The Effect of Sleep on Athletic Performance

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Abstract

Previous research has shown that bad sleep quality and duration could lead to a downfall in one's performance within a sport. This may also lead to one being more prone to injury. The purpose of this study was to test athletes and to see if there was a positive or negative relationship between their sleep and athletic abilities and injury history. High school athletes from The Neighborhood Academy were given a questionnaire and were asked to answer multiple questions based on their average sleep, and everyday sleep habits. Some of the athletes were then also asked to do push-ups, and wall sits, and were measured by their sprint times. Unfortunately, there were few correlations between sleep and athletic performance in the experiment, this could be because not many athletes were active during the testing, which may have impacted the data. The only finding was that poor sleep habits were negatively related to total push-up weight.

Introduction

Sleeping is an essential part of everyone's life, and it's also very important to athletes. It's necessary that athletes are able to get up to 10 hours of sleep to maximize their injury resistance. Many athletes don't get 10+ hours of sleep, which leads to them being more likely to be injured (1). Sleep quality and quantity are also very important, as they can maximize athletic performance (1). For some athletes, if they don't get this amount of sleep, their performances are minimized a little, as they aren't at their full potential. In this study, we tested athletes by having them do various exercises and asked them about their sleep and injury history.

Sleep deprivation is when an individual does not sleep for an acute period of time. This might lead to decreased performance levels (2). Arazi et al. had 12 elite Turkish women soccer players stay up for an entire night and then measured their performance for seven days and compared it to their performance pre-sleep-deprivation. They found that reaction time, aerobic and anaerobic performance, and balance were significantly lower than the pre-scores (2). This means athletes' individual capabilities are harmed by a lack of sleep the night before, which could be useful for any type of game or competition.

McCaskill and Scott investigated correlations between physical activity, and academic performance, among high school students. For this experiment, she wanted to find if sleep quantity and quality could affect an individual person. They used an app to track an individual's sleep for 5 days. She concluded that athletes tend to go to sleep earlier and sleep more than a typical person, but she saw no difference in grades (3). This is important because the current study is doing almost the same thing as hers, which means we can compare scores, and it also can show an athlete how to plan ahead of time for their day if they have a game, practice, etc.

Hoiman lo et al. conducted a cross-sectional study used to examine sleep quality factors and sports performances among sports athletes in Hong Kong. For this experiment, they took 53 females, and 59 males aged from 12-17, and examined their sleep qualities to see if they had healthy sleep habits. They concluded that the average sleep duration was 6.402 ± 1.0566 hours. Most (58.9%) slept less than 7 hours a day, and the average time to fall asleep was 11:26 and woke up at 6:33. They also concluded that 70% have bad sleep quality, which mostly came from caffeine, alcohol, extreme moods before sleep, and loud/bright rooms which leads to poor sleep quality. According to researchers, teens, including athletes, should sleep 8-10 hours a night, so this group is possibly unhealthy, which might lead to injury or decreased performance (4). This has some comparisons with the current project since they both relate to sleep quality and athletes' performances. However, these researchers did not measure the athletic performance of their athletes (4).

Research suggests injury can be affected by sleep. West found that different sleep stages mean different things for athletes, as well as different amounts of sleep may make one more, or less vulnerable to injuries. Getting less than 7 hours of sleep makes one very injury prone and gives them a higher chance of getting injured rather than getting 8+ hours of sleep (1).

Graph 1. Relationship between average sleep per night, and injury likelihood. *This graph shows how frequently a human gets injured depending on how much they sleep a night. The x-axis represents the average sleep in hours per night, and the y-axis represents how likely they would get injured. This graph is taken from source (1).*

West also argues that different sleep stages can result in better athletic performance by decreasing one's injury vulnerability. In general, sleep has four stages. The first stage is short and is where the body relaxes. Then, stages two, three, and four are considered deep sleep. Deep sleep is when the body and muscles are relaxed and tissue growth and repair happen due to growth hormone release. Beyond the physical part, sleep also can restore an athlete's brain. Rapid eye movement or REM sleep happens at the end of each sleep cycle, about five times a night. During REM, the brain replenishes neurotransmitters, to better allow neurons to communicate (1). To perform at a high athletic level, athletes need this sleep to restore their neurotransmitters so they can learn new skills and be mentally prepared (1). West also says that athletes with less sleep will get injured more often due to muscles not being fully prepared for the challenges and their brains are not ready to perform on an elite level.

What are the effects of being sleep deprived, on consecutive say intermittent activities? Skein experimented with 10 male students and has them sleep deprived for 30h and then has them do specific workouts: first, there was a 30-minute run on a treadmill, where they measured distance covered, second, 50 minute sprinting workout. Skein concluded that sleep deprivation leads to slight disadvantages in athletic performance. This consisted of less distance in sprints, slower pace strategies, and reduced muscle glycogen, which means less energy for an athlete's muscles (5). Therefore, those who sleep little will have less energy for their muscles and may sprint slower and cover less distance.

Overall, research concludes that sleep quality and quantity can affect athletes' performances, alongside sleep deprivation affecting athletes very negatively (2, 3). Research also shows that sleeping can make an athlete less vulnerable to injuries (6). Our study will investigate this relationship in a sample of high school athletes. Therefore this study investigated that if an athlete gets within a certain amount of sleep they will be able to reach their peak performance. We tested high school athletes on sprint time, and

weightlifting ability, and asked them to complete a survey on how much, and how well they slept, as well as their injury history.

We hypothesize that there is a positive relationship between sleep quality and athletic performance, and injuries can play a part in your performance (sprint time and reps). This is because research suggests that if someone meets a certain threshold of sleep, they will be able to maximize their performance throughout various sports due to the athlete experiencing all stages of sleep, including REM (1). Next, there will be a difference in athletic performance for athletes who met the recommended amount of sleep compared to athletes that are sleep deprived. This is because sources say deprivation impacts performance negatively (2, 6), and also people who sleep more tend to be more active (3). We hypothesize that there is a negative relationship between sleep, and how often one was injured in the past year. Last, we hypothesize that more negative sleep habits will lead to lower performance. This is because research says poor habits lead to poor sleep and therefore bad performance (4).

Method and Materials

A total of 14 students that ranged from 10th to 12th grade (15-18 years old) participated in my study, all being African American and going to the same school. The participants also all currently participated in at least one sport, which suggests that they were moderately conditioned. The workout data was collected by the primary author and another researcher working on a similar project. In order to increase the sample size of the project's question about injuries, and sleep, additional student-athletes were recruited to respond to our survey, even though they did not complete the workout.

The participants were required to do 3 activities and had a total of 2 sets. They were asked to do wall sits, sprints, and pushups. These specific activities were to see if the athlete that had consumed caffeine had a different outcome from the athletes who didn't have caffeine. Caffeine consumption is not part of our study, but we used the athletes for our data. In order to get the data the athletes were measured by having the person do as many sit-ups and push-ups, and for the 3 three sprints, we allowed the person to do the 3 sprints and averaged the three scores. After the students completed their trials per each activity, we jotted it down on our record log in order to see where everyone stood.

After the athlete completed certain activities, they were asked to answer questions from the Groningen Sleep Quality questionnaire (7). The sleep questionnaire was made up of questions that asked the athlete true or false questions on how they slept the night before the test. These questions were specifically asked to see how the person varies in their different sleep qualities and quantities from others. For example, in my questionnaire one of the questions is "I often take naps/sleep during classes'. These specific questions are to get a brief understanding of how one of the participants sleeps when exercising.

In order to conduct this experiment, first we had to recruit participants that ranged from 10-12th grade and give them permission slips for their parent, or guardian to sign. The reason for the slips is that I am working with another researcher, whose study contains caffeine; which leads to us having to get permission from someone that is at least 18. After seeing who was able to do it, we went to a room after school hours, mixed the drinks up with caffeine, and handed them out to the participants without telling them who got caffeine and who didn't. After about 35 minutes we then gathered the participants and explained to them the study. After explaining they did sprints, wall sits (to failure), and push-ups (to failure). These were done in small groups so it could be easier to time, and luckily no one had bad forms, so we didn't have to disband the experiment. We only used the data from the non-caffeine workouts. To

conclude the experiment I handed out my sleep surveys, thanked the people for doing it, and talked to my researcher about the make-up day for the people who weren't available that day.

Results

This experiment, and survey measured the connections between athletes and their performances, varying on how much sleep they usually get. Another factor of this experiment is the athletes' injury history, and how many times they have been injured within a 12-month period. This experiment is to ultimately visualize how our athletes would perform depending on how much sleep they get, alongside other side activities before.

In this project, 40 people replied to the survey, while out of those 40 people, only 14 completed my workout. While looking at total sleep time it appears that most people fall within a 5.5-8.5 range, with one outlier student that tends to sleep a lot more than the others. Without one outlier, most of the data is symmetrical. Most people fall within the 4-8 range, and half of the people score a six or higher on sleep quality, which is bad sleep. While the average amount of sleep is supposed to range from 9-9.5, these students ended up getting an average of 6.73 hours of sleep on average which is pretty low, and also bad for their health. The typical bedtime is 12:07 AM, and the wake-up time is 6:07 AM. 78% of TNA students use their phones before bedtime, and 37% use a Television, which isn't a good habit. Our average injury time for the past is 15.1 weeks, and out of those people, they tend to get injured 1.3 times.

Bedtime n=41	Wake-up n=41	Total n=41	Sleep Quality n=41	Phone Use n=41	TV n=41	Video Games n=41	Injury Time n=18	Total Frequency n=20
12:07 AM	6:07 AM	6.73 hours	5.9	78%	37%	37%	15.1 weeks	1.3 injuries

Table 1. *This table represents the average from the sleep questionnaire questions*

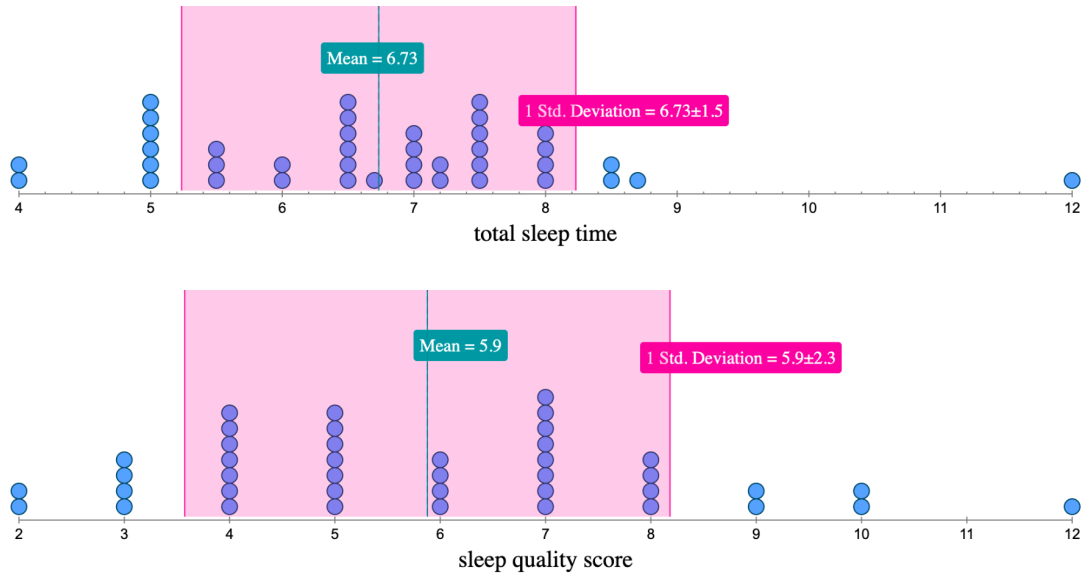

Figure 3. Relationship between sleep quality and total sleep time. *The first graph represents the athletes' average total sleep time, and the 2nd represents how well they sleep on average.*

Our first hypothesis was sleep quality would be negatively related to athletic performance (sprint, wall-sits, and total push-up weight). Sprints were average of three 35-yard runs, wall-sits were until failure and push-up weight was the number of push-ups multiplied by their weight. Sleep quality came from the Gronginen Sleep Questionnaire, and higher numbers meant poor sleep. A correlation coefficient r-test found a non-significant negative relationship between quality and sprint times ($r(12)= -0.37$, $p=0.09$). There was also a non-significant, positive relationship between wall-sit time and quality ($r(12)= 0.45$, $p=0.054$). For total push-up weight, there was a non-significant negative relationship as well ($r(12)= -0.17$, $p=0.29$). Sleep quality did not seem to have a big effect on these fourteen athletes' performance, perhaps because only 4 of them had poor sleep.

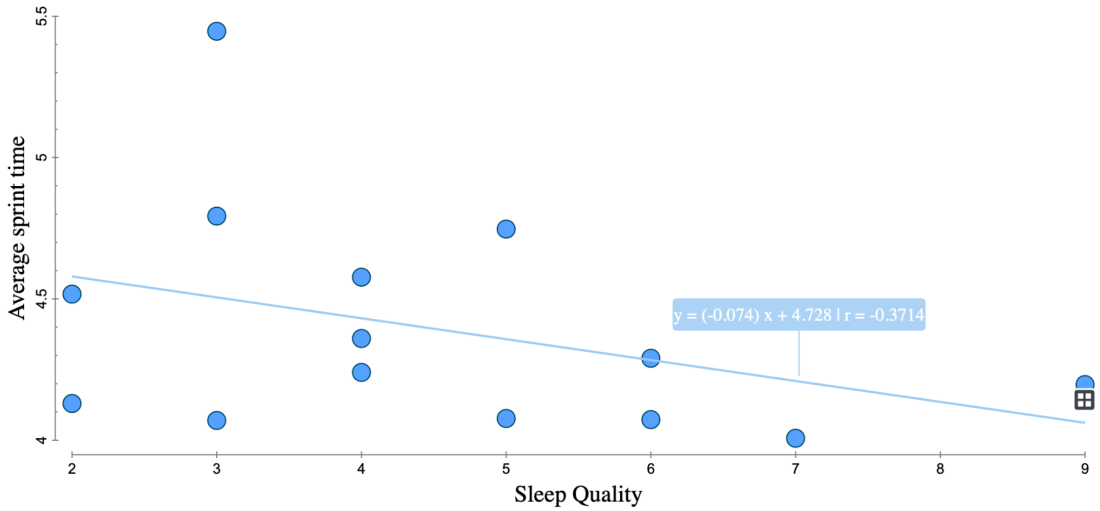

Figure 4. Relationship between sleep quality and average sprint time. *The horizontal axis is sleep quality (0-14), with higher numbers meaning worse sleep. The vertical axis is the average of three sprints. The relationship was negative, but not significant (p>0.05).*

Our second hypothesis states that sleeping more than the recommended amount would guarantee better athletic performance, however out of my 14 athletes, none of them slept the recommended amount, therefore I couldn't test the hypothesis. Instead, we looked at a correlation between total sleep time, and performance. The correlation regression test found nothing significant between total weight ($r(12) = -0.28$, $p=0.16$), wall sits ($r(12)= 0.28$, $p= 0.17$), and sprint time ($r(12) = 0.12$, $p=0.35$), and the athlete's total sleep time. Therefore this suggests that sleep amount and athletic performance do not correlate, perhaps because all of the athletes didn't sleep enough.

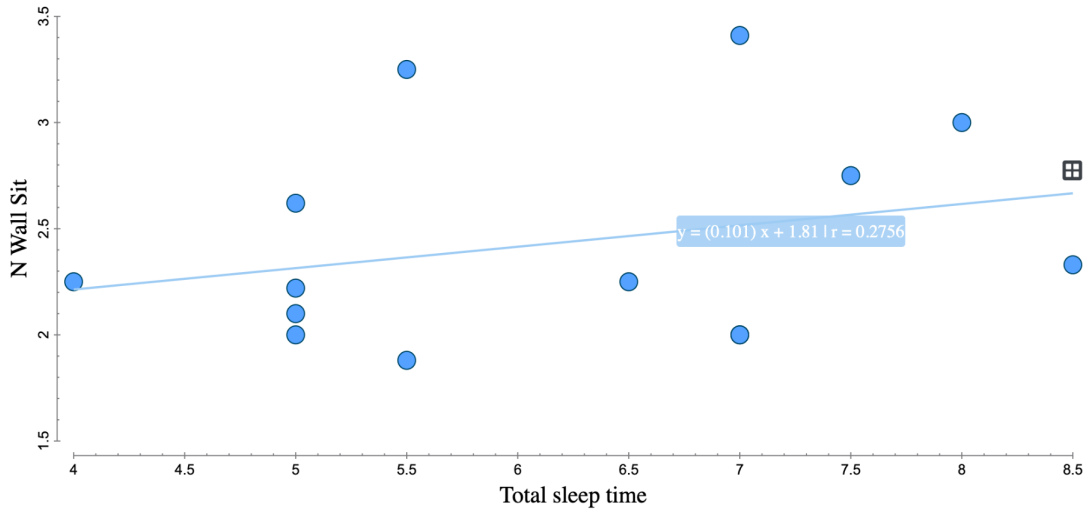

Figure 5. Relationship between total sleep time and wall sit time. *The horizontal axis is total sleep time (4-8.5), with higher numbers meaning more sleep The vertical axis is the number of minutes a person maintains a wall sit. The relationship was positive, but not significant (p>0.05).*

My third hypothesis was injury frequency would have a negative relationship with sleep, meaning the more sleep someone gets, the less chance one may have of getting injured. The average amount of sleep for all athletes was around 6.73 hours, which is almost 3 hours below the recommended 9-9.5 hours that scientists recommend one should receive. We received the total sleep time, and the number of injuries in the past 12 months both through the questionnaire, in which the athlete answered various questions to the best of their ability. My F-value (0.04) shows us that the groups are almost similar to each other, and shows that it is very common to have bad sleep among my athletes. The p-value for each group was also very similar, and almost identical between the 3 groups (p=0.96). This can show us that an athlete's total sleep time, and how often they get injured are not correlated with each other in any type of way. Athletes who were injured 0 times (M= 6.68, SD=1.87), 1 time (M= 6.84, SD=0.84) and 2+ times (M=6.74, SD=0.85) slept almost the same.

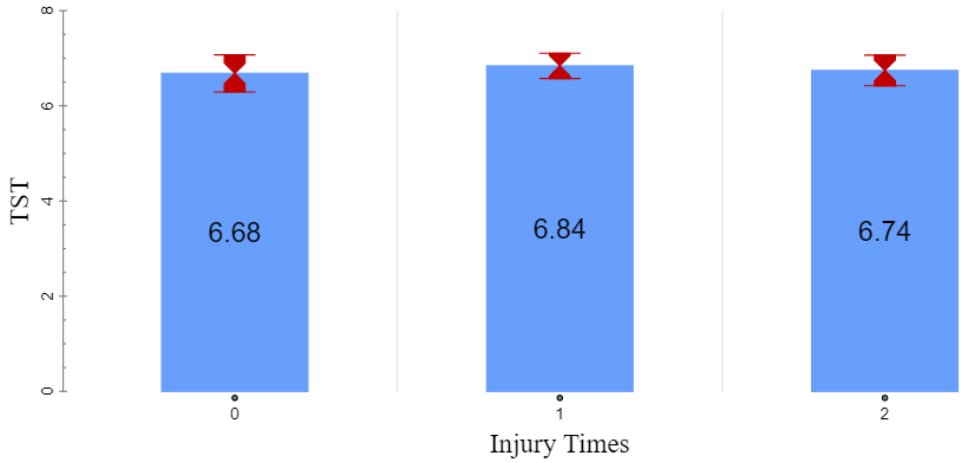

Figure 6. Relationship between total sleep time, and injury in the past 12 months *The horizontal axis is injuries within 12 months(0-2), with higher numbers meaning more times injured The vertical axis is the total sleep time an athlete sleeps per night on average (0-8.5). The three groups here are similar, with no significant difference.*

Our fourth hypothesis is that negative sleep habits would lead to worse athletic performances. From our athletes, their sprints were an average of three 35-yard runs, wall-sits were time until failure and push-up weight was the number of push-ups until failure multiplied by their weight. The number of bad habits was calculated from the questions about TV, caffeine, exercising, and video games before bedtime, and as well as catch-up naps that were tallied up by all the yes responses that people said. A correlation coefficient r-test found a non-significant relationship between the number of negative sleep habits and average sprint time (r(.09)= .01, p=0.36). There was also a non-significant relationship between sleep habits and wall sits (r(-.15)= 0.02, p=0.30). For total push-up weight, there was a significant negative relationship (r(-.55)= 0.30, p=0.02). Sleep habits didn't seem to affect the athletes too much with the wall sits, and the sprints, but it appears that an athlete that doesn't have good sleep habits won't be able to do as many push-ups as athletes with better habits.

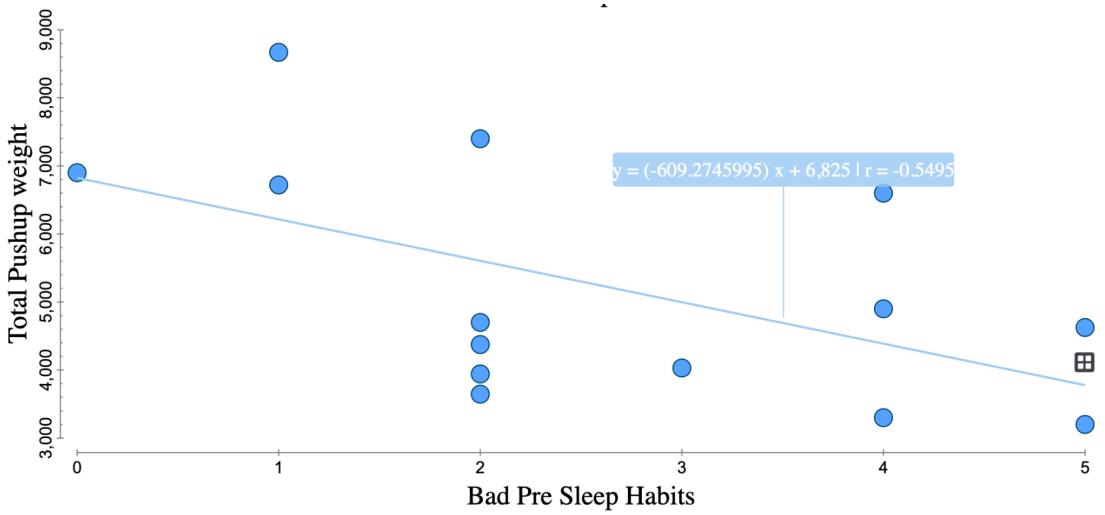

Figure 7. Relationship between push-up total weight, and sleep habits. *The horizontal axis is how many bad sleep habits an athlete obtains (0-5), with higher numbers meaning more bad habits. The vertical axis is the amount of weight an athlete can push up (weight-wise). The relationship was negative, and significant ($p<0.05$).*

Discussion

In this study we investigated if sleep would affect an athlete's performance through various activities. A side factor of this experiment was injuries that the athlete experienced from 12 months ago, as well as how many times they were injured. The first hypothesis was sleep quality would be negatively related to athletic performance. We found out that sleep quality did not seem to have a big effect on these fourteen athletes' performance, but only 4 people had high-quality sleep (Figure 4). Our second hypothesis states that sleeping more than the recommended amount would guarantee better athletic performance, however out of the 14 athletes, none of them slept the recommended amount, therefore we couldn't test the hypothesis very well (Figure 5). My third hypothesis was not supported as injury frequencies would have a positive relationship with sleep, meaning the more sleep someone gets, the less chance one may have of getting injured. This can show us that an athlete's total sleep time, the amount, and how often they get injured are not correlated with each other in any type of way (Figure 6). Our fourth hypothesis is that negative sleep habits would lead to worse athletic performances. This was supported partially as only 1 out of the three activities showed a connection, and those were the push-ups.

So we can conclude from our results are consistent with other research on high school students' sleep quality. My source and Hoiman lo et al.'s sources are almost identical as in their source the average sleep time was 6.4 hours, while having 70% with bad sleep quality, compared to my studies had an average sleep time of 6.73, and 50% of my athletes had bad sleep quality. This can conclude that poor sleep quality is a global thing, and isn't just within the United States, since Hoiman et al. tested Hong Kong athletes. Therefore we need to limit the bad habits of sleep, or else this can lead to depression, hypertension, obesity, diabetes, etc in the long run (8). Perhaps sleep quality is an epidemic that many teenagers are facing, which they should care a lot more about.

Unfortunately, we were unable to conclude that the more an athlete sleeps, the better their athletic performance would be. We found no relationships with sprint times, wall sits, push-ups, and an athlete's sleep time. This is inconsistent with, Azari et al, who found a difference between the athletes and the sleep times, but they were sleep deprived, which tells us that sleep deprivation leads to worse performances. However, don't get it mixed up that sleep deprivation and poor sleep are not the same things. Almost all of my athletes had bad sleep, which was on average 6.2 hours, with the most amount of sleep being 8 hours, and 30 minutes. Scientists suggest getting 9-9.5 hours of sleep, but none achieved that. Because all of the athletes had bad sleep, we couldn't conclude whether sleep makes an athlete worse or better. This leaves the question unanswered.

So we are partially able to conclude our results concerning injury were not consistent with previous research. Not many people were injured, and neither did any of my athletes get the amount of sleep that they were supposed to get, which is 9-9.5 hours. Our average injury time for the past is 15.1 weeks, and out of those people, they tend to get injured 1.2 times, but it would be hard to conclude knowing sleep would cause injury, as few people were injured. This is in contrast to West's research, which found that athletes who get less than 8 years are more vulnerable to injury.

Our study had limitations and I would recommend future researchers fix up these things. One is that I didn't have the most athletes to test. This could be a problem, as data with more people means that it would be more accurate since more participants will be available. Even though I had some participants, I still wasn't able to get the best data possible since none of these athletes actually got the recommended amount of sleep which is 9-9.5 hours. This could be a major factor, as having multiple variations of sleep could reveal a lot more to me depending on who actually got the recommended amount of sleep. Future researchers should consider a sleep intervention, where athletes who don't sleep as much are able to sleep more and measure the changes in their athletic performances.

In conclusion, our research suggests that students at The Neighborhood Academy don't get enough sleep, so it's impossible to see if sleep makes people perform better. We recommend that teenagers make better choices while considering when they are going to bed. Students also had a lot of bad sleep habits, and it would be beneficial to improve them. I would also recommend that teachers and schools tell their students how dangerous it is that they lack so much sleep. This could lead to long-term problems with one's health and could affect them negatively.

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