The Correlation Between Later School Start Times and High School Athletes' Athletic Performances

Karyn Opara[1] and Mark Ahn[1#]

[1]Hoffman Estates High School
[#]Advisor

ABSTRACT

Research on the positive and negative effects that school start times can have on a high school student athlete's athletic performance depending on how early or late they start school faces a significant gap in research. Research has shown that early school start times are a major cause of sleep deprivation in student athletes as well as how it can cause a decline in one's athletic performance. This study aims to determine the correlation between later school start times and student athletes' athletic performances. Based on many literature reviews, correlational research was chosen to be able to determine the relationship between the two variables, school start times and high school student athletes' athletic performances. The latter is determined based on a school's winning percentage for one of the seven varsity sports. Analysis of the relationship between the two variables demonstrated that for 6 out of the 7 sports, there was a positive correlation between later school start times and greater athletic performances in high school student-athletes. The results indicate that later school start times have a positive effect on high school-student athletes in the case of their athletic performances. In view of this, it is suggested that schools look to push back school start times in order to give all student athletes, regardless of what school or school district they come from, an equal playing field when competing. Further research is needed to determine whether this correlation between the two variables is still apparent when analyzing non-clear-cut win sports.

Literature Review

Before considering the purpose of why this paper proposes the positive correlation between later school start times and high school student athletes' athletic performances, it is vital to acknowledge the existing research on the subject matter. Presently, there are a few studies that address how early school start times cause sleep deprivation in students and then others that address how sleep deprivation affects athletic performance.

One study conducted by Dexter, et al. (2003) found that students at the early start school reported less sleep and more sleepiness than their counterparts at the later starting school when they compared sophomore and junior students in 2 nearby high schools with differing start times. These two high schools had similar ethnic and racial backgrounds, were in the same community, and the start time between them varied by 45 minutes (p. 44-45). The results of this study confirm that early school start times are linked to students' claims of less sleep and an increase in sleepiness. Looking more closely at how early school start times can cause sleep deprivation in students, results have shown that even just a 45-minute later start can set the difference between students being in the pathologically sleepy range, which was seen in the early start school, or being in the normal range, which was seen in the late start school. The consequences of sleep deprivation in high school students are numerous and some may be seen in athletic performance.

A study conducted by Mah, et al. (2011) found that when comparing 7 weeks of at least 10 hours of sleep every night to a 4-week baseline period of habitual sleep "basketball performance measures were enhanced, sprint times were faster (15.5 ± 0.54 seconds versus 16.2 ± 0.61), and shooting accuracy improved by 9% coupled with decreased reaction times" (p. 946). In athletes who habitually endure sleep deprivation or who have a significant sleep

debt, the use of an extended sleeping time was studied. The results of this study help to prove that instead of having sleep regulated by training and academic scheduling, it was successful to change the subjects' academic and training timetables around an extended sleeping interval. Although this study was on collegiate athletes and did not have a control group, it confirms that an extended sleep schedule is effective in enhancing athletic performance.

In addition, an extended sleeping schedule, such as those recorded in the aforementioned study, could be beneficial to improvements in measures of athletic performance and mood. Another study conducted by Mah, et al. (2008) about extended sleep and its effects on mood and athletic performance in collegiate swimmers found that improvements included faster 15-meter sprints, faster reaction times, improved turn times, and increased kick strokes. More results from the same study found that their moods also improved with decreased Profile of Mood States (POMS) fatigue scores and their vigor ratings improved (p. A128). According to the American Psychological Association (2023), POMS is a questionnaire where one self-reports fluctuating mood states over time on a 5-point scale ranging from not at all to extreme. Two of these mood states include vigor or activity and anger or hostility. This indicates that these collegiate swimmers, after extending their sleep time for Mah's study, self-reported that they were less fatigued and more vigorous. Since the mood states were self-reported and not observed, there may be some bias because certain athletes may have rated themselves higher to be seen in a more positive light. Although once again this study was performed on collegiate athletes, the aforementioned studies help to conclude that the implementation of extended sleep schedules reveals significant improvements in measures of athletic performance and mood.

A gap in research arises from the fact that no studies have been conducted to see how later school start times correlate to an improvement in athletic performance in high school student-athletes. A study conducted by Hamlin, et al. (2021) looked into the effect of sleep quality and quantity on athletes' health and perceived training quality. This study proved that "there is a strong positive association between sleep and athletic performance including sports-specific skill execution, strength, and anaerobic power" (p. 3). Also, they found that on days when both male and female athletes slept for eight hours or more subjective markers of mood state, sleep quality, and energy levels showed small to moderate improvements. In female athletes, training quality showed a small improvement with longer sleep while all other changes were trivial in both male and female athletes. This data shows that lower stress levels or an improved mood, improved sleep quality, energy levels, and increased perceived training quality were associated with eight or more hours of sleep as well as better sleep quality. There was also a connection found between sleep duration and sleep quality and injuries and illnesses, when athletes slept for eight or more hours they were less likely to suffer from injuries or illnesses (Hamlin, et al, 2021, p. 4-6). This study however only focused on the perceived training quality, decreased illnesses, and decreased injuries, in athletes which are only a portion of the aspects of athletic performance. In addition, this study focused on young elite athletes at the collegiate level and not high school athletes. This study never mentioned school start times but there are other studies, as previously mentioned, that have talked about academic and training timetables and showed how it was successful to change the subjects' academic and train-ing timetables around an extended sleeping interval. Therefore, a gap in research arises where many studies have shown how sleep deprivation can affect athletic performances, but none of these studies have looked into school start times at high schools and how they can positively or negatively affect a high school student's athletic performance.

From the basis of all of these studies, the research question arises: what is the correlation between later school start times and high school student athletes' athletic performances? It is vital to put forth a hypothesis to investigate this issue with the least amount of bias possible: high school student-athletes with later school start times will show greater athletic performances compared to their counterparts at schools with earlier start times.

Methods

This research inquiry analyzed the correlation between school start times and high school student athletes' athletic performances. To test the hypothesis that high school student-athletes with later school start times will show greater athletic performances compared to their counterparts at schools with earlier start times, the methodology that was

chosen was correlational research. The correlational research method is defined as "a type of study in which relationships between variables are simply observed without any control over the setting in which those relationships occur or any manipulation by the researcher" (APA, 2023). This is a qualitative and non-experimental research method.

Many other methods were considered, the two main ones being causal-comparative and trend analysis. If the causal-comparative method was chosen, it would need to be proven that the school start time was the sole cause of an athlete's athletic performance. This would be difficult to accomplish because many other factors go into an athlete's performance such as nutrition, fitness, training, etc. However, with correlation research, the only thing that has to be proven is the correlation between earlier and later start times and better or worse high school student athletes' athletic performances. In correlational research, it does not mean that a change in one variable is what caused the values of the other variable to change. Trend analysis, while it is a great method, could not be used because it requires a trend to be determined and then to predict the future of the trend. A trend in my data was not guaranteed because there was a chance that there could be no correlation and then it would have been difficult to attempt to predict the future of the data.

The first step in carrying out the research was to determine how "athletic performances" would be examined. It was determined that it would be examined through the winning percentage of each of the individual sports that were examined. The winning percentage is the number of games a varsity team has won out of the number of games a team has won and lost in a season. The correlation between the school start times and high school student athletes' athletic performances was calculated with a scatter plot where a line of best fit near one meant a high positive correlation, one near 0.5 meant a low positive correlation, one near zero meant no correlation, one near -0.5 meant a low negative correlation, and one near -1 meant a high negative correlation. Out of all the sports that were used to collect data, the average was found by adding up all of the correlation coefficients and dividing them by the number of sports that were examined. By using multiple sports to test the correlation instead of just one sport, it proves that the correlation or lack of correlation is stronger and was not just coincidental with one singular sport.

This would then lead to the next step in research which was to determine how the data would be collected. It was determined that the area that the data would be collected from are schools in the northwestern suburbs of Chicago, Illinois. For this to be done, there would need to be a clear cut-off time between what was considered an early school start time and what was considered a late start time. According to the CDC, middle and high schools should open around 8:30 a.m. or later, according to the American Academy of Pediatrics, to allow students to receive the necessary amount of sleep (CDC, 2020). With this being said, there were not many schools in the area that started after 8:30, so to get enough data the time of 8:00 A.M. was chosen. To collect the data, twenty-six schools in total were gathered, 12 that started before 8:00 A.M. and 12 that started after 8:00 A.M. To determine the start times most of them were easy to locate and were on the school's website. The next variable was high school student athletes' athletic performances, which as previously stated would be determined by the winning percentages of each sport that was examined. To determine the winning percentage of each sport examined, a secondary source, MaxPreps was used. MaxPreps is a source for high school sports where rankings, stat leaderboards, schedules scores, etc, of any high school team in America, can be found (MaxPreps, 2005). Using a secondary source rather than collecting a primary source was the best option for this case because to gather the information needed for a primary source, contacting the coaches for the sports examined at all 26 schools would've needed to be done. This is not optimal because the response of these coaches is not guaranteed, while all of the data needed is readily available on MaxPreps. There is no subscription necessary to get the information that is required and it is freely accessible to anyone who wants it.

After determining how "athletic performances" would be examined and how the data would be collected, the final step was to determine how the data would be organized as well as how the sports used in the data would be chosen. As previously mentioned, a scatter plot would be used to calculate the correlation between the two variables. On the x-axis of the scatter plot would be a range of the times of the schools chosen from earliest to latest. On the y-axis, there would be a range of 0% to 100% in decimal increments and would represent the winning percentages. The titles of each scatter plot would clarify the sport that is being examined for that scatter plot. The sports chosen were clear-cut win-or-lose sports, meaning that a school team either won or lost and there were no other placements such

as second or third place. Each sport used would have its scatter plot and the genders would be separated. For example, sports such as girls' volleyball and boys' volleyball would have separate scatter plots. Seven scatter plots were used to find a correlation and then the line of best fit of all was taken and an average was found. The sports chosen were girls' volleyball, boys' volleyball, girls' basketball, boys' basketball, football, softball, and baseball. The data for all sports was taken from the latest school season's varsity team. Football was not separated by gender because it is a unisex sport where males and females can be on the same sports team. Softball and baseball are also not separated by gender; however, softball is predominantly played by females and baseball is predominantly played by males.
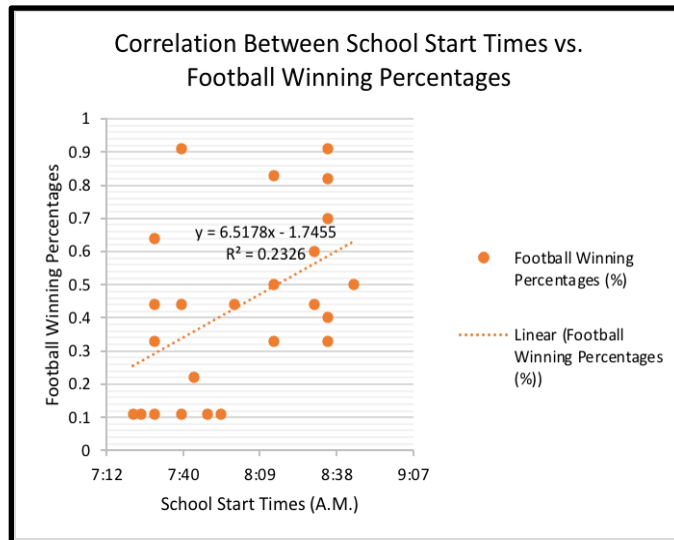
Results

Figure 1. The correlation between school start times and football winning percentages.
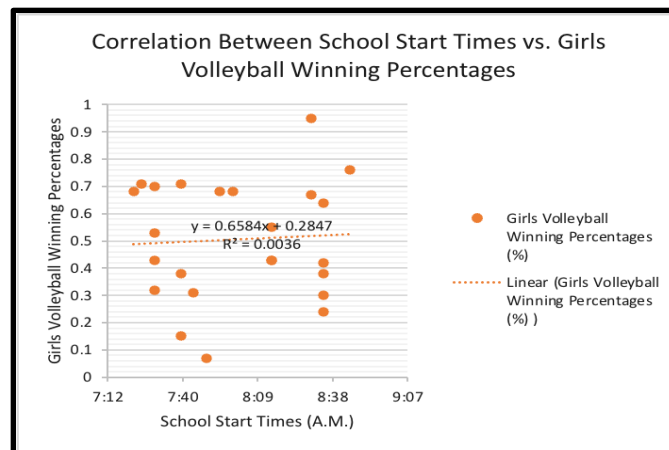

Figure 2. The correlation between school start times and girls volleyball winning percentages.
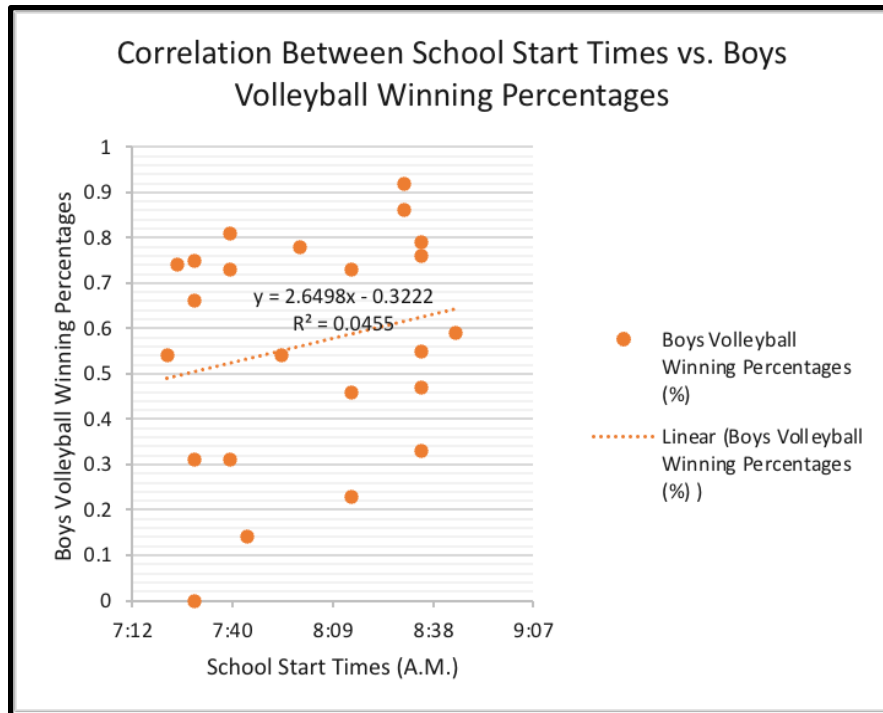
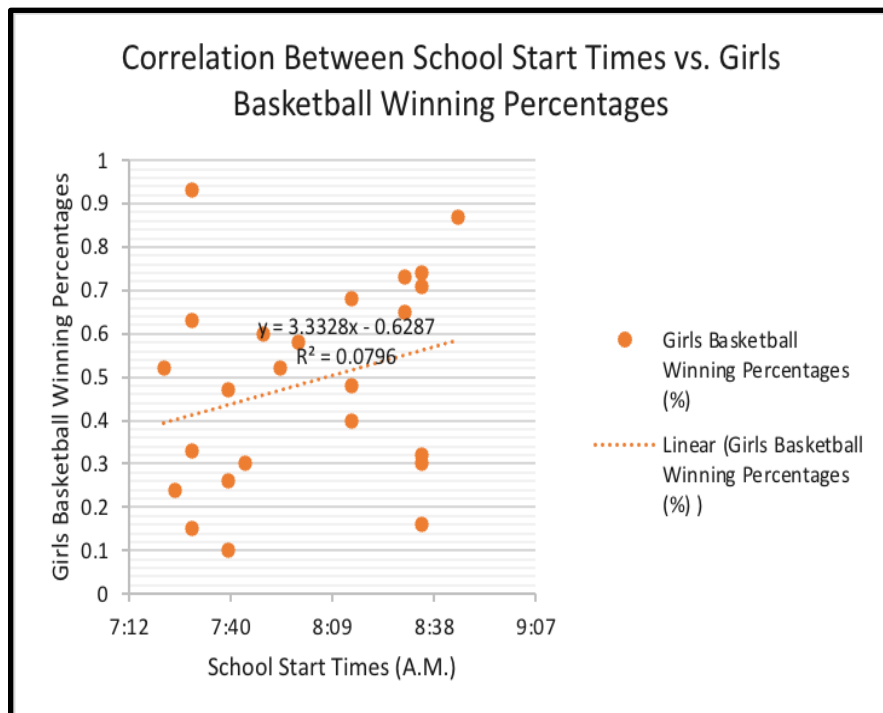**Figure 3.** The correlation between school start times and boys volleyball winning percentages.

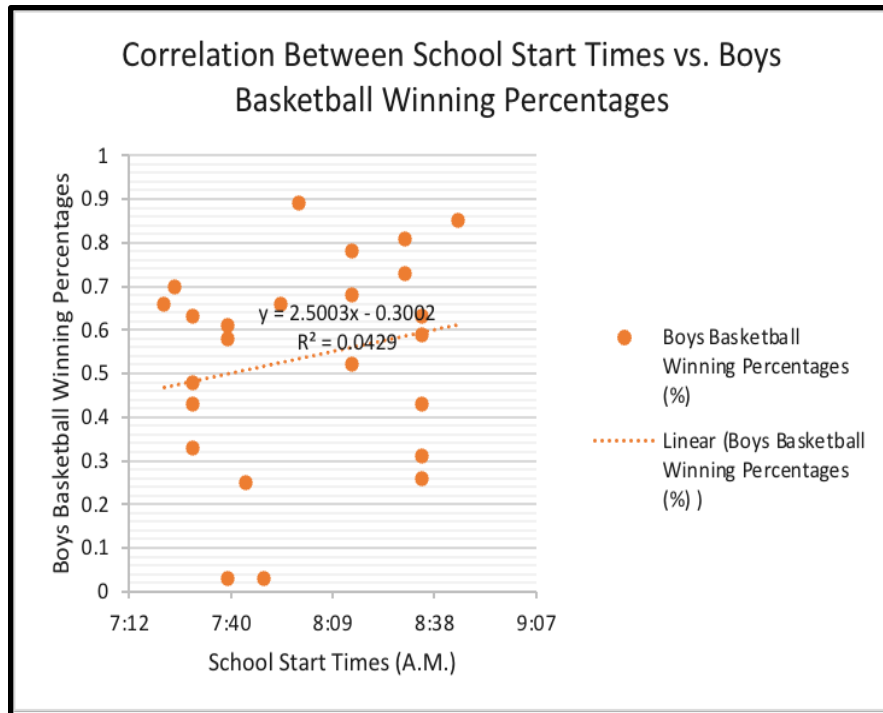**Figure 4.** The correlation between school start times and girls basketball winning percentages.

Figure 5. The correlation between school start times and boys basketball winning percentages.
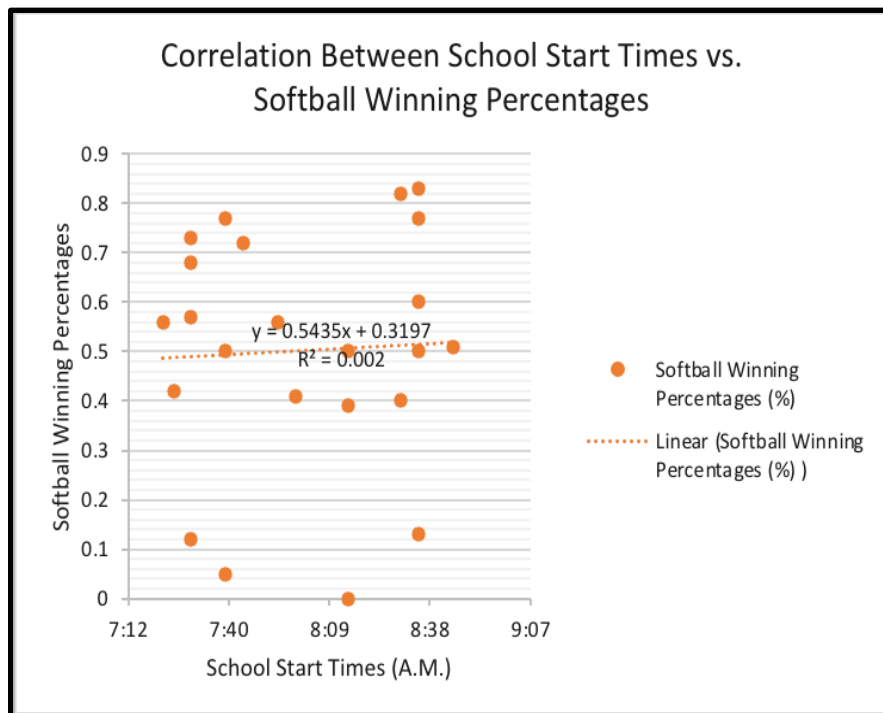

Figure 6. The correlation between school start times and softball winning percentages.
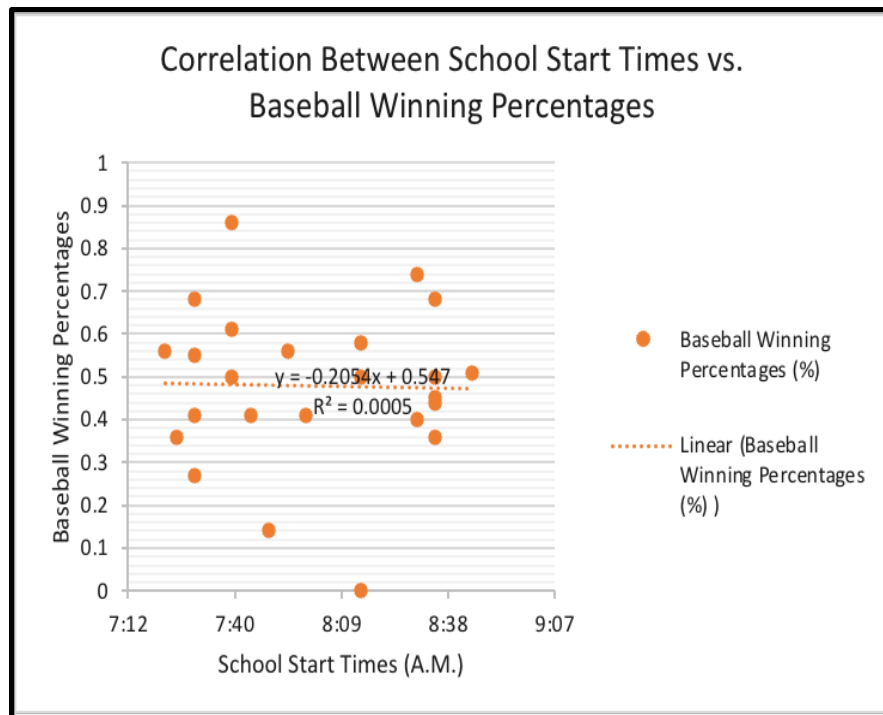
Figure 7. The correlation between school start times and baseball winning percentages.

The previous seven graphs are used to determine the correlation between school start times and student athletes' athletic performances using winning percentages in seven categories (football, girls' volleyball, boys' volleyball, girls' basketball, boys' basketball, softball, and baseball). Linear trendlines have been added to show if the correlation is positive or negative. Out of all 24 schools, the school start times ranged from 7:30 to 8:35 on the x-axis. On the y-axis, the winning percentages out of all sports ranged from 0% to 95%. All of the percentages presented on the graph are in decimal form. Football, girls' volleyball, boys' volleyball, girls' basketball, boys' basketball, and softball have a positive correlation to school start times and winning percentages. This means that as the school start times progress, the winning percentages increase. On the other hand, baseball has a negative correlation with school start times and winning percentages. For baseball, as the school start times progressed, the winning percentages decreased. The correlation coefficient, also known as the Pearson product-moment correlation, is represented with the r value and it shows "the linear dependence of two variables or sets of data" (Oxford Languages, 2023). The R^2 value, as shown in the graph, is the coefficient of determination and is the square of the Pearson product-moment correlation. The closer the r value is to 1 the stronger the correlation is and the closer it is to -1 the weaker the correlation is. Overall, the correlation between later school start times and winning percentages had the strongest correlation in football while baseball had the weakest correlation. As previously stated, the hypothesis was that high school student-athletes with later school start times will show greater athletic performances compared to their counterparts at schools with earlier start times. According to the data gathered from the scatter plots, six out of seven sports suggest that the hypothesis is accurate.

Discussion

The results indicate that with six out of seven sports, there is a positive correlation between later school start times and student athletes' athletic performances. One out of seven sports indicates that there is a negative correlation between school start times and student athletes' athletic performances.

Looking at Figure 1, the scatter plot shows that as school start times progress later into the day, there is a positive relationship with winning percentages in football games. Football had the strongest correlation between progressing school start times and winning percentages when compared to the six other sports. BMJ (2020) found that to determine the strength of the two variables' correlations for absolute values of r, 0-0.19 is very weak, 0.20-0.39 to be weak, 0.40-0.59 to be moderate, 0.6-0.79 to be strong, and 0.8-1 to be a very strong correlation. In Figure 1, the correlation coefficient was 0.48 which is considered to be a moderately positive correlation between the two variables. A potential reason for football having the strongest correlation compared to the other sports is that their games tend to be very late into the evening compared to other sports. This could mean that the fatigue kicks in more compared to other sports that have their competitions earlier in the day. The adrenaline from late-night games may also affect athletes' sleep quantity and quality. Therefore, later start times could positively impact their game performance more compared to other sports because they would have more time to recover from their late-night games.

In Figures 2 and 3, the scatter plots reveal that there is a positive relationship between school start times progressing and winning percentages for girls and boys volleyball. For girls' volleyball, there was a correlation coefficient of 0.06 which indicates that there is a very weak positive correlation between the two variables. For boys' volleyball, there was a correlation coefficient of 0.21 which means that there is a weak positive correlation between the two variables. Although both boys' and girls' volleyball has either very weak or weak correlations, they are both still positive linear relationships. Other factors may affect athletic performance in students such as nutrition, sleep quality rather than quantity, and quality of training. Poor nutrition can affect an athlete's performance because they are not getting the proper fuel to be able to keep up with their training, therefore, their performance could decline. Sleep quality is important because although someone can sleep for a long time if it is interrupted by them continuously waking up and going back to sleep then the quality of that sleep most likely is not optimal. Quality sleep can help an athlete's body rest and be able to repair itself for the next day. In addition, having high-quality training is important to an athlete's performance because it pushes athletes to their full potential.

In Figures 4 and 5, it is evident that there is a positive correlation between school start times and winning percentages in both girls' and boys' basketball. For girls' basketball, there was a correlation coefficient of 0.28. For boys' basketball, there was a correlation coefficient of 0.21. These are both weak positive correlations, however, there is still a correlation between the two variables. As previously stated, many other factors can affect student athletes' athletic performances aside from school start times. Basketball games also tend to be later in the evening, similar to football games. However, their season is later into the school year, occurring in the winter season while football is in the fall season. Therefore, these athletes' sleep could also be more affected by adrenaline, a stress hormone that could keep athletes awake. In addition to the adrenaline, since these two sports are in the winter, it is likely that these athletes already have a built-up loss of sleep regardless of start times, explaining the weaker correlation when compared to football.

Lastly, in Figure 6, there is a positive correlation between school start times and softball winning percentages. For softball, there was a correlation coefficient of 0.01 which indicates that there is a very weak positive correlation between the two variables. On the other hand, Figure 7 shows that there is a negative correlation between school start times and baseball winning percentages. Baseball was the only sport to have a negative correlation between the two variables. Baseball had a correlation coefficient of -0.02, indicating a very weak negative correlation between the two variables. Baseball and softball, two similar sports, had the two lowest correlation coefficients, indicating that the strength between the two variables was weakest with these two sports. Baseball and softball are both physically demanding sports, and with their games on the earlier side of the day compared to the five other sports, this gives them more time to sleep regardless of school start times. Also, the quality of sleep is higher because of vigorous exercise.

From the data collected in this study, it can be concluded that as school start times progress into the day, there is a positive correlation between that and student athletes' athletic performances. Winning percentages were used as a way to measure the athletic performances of student-athletes. It is necessary to note that correlation does not equal causation and that more studies would need to be conducted to strengthen and solidify these results and findings.

Conclusion

Many studies and analyses have been conducted about early school start times and their connection to sleep deprivation in students as well as a decline in academic achievement. A multitude of these studies has found strong correlations between school start times and sleep deprivation. This study sets out to investigate a gap in research which was that no studies have been conducted to see how later school start times correlate to an improvement in athletic performance in high school student-athletes. It was hypothesized that high school student-athletes with later school start times will show greater athletic performances compared to their counterparts at schools with earlier start times. Upon the completion of the research process, it can be suggested that as school start times progress, winning percentages increase. Therefore, there is a positive correlation between school start times and student athletes' athletic performances. These findings can bring about a step forward to pushing school start times back and leaving school days starting before 8:00 A.M. in the past. It is necessary to push back school start times which will in turn improve student athletic performance because overall it promotes a healthier lifestyle. Pushing back school start times will allow students to obtain more sleep and an improvement in athletes' athletic performances will likely boost the self-esteem of high school student-athletes and allow them to be more confident in themselves when playing their sport which will likely transfer to their lives outside of school and sports.

Future researchers can look to conduct similar studies as there is still a limited amount of studies on the correlation between school start times and student athletes' athletic performances for sports that are not clear-cut win sports. Sports that were categorized as clear-cut winning sports, were those that either lost together or won together as a team. This means that there is no placement such as first, second, or third place, and there are no individual aspects. Sports that would not be identified as clear-cut winning sports are gymnastics, wrestling, cross country, track and field, cheer, etc. Doing this would allow for more data on the correlation of these two variables, with sports that have more of an individual aspect compared to the seven examined in this study. This would strengthen the results because of a bigger sample size.

Another place for future research could be an investigation into whether later school start times cause better student athletic performance, or vice versa, that earlier school start times cause worse student athletic performance. Although the results for six out of the seven sports show that there is a correlation between later school start times and better student-athlete athletic performance, it has been established that correlation does not equal causation. The use of causal-comparative research as a methodology could help determine if there is a cause-and-effect relationship between two variables. Finding out if early school start times cause worse athletic performance, or if later school start times cause better athletic performance in students would help strengthen the argument that school start times should be pushed back and further suggest that the proposed hypothesis is correct.

Limitations

After addressing the conclusions and future directions of this study, it is important to mention the limitations of this study. First, for the correlation coefficients of boys' volleyball and softball, one of the schools that were used for the winning percentages on Maxpreps had no data available for these two sports. This shifted the correlation coefficients when compared to the other five sports because their scatter plots consisted of 24 schools, while for boys' volleyball and softball, it consisted of 23 schools.

Another limitation is that the schools used in the study were strictly from the northwestern suburbs of Chicago. In some other states, such as California, some laws state that schools cannot start earlier than a certain time. Therefore, in other areas, the range of school start times may not have as much of an effect on student athletes' athletic performances because the range may not be as wide when compared to states that have fewer regulations on school start times.

A third limitation that should be considered is selection bias. Since the schools that were chosen were not randomly selected, it is possible that there was an implicit bias when choosing schools. For example, choosing higher income schools that start later and also perform better in athletics possibly due to having a higher rate of athletes with outside experience. Or on the other hand, choosing lower-income schools that start earlier and perform not as adequately due to athletes having less experience in their chosen sport. This could make the correlation between the two variables stronger, compared to if the schools were randomly selected.

A final limitation is the fact that MaxPreps, which was used to gather the winning percentages of each sport, is a secondary source. It was necessary to use a secondary source because otherwise, 7 varsity coaches from each of the 24 schools would need to be contacted, a total of 168 coaches. Emailing 168 coaches is time-consuming and there was also a time constraint on when they would need to respond. A response from all 168 coaches was not guaranteed, while the information on MaxPreps was readily accessible. The use of MaxPreps as a secondary source is a limitation because the scores are not reported by the coaches, therefore there is a possibility that the scores may be inaccurate which could shift the data.

This study provides new insight into the relationship between school start times and student athletes' athletic performance. Student-athletes perform better when they start school later. If student-athletes are competitively playing other student-athletes from schools that have later school start times than them, then they are at a disadvantage. Moving forward, to give student-athletes equal playing fields, it is necessary to push back school start times. Understandably, this may not be practical in some areas due to a necessary shift in timetables of school buses, after-school activities, parents' work schedules, etc. However, eventually with this shift, if it is widespread, people and businesses will start to adjust, and it may become the new normal.

Acknowledgements

References

APA Dictionary of Psychology. (n.d.). In *APA*. https://dictionary.apa.org/profile-of-mood-states

APA Dictionary of Psychology. (n.d.). In *APA*. https://dictionary.apa.org/correlational-research

CDC. (2020). *Schools start too early*. Centers for Disease Control and Prevention. https://www.cdc.gov/sleep/features/schools-start-too-early.html#:~:text=One%20of%20the%20reasons%20adolescents

Dexter, D., Bijwadia, J., Schilling, D., & Applebaugh, G. (2003). Sleep, sleepiness and school start times: A preliminary study. *Wisconsin Medical Journal*, 102(1). https://projectneuron.org/sites/default/files/U3_L8_Supplement_DexterEtal2003.pdf

Hamlin, M. J., Deuchrass, R. W., Choukri, M. A., Marshall, H. C., Lizamore, C., Leong, C., & Elliot, C. A. (2021). The effect of sleep quality and quantity on athlete's health and perceived training quality. *Frontiers*, 3. https://doi.org/10.3389/fspor.2021.705650

Mah, C. D., Mah, K. E., & Dement, W. C. (2008). Extended sleep and the effects on mood and athletic performance in collegiate swimmers. *SLEEP*, 31. http://www.oliverfinlay.com/assets/pdf/mah%20et%20al%20(2008)%20extended%20sleep%.20&%20the%20effects%20on%20mood%20&%20athletic%20performance%20in%20collegi   ate%20swimmers%20(abstract).pdf

Mah, C. D., Mah, K. E., Dement, W. C., & Kezirian, E. J. (2011). The effects of sleep extension on the athletic performances of collegiate basketball players. *SLEEP*, 34(7), 943-950. https://doi.org/10.5665/SLEEP.1132

Marshall, G. J., & Turner, A. N. (2016). The importance of sleep for athletic performance. *Strength and Conditioning Journal*, 38(1), 61-67. https://journals.lww.com/nsca-scj/Fulltext/2016/02000/The_Importance_of_Sleep_for_Athletic_Performance.9.aspx

MaxPreps. (2005). MaxPreps. https://www.maxpreps.com/Oxford Languages (n.d.). *Oxford dictionaries*. Oxford University Press. https://languages.oup.com/

The BMJ. (2020). 11. correlation and regression. The *BMJ*. https://www.bmj.com/about-bmj/resources-readers/publications/statistics-square-one/11-correlation-and-regression#