
F	1.37	
P(F<=f) one-tail	0.04	
F Critical one-tail	1.36	

Table 3

t-Test: Two-Sample Assuming Unequal Variances		
	<i>PSQI - 7:50 A.M.</i>	<i>PSQI - 8:59 A.M.</i>
Mean	12	9.5
Variance	27.19	19.79
Observations	114	121
Hypothesized Mean Difference	0	
df	223	
t Stat	3.95	
P(T<=t) one-tail	5.25E-05	
t Critical one-tail	1.65	
P(T<=t) two-tail	0.000105024	
t Critical two-tail	1.97	

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