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SPORT SPECIALIZATION AND INJURY RISK IN NAIA ATHLETES

By

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Honors Scholarship Project

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in

Biology

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ABSTRACT

Background

Sport specialization is defined as intense year-round training in a single sport while excluding other sports. Though some studies have supported a relationship between increased levels of sport specialization and injury risk, others have contradicted this. Previous literature has also suggested that sport specialization levels increase dramatically throughout high school, though this hypothesized increase and possible relationship between sport specialization and injury risk has not been investigated in post-high school athletes at the NAIA level.

Methods

This study aimed to investigate the possible relationship between sport specialization and injury risk, as well as how sport specialization levels change throughout college. A questionnaire was distributed online to 251 undergraduate NAIA athletes, and participants were assessed according to their levels of specialization using a 3-point scale. The injury history of participants was also gathered and compared to their level of specialization.

Results

The data were analyzed using correlational tests, showing a significant increase in specialization and a R^2 value of 0.94 between injury frequency and level of specialization, though there were not enough unspecialized athletes to investigate a relationship between sport specialization and injury risk with regards to unspecialized athletes vs. specialized athletes.

Conclusion

It is difficult to draw conclusions regarding a relationship between sport specialization and injury risk. However, the increase in both specialization and injury rates within the levels of specialization shows the need for further research into both sport specialization and injury risk, as well as research into NAIA athletes specifically.

INTRODUCTION

Studies have indicated that sport specialization can lead to an increased risk of injury in athletes compared to non-specialized athletes (Bell et al., 2016; Hall et al., 2015; Post et al., 2017). However, other studies contradict this claim (Frome et al., 2019), indicating no link between sport specialization and injury rates. These studies indicate that additional research is needed to determine the extent of a possible link between sport specialization and injury rates. Studies have also shown that specialization increases with age throughout high school (Post et al., 2017). It is likely that specialization continues to increase throughout college.

Research on specialization has been conducted on elite Division I athletes regarding the prevalence and effects of sport specialization (Post et al., 2017), but no research has been conducted that explores specialization in NAIA athletes. This is a significant gap, as approximately 60,000 college athletes compete at this level. In addition, the NAIA is comparable in terms of the skill level of its participants to the Division III level, which itself holds another 188,000 athletes. The NAIA and Division III together account for approximately 70,000 more athletes than the Division I level, making this a significant body of athletes to examine that have been neglected in previous research.

Given the correlation between sport specialization, age, and injury rates in Division I athletes, it is likely that the same increased trend of both specialization and injury rates studied in research involving Division I and high school athletes will be observed in NAIA athletes. The extent of this hypothesized increase and its comparison to injury rates among elite athletes at the collegiate level is unknown. The aim of this

study is to assess the percentage of highly specialized athletes at a NAIA university in Illinois and determine if there is a correlation between high levels of sport specialization and injury risk in NAIA athletes. This paper will examine the concept of sport specialization, its context, and previous and related research on the topic. The importance of this current research project, its results and limitations, and further areas to explore will also be discussed.

LITERATURE REVIEW

Concept

Sport specialization is defined as intense, year-round training in a single sport while excluding other sports (Jayanthi et al., 2015). Specialization is thought to increase injury rates in highly specialized athletes compared to non-specialized athletes, though this relationship has only been studied in high school, elite college, and among professional athletes. The primary type of injuries caused by sport specialization are overuse injuries, which are defined as damage and pain caused by repetitive movement and overuse (*Niams Health Information on Sports Injuries*, 2022). The current theory explaining the prevalence of this type of injury among highly specialized athletes is that such athletes are more likely to repeat the same motions over and over again, wearing down specific joints and eventually resulting in injury.

Non-specialized athletes are believed to be less susceptible to overuse injury because the multiple sports they play often use different motions, allowing their joints time to rest and heal after repeating a motion many times over an athletic season. For example, a player who plays baseball for part of the year may make significant use of the

elbow joints. If that player is not specialized, they may then spend another portion of the year playing soccer, which makes less use of the elbow joints and allows time for healing, thus preventing overuse injury. Acute injuries, generally defined as a severe injury with a sudden onset, such as a torn ACL or broken bone, are also more likely in highly specialized athletes (Wilhelm et al., 2017). The researchers noted that pinpointing one specific cause for increased acute injuries is extremely difficult but theorized that specializing early may cause athletes to fail to develop sound functional movement patterns, increasing the risk of acute injuries.

The ultimate goal of this research is to give coaches and athletic directors the information necessary to create and improve training programs to reduce injuries. This research helps to show the dangers of over-specialization and could be used to help stress the importance of variety for athletes to avoid specialization and reduce injuries.

Context

There have been relatively few studies regarding the relationship between sport specialization and injury risk. Most studies have been on high school age or younger athletes and have found that increasing levels of sport specialization increased the risk of injury in athletes, especially overuse injuries.

In one study, Hall et al. (2015) studied the effects of sport specialization, specifically on knee injuries, in adolescent females. They used a retrospective survey and medical diagnoses and examinations from registered physicians to determine the specific injury caused. The researchers found that sport specialization increased the risk of some, but not all, of the injuries they tested for. Injuries and conditions such as Sinding Larsen Johansson/patellar tendinopathy, Osgood Schlatter disease, and general patellofemoral

pain showed an increased risk due to sport specialization, but other injuries/conditions such as Fat Pad, Plica Trauma, Pes Anserine Bursitis, and IT Band Tendonitis showed no difference between highly specialized and non-specialized athletes. This study adds weight to its findings by coordinating with physicians to help confirm and diagnose injuries, removing recall bias from the study.

In another study, Jayanthi et al. (2015) demonstrated the effect of sport specialization on injury rates by using a questionnaire on 1190 pre-college athletes to determine if sport specialization was associated with an increased risk of injuries, especially overuse injuries. They also developed a three-point survey to identify the athletes' degree of specialization, which was adapted for use in this study. Jayanthi et al. found that athletes with overuse injuries were 1.9 times more likely to be highly specialized and 1.45 of being injured in general when compared to moderate and low specialized athletes. Highly specialized athletes did not have a greater risk of acute injuries, though the researchers believed more research is needed to both confirm these findings and determine the exact reasons behind them, as other factors may be influencing the data gathered. One strength of the study is that it did not require a great amount of resources or coordination with physicians or medical records, though this may have allowed recall bias from the participants to skew the data.

Other studies have observed a particular school or athletic team for an extended period of time, noting the specialization levels of athletes and recording injuries as they occur. Bell et al. (2016) studied the prevalence of sport specialization in two high schools, one large and one small, by following athletic teams for one year and reviewing their responses to a survey regarding injury rates with a certified athletic trainer. They

found that athletes from the smaller school were more likely to be in the low specialization group (43%) than the medium (32%) or high specialization group (25%) than the larger school (low, 26%; medium, 26%; high, 48%). As a secondary goal however, the researchers found that highly specialized athletes were more than twice as likely to report knee and hip overuse injuries. Though this study was limited by the small sample size (302 athletes), it still shows the effects of sport specialization in high school athletes.

In another study, McGuine et al. (2017) demonstrated how sport specialization affected lower extremity injury (LEI) rates in 1,544 high school athletes. The researchers collected data by first using a questionnaire to determine the athletes' level of specialization and injury history, and then by staying in contact with the athletic trainers of those athletes who reported any LEI injuries sustained by the athletes during each sport season over one school year. The study found that players classified as moderately specialized had 50% higher incidence of LEIs, and high specialized athletes had an 85% higher incidence rate than athletes classified as low specialization.

Though this type of study is more accurate, it has several major limitations. The first of these is adequate sample size. It is very difficult to gather a large enough sample size to achieve statistical significance while closely monitoring several groups to ensure accuracy. Researchers must also spend significant time observing each group, which can be challenging since overuse injuries take a long time to develop. Given this challenge, I decided to conduct a survey-based study and control for recall bias by asking athletes to list only injuries they experienced during their college and high school athletic career.

Besides the limitations of any potential study on specialization and injury, there are also contradicting studies that indicate that sport specialization actually has no effect on injury rates in athletes. One notable example is the study done by Frome et al., who surveyed 2,099 elite male soccer athletes between the ages of seven and seventeen to determine if there was a relationship between sport specialization and injury history (Frome et al., 2019). They found no significant difference between specialized and unspecialized athletes regarding likelihood to have experienced a past lower extremity overuse injury (31.8% injury rate among specialized athletes versus a 34.6% injury rate among non-specialized athletes). Moreover, they discovered that specialized athletes had an approximately 20% less chance of reporting any type of previous injury than unspecialized athletes.

Frome et al. noted the discrepancy of their data compared to other studies and suggested that it could have resulted from their study's focus on a single sport, sex, and competitive level. This may be especially significant as Frome et al. studied male soccer players, and other studies have shown that female athletes are more likely to specialize and have high training volumes (Post et al., 2017), which also increases injury risk (Bell et al., 2018; Post et al., 2017). Frome et al. also suggested that studying soccer specifically may have resulted in a phenomenon that is not applicable to other sports. Finally, the researchers also suggested that other sports such as tennis and gymnastics, where more technical motions are required, could lead to an increased risk of injury compared to soccer, which has a greater variety of movement patterns. These various considerations led the authors of the study to conclude that there was a significant need for more research on the relationship between sport specialization and injury risk.

There is also a significant lack of studies assessing sport specialization in athletes after high school. A small number of studies involving professional and Division I athletes found a positive correlation between sport specialization and injury rates (Rugg et al., 2018; Wilhelm et al., 2017), but all these studies suffer from a small sample size due to the elite status (and therefore scarcity) of possible participants. The exclusivity of Division I by definition is not representative of most athletes. A study by Post et al. (2016) on Division I athletes found that specialization increased throughout high school by 24.2% from 9th to 12th grade. It seems likely to assume that collegiate athletes would be more specialized than high school athletes, but without further study it's impossible to conclude whether this is unique to students who go on to play for elite Division I teams.

Few studies have examined NAIA athletes or Division III athletes, for example, though these populations contain a larger sample size and the athletes examined would represent a wider segment of the population. This population may also differ from Division I athletes in average levels of specialization. Studies have shown an average of at least 80% of Division I athletes to be specialized (Post et al., 2016), though the prevalence of specialization in NAIA and Division III athletes is unknown and would likely influence injury rates. In the current study, a small Midwest liberal art university, consisting of approximately 500 athletes, was surveyed to determine the prevalence of sport specialization and a possible relationship between sport specialization and injury risk.

Importance

Current studies on sport specialization are not representative of the majority of college athletes, who continue to compete after high school in the NAIA or Division III

level. Together, these organizations represent a group of 248,000 athletes. The current study aims to fill the gap in knowledge on NAIA athletes regarding sport specialization and injury rates by surveying a subsample of this previously overlooked population. If the relationship between sport specialization and injury risk is shown to be significant in NAIA athletes, coaches and athletes will be able to make more informed decisions regarding training volume and specialization levels. This work also could inspire further studies to investigate safer ways for athletes to train. Finally, this study will help clarify the possible relationship between sport specialization and injury risk as a whole. A related outcome of this study will also be to determine if NAIA athletes continue to become more specialized after high school.

METHODS

Participants

Participants were selected based upon their status as both a student and athlete at an NAIA university. To be eligible for the study, participants had to qualify as both a full-time student and be on a varsity or junior varsity athletic team for the university. Approximately 500 athletes received the survey, soliciting 255 responses in total and 251 responses used in the survey.

Materials

Sport specialization was assessed using a scale developed by Jayanthi et al. This scale uses three questions, marked with an asterisk in appendix A, to determine participants' level of specialization. A positive response to each of these questions adds one point to the athlete's level of specialization, with zero points indicating very low/no

specialization and three points a very high level of specialization. The Jayanthi scale was selected due to several factors. Firstly, it has been used in several other reliable studies (Post et al., 2017; Wilhelm et al., 2017; McGuine et al., 2017). It is also a brief survey, which is intended to boost participation by lowering time commitment. The survey was also simple and straightforward, allowing it to be easily adapted to college athletes.

Procedure

Participants received an email briefly describing the study and requesting their participation. Participants could then follow the link to an online survey and opt into the study to complete the survey. Participants were given the option to enter their email address for the chance to win one of five \$10 Amazon gift cards. A reminder email was sent twice to students whose link had not been used after at two and four weeks after the initial email. This method of soliciting responses obtained responses from approximately 50% of eligible student athletes.

In addition to data regarding specialization, the survey solicited responses regarding injury history. This allowed percentages of highly specialized athletes with injuries to be compared to medium and low specialized athletes with injuries. The data from the survey were then analyzed using R^2 values to assess the correlation between sport specialization and injured athletes. Outliers in the data were analyzed and controlled for using the Grubbs test for outliers to exclude very unlikely answers that greatly affected the data. Some responses were also excluded due to extremely unlikely/impossible answers, such as participants reporting having practiced over 168 hours per week.

RESULTS

Participants included 251 undergraduate student athletes at a NAIA university in the Midwest, recruited using an online survey sent to their school email address. Figure 1 shows the number of participants for each sport. Thirty-four participants reported specializing before age 14, 118 reported specializing after age 14 (i.e., during high school or college). Figure 2 shows the sports played in high school by the participants.

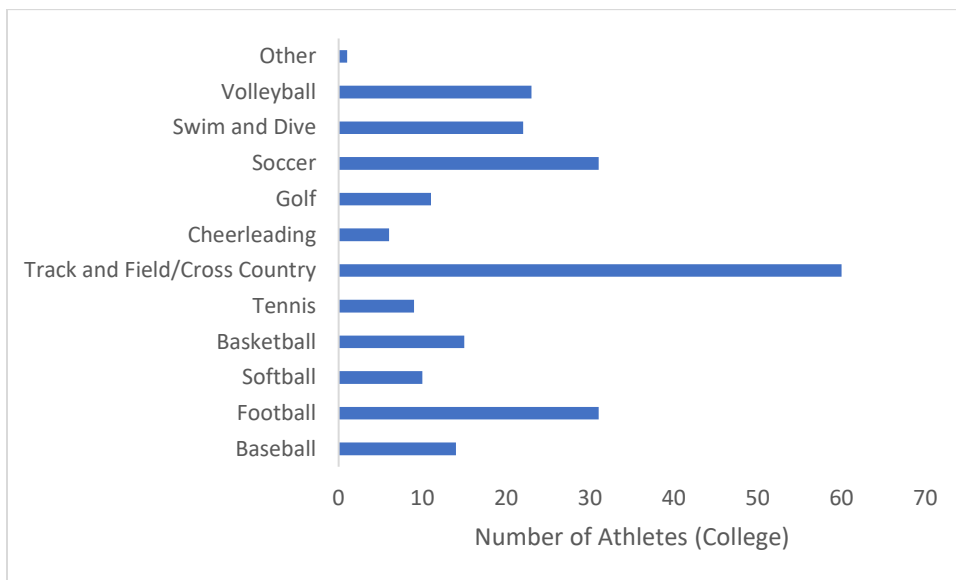


Figure 1: Number of Participants per Sport in College. With the exception of Track and Field/Cross Country, there is a relatively even distribution between sports. This distribution is similar to the one seen in Figure 2.

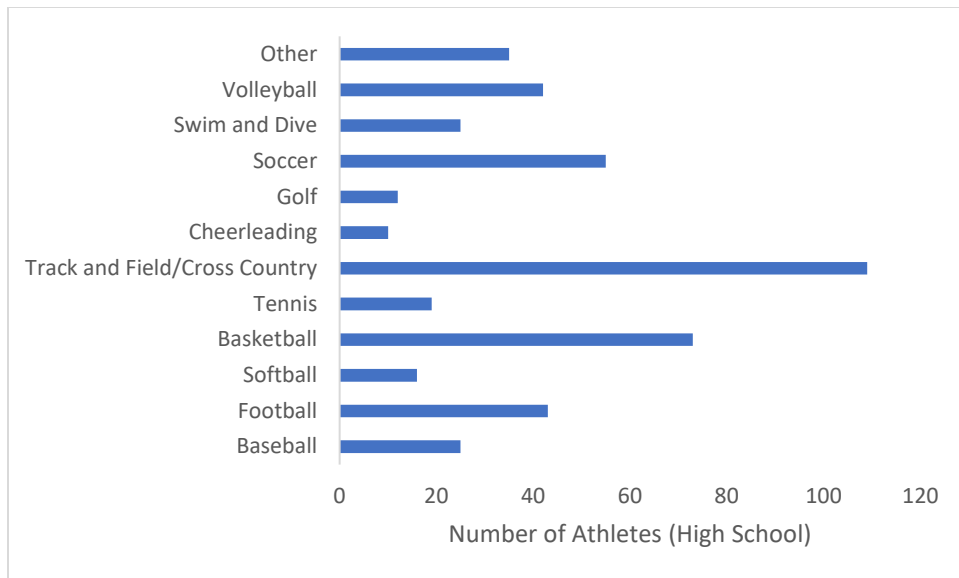


Figure 2: Number of Participants per Sport in High School. There is a similar distribution of athletes across sports when compared to Figure 1. However, though the proportions are similar, there are almost twice as many athletes in most sports as compared to Figure 1. For example, the number of track and field athletes decreased from 109 in high school to 60 in college. This drop in numbers indicates an increase in levels of specialization.

Table 1. Sports Participated in High School and College. Data were gathered using responses to the survey. The data shows a large decrease in sports participated in from high school to college, indicating a large increase in specialization.

Sport	Athletes (College)	Athletes (High School)
Baseball	14	25
Football	31	43
Softball	10	16
Basketball	15	73
Tennis	9	19
Track and Field	60	109
Cheerleading	6	10
Golf	11	12
Soccer	31	55
Swim and Dive	22	25
Volleyball	23	42
Other	1	35
Total Sports Participated	233	464

Sport Specialization and Injury Rates

Participants in this study had an average specialization level of 2.375 on the adapted Jayanthi scale. Data on other collegiate level athletes using this scale of specialization is not available. However, there was a large increase of 0.475 when

compared to pre-college athletes in the original Jayanthi study. Overall, an increase in injury associated with specialization was observed (Figure 3), with nearly half (40.5%) of participants reporting sports related injuries in the past year that prevented them from playing. Participants with a specialization score of 1 (low specialization) had an injury frequency rate of 25% (n=24). Participants with a score of 2 (medium specialization) had an injury frequency rate of 31.5% (n= 92). Participants with a score of 3 (high specialization) had an injury frequency rate of 48% (n= 127). Though a higher injury frequency rate of 40% among non-specialized athletes (n=5) was observed, small sample size may have skewed the data for that group. When assessed in aggregate, specialization was positively correlated with injury risk (Figure 4; $R^2 = 0.94$ when participants with a score of 0 were excluded due to the low sample size). This trend seems to support the expected relationship between specialization and injury. With the exception of participants with a score of 0, injury frequency increased as specialization increased. The small sample size, which was only 2% of the total sample size, is unlikely to represent unspecialized athletes as a whole or even athletes in this local population. The small sample size also causes a large degree of uncertainty. If one more participant in that sample had reported an injury, the injury frequency would have increased by 20%.

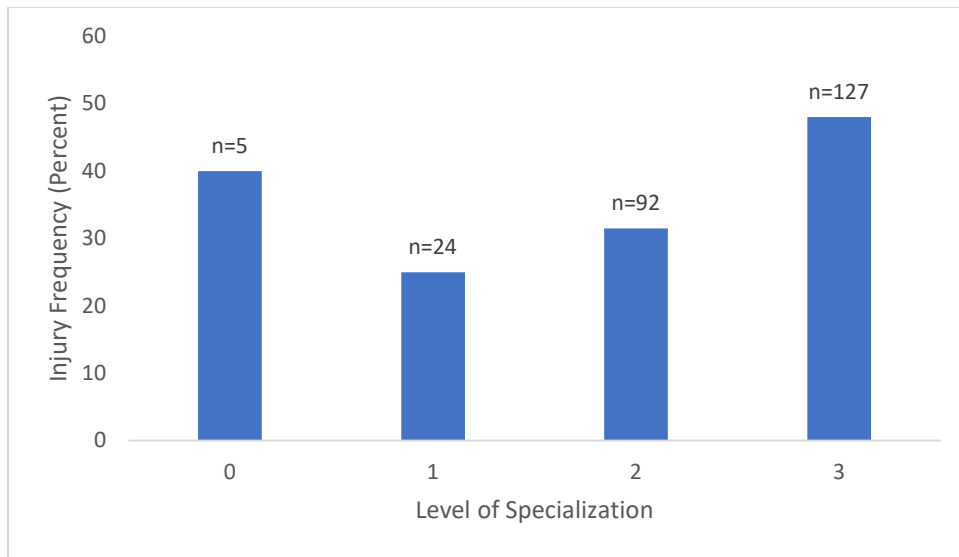


Figure 3: Injury Frequency According to Level of Specialization. Participants' injury history was compared to their level of specialization, showing a positive correlation between injury frequency and level of specialization, with the exception of level zero. Level zero is likely an outlier due to the low sample size. The number of participants for each level is indicated above each bar.

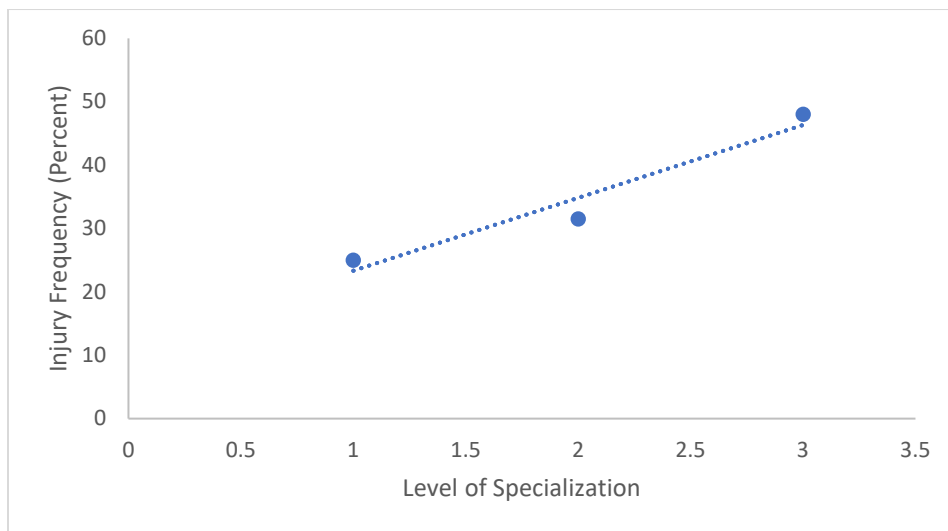


Figure 4. Injury Frequency According to Level of Specialization Excluding Level Zero. Athletes with low, medium, and high specialization exhibited increased risk of

injury ($R^2 = 0.94$), suggesting positive correlation between injury frequency and specialization within specialized athletes.

Table 2. Sport Specialization and Injury Rates. Data were gathered using responses to the survey. The data supports a positive relationship between sport specialization and injury rates, with the exception of level zero.

Specialization Level	Injury Rate	n
0	40	5
1	25	24
2	31.5	92
3	40	127

Prevalence of Sport Specialization

According to the survey, in 2021, study participants spent an average of 13.2 hours in practice, 0.68 hours in intramurals, and 6.4 hours in competitive sports each week. The average age at which participants began playing sports was approximately eight years old. A large majority of participants agreed with a statement asking if they believed they spent seventy-five percent of their practice time training for one sport, further supporting the prevalence of sport specialization in NAIA athletes.

More than half also agreed that learning a new skill at practice was more important than having fun with their friends at practice, that they would not play sports if they did not receive a scholarship, and that they miss opportunities to hang out with friends because of sports related obligations. A majority of athletes reported that they had quit other sports to focus on one sport and the average age of quitting other sports for those athletes was approximately fifteen years old, showing that average NAIA athlete

specialized early in high school. Most athletes also said that one main sport was more important than other (Table 1). The participants spent an average of 10.7 months per year training for sports and six months per year competing in a sport. Overall, this data shows that the average NAIA athlete would classify as highly specialized and helps underscore the prevalence of specialization in NAIA athletes.

Table 3. Responses to Survey Questions. Data were gathered using responses to the survey. Overall, the data indicates high levels of specialization in the surveyed population, highlighting the prevalence of sport specialization.

Question/Statement	Positive Response (Percent)	Negative Response (Percent)
“I spend more than 75% of my training in only one organized sport?”	93.7	6.3
“At practice, I think learning something new or improving my skill is more important than having fun with my friends?”	70.1	29.9
“I would play sports in college even if I did not receive a scholarship for doing so?”	39.4	60.6
“I often miss spending time with my friends that don’t play sports because I have practice or competition (games, matches, tournaments, etc.) for my sport?”	68.1	31.9
Have you quit other sports to focus on one main sport?	60.6	39.4
Is one main sport more important to you than any other?	87.6	12.4

DISCUSSION

This study assessed the prevalence of sport specialization and its relationship with injury rates in NAIA athletes. As expected, both a significant increase in specialization

after high school and a positive correlation between specialization and injury rates was found. This supports the research hypotheses and agrees with the current literature on sport specialization and injury rates in Division I athletes. It also demonstrates a high degree of specialization among NAIA athletes, highlighting the importance of this work and indicating the need for further studies on sport specialization in NAIA athletes. The study also found a positive correlation between injury frequency and specialization within low, medium, and highly athletes.

The results of this study may be limited by several factors. First, the study was distributed online, which may have affected the data's accuracy. The study may also be limited by the aspect of self-reporting used to gather data. The survey tool used appears to be capable of improvement, with some of the questions leading to incorrect classifications of athletes. One possible way the survey tool could be improved is by clarifying the questions and making them more specific and clearer to the participants. By clarifying some of the questions and allowing for multiple options rather than a binary choice, the survey's effectiveness would increase. For example, one question asked if athletes had quit other sports to focus on one main sport and used a positive response to indicate specialization. The problem with this is that some athletes had never played multiple sports to begin with, and therefore truthfully gave a negative response. This is a large flaw in the survey tool, as those athletes that had never played multiple sports are likely more specialized than athletes that had played multiple sports at some point.

Further studies could modify the existing survey tool or create a new tool to be used for college or high school athletes by examining and accounting for the challenges presented above. A potential improved survey based on the tool used in this study and

incorporating the improvements suggested is presented in Appendix C. Further studies could also address weaknesses in the tool by connecting directly with medical professionals treating student athletes for the organization, removing possible recall bias from the data. By accessing student medical data with permission, medical records could be compared to the survey results to give an accurate comparison between injury history and level of specialization.

Based on the data from this study, there are strong implications for coaches and athletes at the NAIA level regarding how athletes train and compete in order to minimize injuries. These implications include being aware of the effects of year-long training on athletes, the importance of playing multiple sports, and understanding the prevalence of specialization and its consequences. There are also implications for high school athletes due to the large increase in specialization after high school. High school athletes, coaches, or parents may want to plan how the athlete will prepare for or avoid a large increase in specialization after high school. If students, parents, and coaches are made aware of the strong positive correlation between specialization and injury, and the fact that this holds even for non-Division I schools, then new training regimens could be developed to minimize injury risk, and athletes could make a more informed choice when considering specializing for one sport.

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APPENDIX A

Original Jayanthi Survey

Survey Questions:

1. What sports do you compete in during the course of the year?
2. During the last 6 months, in a typical week, how many hours per week did you spend in gym class? Playing sports just for fun? Playing competitive sports?
3. How old were you when you started to participate in competitive sports?
4. Have you had an injury in the last 6 months related to sports that has prevented you from playing sports?
5. Would you agree or disagree with the following statement: "I spend more than 75% of my training in only one organized sport?"
6. Do you agree with the following statement: At practice, I think learning something new or improving my skill is more important than having fun with my friends?
7. Do you agree with the following statement: I often miss spending time with my friends that don't play sports because I have practice or competition (games, matches, tournaments, etc.) for my sport?
8. *Have you quit other sports to focus on one main sport? If yes, how old were you when you quit other sports?
9. *Is one main sport more important to you than any other?
10. Do you regularly travel to other states to compete in your sport?

11. *How many months per year do you train for one main sport?
12. How many months per year do you compete in one main sport?
13. On a scale of 1-10 mark how much you enjoy playing sports.

* Answers to these “sports specialization questions” form the basis for determining the athlete’s degree of sports specialization.

APPENDIX B

Adapted Jayanthi Survey

Survey Questions:

1. What sports do you compete in during the course of the year?
2. What sports did you compete in during high school?
3. During the last 6 months, in a typical week, how many hours per week did you spend in practice? Playing intramurals? Playing competitive sports?
4. How old were you when you started to participate in competitive sports?
5. Have you had an injury in the last 6 months related to sports that has prevented you from playing sports?
6. Would you agree or disagree with the following statement: “I spend more than 75% of my training in only one organized sport?”
7. Do you agree with the following statement: “At practice, I think learning something new or improving my skill is more important than having fun with my friends?”
8. Do you agree with the following statement: “I would play sports in college even if I did not receive a scholarship for doing so?”
9. Do you agree with the following statement: “I often miss spending time with my friends that don’t play sports because I have practice or competition (games, matches, tournaments, etc.) for my sport?”

10. *Have you quit other sports to focus on one main sport? If yes, how old were you when you quit other sports?

11. *Is one main sport more important to you than any other?

12. Do you regularly travel to other states to compete in your sport?

13. *How many months per year do you train for one main sport?

14. How many months per year do you compete in one main sport?

15. On a scale of 1-10 mark how much you enjoy playing sports.

* Answers to these “sports specialization questions” form the basis for determining the athlete’s degree of sports specialization.

APPENDIX C

Improved Jayanthi Survey

Survey Questions:

1. What sports do you compete in during the course of the year?
2. During the last 6 months, in a typical week, how many hours per week did you spend in gym class? Playing sports just for fun? Playing competitive sports?
3. How old were you when you started to participate in competitive sports?
4. Have you had an injury in the last 6 months related to sports that has prevented you from playing sports?
5. Would you agree or disagree with the following statement: “I spend more than 75% of my training in only one organized sport?”
6. Do you agree with the following statement: At practice, I think learning something new or improving my skill is more important than having fun with my friends?
7. Do you agree with the following statement: I often miss spending time with my friends that don’t play sports because I have practice or competition (games, matches, tournaments, etc.) for my sport?
8. *†Have you competed in more than one sport?
9. *Have you quit other sports to focus on one main sport? If yes, how old were you when you quit other sports?
10. *Is one main sport more important to you than any other?

11. Do you regularly travel to other states to compete in your sport?

12. *How many months per year do you train for one main sport?

13. How many months per year do you compete in one main sport?

13. On a scale of 1-10 mark how much you enjoy playing sports.

* Answers to these “sports specialization questions” form the basis for determining the athlete’s degree of sports specialization.

† Added question to improve accuracy of the survey