Is sport specialization worth the risk? Myths vs. reality

A synthesis of the research literature

A Synthesis Project

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Abstract

The purpose of this synthesis project was to explore whether sport specialization is worth the potential risks. Another purpose was to explore the myths and realities of sport specialization. A comprehensive literature review took place that included 17 data based peer-reviewed articles published between 2003-2019. Results indicated that sport sampling is the best way to achieve future success in sport, not sport early specialization (Hastie, 2015). Athletes who specialize in one sport are more likely to have a lower extremity injury occur compared to athletes who sport sample (McGuine, Post, Hetzel, Brooks, Trigsted & Bell, 2017). Another factor to consider is that while athletes may be choosing to specialize to obtain collegiate scholarships, athletes who played multiple sports actually received athletic scholarships more often compared to their specializing counterparts (Ginsburg, Danforth, Ceranoglu, Durant, Robin, Smith, Kamin, Babcock, Masek, 2014). It is critical that athletes, parents/guardians, coaches and others who influence the decision to specialize or sport sample know the true risks involved when making the decision.

Chapter 1

Introduction

The norm of multi-sport athletes is becoming a thing of the past as sport specialization among youth athletes is gaining popularity and becoming a growing trend in today's society, according to a majority of high school athletic directors (Jayanthi,Pinkham, Dugas, Patrick, & LaBella, 2013). The size of the school that an athlete attends can have an impact on whether the athlete considers themselves a multi-sport athlete or an athlete that specializes. Athletes from small schools were more likely to consider themselves multi-sport athletes than those from larger schools (Bell, Post, Trigsted, Hetzel, McGuine & Brooks, 2016).

There are a variety of different definitions of sport specialization: 1. training for a single sport eight or more months a year; 2. choosing a single main sport; 3. and/or quitting all other sports to focus on just one (Myer, Jayanthi, Difiori, Faigenbau, Kiefer, Logerstedt, Micheli , 2015). Coaches, parents and the athletes themselves see specialization as a way to maximize their potential in a single sport and earn many of the potential accolades that accompany achievement. Obtaining a collegiate scholarship or becoming a professional athlete is an overwhelming motivation for many athletes to specialize (Padaki, Popkin, Hodgins, Kovacevic, Lynch, Ahmad, 2017). While these notions may be the hopes and dreams of a young athlete, parent or coach, do those involved in making the decision really understand all of the positives and negatives that are intertwined with the decision? According to Stewart and Shroyer (2015), athletic scholarships are incredibly rare to attain to begin with, with well under 10% of athletes receiving scholarships upon graduation of high school. Will sport specialization lead to scholarships? Odds say no, and at what risk? (Stewart & Shroyer, 2015). It is important for

coaches to be able to share information about burnout rates, injuries and the risks involved in specialization with parents (Stewart & Shroyer, 2015).

Intense, almost year round, repetitive training, has been shown to put enormous physical stress on the body. As a result, athletes who specialize at a younger age are more susceptible to lower extremity injuries (McGuine, Post, Hetzel, Brooks, Trigsted, & Bell, 2017). While the physical stress that is endured is great, the toll that can be experienced psychologically is also substantial. In a study of specialized and multi-sport athletes at the division II and division III level, multi-sport athletes had less psychological stress than athletes who specialized (Garinger, Chow, Luzzeri, 2018).

Statement of the Problem

Athletes are choosing to specialize in a single sport instead of diversifying in the hopes of achieving athletic successes, including collegiate scholarships and becoming a professional athlete (Padaki, Popkin, Hodgins, Kovacevic, Lynch, & Ahmad, 2017). However, sport specialization comes with many risks. Do the athletes and others involved in the decision making process know all the risks that are involved in sport specialization? Are they choosing to specialize instead of diversifying for the right reasons? The risks that can be endured by the athlete can be both physical and psychological. Often, early sport specialization may have more negative outcomes than benefits (Gould, 2010). Yet, peak performance demands intense training. The key may be at what age specialization should occur.

Injury risk is one of the greatest problems when it comes to sport specialization, specifically, lower extremity injuries. It was found that athletes who specialized are more likely to have a lower extremity injury occur (McGuine, Post, Hetzel, Brooks, Trigsted, & Bell, 2017). Additionally, female athletes who played a club sport or were highly specialized had higher

levels of lower extremity injuries (Post, Bell, Trigsted, Pfallar, Hetzel, Brooks & McGuine, 2017). In addition to injury risk, the psychological toll that can be seen on the athlete is significant. According to Garinger, Chow and Luzzeri (2018), the link between perfectionistic concerns and burnout is stress. Specialized athletes consistently report higher amounts of stress than their multi-sport counterparts.

Purpose of the Study

The purpose of this synthesis project is to outline whether or not sport specialization is worth the risk. In addition, this synthesis will explore the myths of sport specialization as well as the realities and attempt to determine whether there is a difference between early and late specialization.

Research Questions

1. What are the statistical trends in sport specialization? How common is specialization among youth?
2. What are the roots of specialization? Why do children specialize?
3. What are the potential benefits of early specialization? What are the potential benefits of late specialization?
4. What are the potential risks of specialization vs diversification?
5. Is specialization more effective in some sports than others?

Operational Definitions

1. Sport specialization- a. Training for a single sport eight or more months a year; or choosing a single main sport; or and/or quitting all other sports to focus on just one (Myer, Jayanthi, Difiori, Faigenbau, Kiefer, Logerstedt, Micheli , 2015).

2. Sport sampling- participating in more than one sport (Distefano, Beltz, Root, Martinez, Houghton, Taranto, & Trojian, 2018).
3. Single sport athlete- focus on training and development in a single sport on a year round basis (Martin, Ewing, & Oregon, 2017).
4. Multi-sport athlete- an athlete that participates in at least one other sport other than their "main" sport (Rugg, Kadoor, Feeley, & Pandya, 2018).
5. Sport diversification or diversifying- children trying a variety of sports and physical activities (Distefano, Beltz, Root, Martinez, Houghton, Taranto, & Trojian, 2018).
6. Early specialization- playing and training for a single sport, while excluding other sports, for eight or more months of the year, before the age or 12 (Padaki, Popkin, Hodgins, Kovacevic, Lynch, Ahmad, 2017).
7. Late Specialization- year round training in one sport after the age of 12 (Garinger, Chow & Luzzeri, 2018).

Assumptions

1. All the participants in the studies answered all of the questionnaires truthfully.
2. All the participants put in the maximum effort when performing any of the tests given.
3. All the data instruments used are reliable.
4. The literature review was exhaustive and comprehensive.

Delimitations

1. All articles that were reviewed were within the last 15 years.
2. The research articles used in this study were peer reviewed and data driven.
3. All articles focused mainly on youth athletes.
4. All articles focused on either early or late specialization

Limitations

1. The studies may not contain a large enough sample of literature review to form generalizations.
2. The topic is relatively new and therefore there is not an abundance of research available.
3. Much of the literature focuses on team sports.

Chapter 2

Methods

The purpose of this synthesis project is to outline whether or not sport specialization is worth the risk. Another purpose is to explore the myths and realities of sport specialization. The purpose of this chapter is describe the methods and procedures that were used to locate a critical mass of articles to be synthesized for this review. This chapter will also describe how each article was chosen to be included in this synthesis project.

The research for this synthesis project was conducted by using The College at Brockport Drake Memorial Library's website. Specifically, EBSCO Host was utilized and the search engines SportDiscus and Academic Search Complete were used. The searches that were conducted provided thousands of results. Through the thousands of results that were found, 17 articles were selected to meet the specific criteria that had to be met for this synthesis project. All of the articles that were chosen were full text articles and peer reviewed in academic journals between the years 2003 and 2019.

One of the first searches that was performed through SportDiscus and Academic Search Complete utilized the key words *sport specialization*. The search was for articles within the last 10 years and was limited to only scholarly (peer reviewed) journals. This search produced 1,031 results. Another search was done through SportDiscus that included the *sport specialization* and *statistics*. This search was narrowed to peer reviewed articles between 2004 and 2019. This search resulted in 313 different articles. When the search was moved the years of 2009 and 2019, which resulted in 303 articles. The next search completed consisted of the words *sport specialization,* but those words to only be included in the title of the articles. Again, this search was done between the years 2004 and 2019 and only for peer reviewed articles. This search

produced 109 results. Other searches were done that included the combination of *sport specialization* and *age, trends, benefits, burnout* and *when*. These searches resulted in 355, 39, 43, 27 and 56 articles respectively. Sport diversification was searched resulting in 353 results. To try and narrow that search down, "sport diversification" OR "sport sampling" was searched, only garnering 10 results. However, when sport (diversification OR sampling) was searched there were 9,445 results. From all of these searches I was able to select 17 peer reviewed articles to be included in the critical mass. The 17 articles were chosen, after thorough examination of all the resulting articles and reflecting on them in accordance with the title and the specific set of research questions outlined for this synthesis. This narrowed the hundreds and thousands of results down to the very specific 17 reflected in the synthesis.

A very specific set of criteria had to be met for an article to be considered for the critical mass in this synthesis project. All of the research articles included in this synthesis were full text articles in peer reviewed journals no earlier than 2003. Additionally, research articles in this synthesis had to be about sport specialization for youth and the benefits and the risks involved.

A total of 17 research articles were selected after an exhaustive and comprehensive search of the available literature. The articles that were selected for this synthesis came from the following journals: *American Journal of Sports Medicine, Sports Health: A Multidisciplinary Approach, High Ability Studies, Athletic Training & Sports Health Care: The Journal for the Practicing Children, Current Sports Medicine Reports (American College of Sports Medicine), Journal of Sport Behavior, Kinesiology Review, Scandinavian Journal of Medicine & Science in Sports, Journal of Applied Sport Psychology, Journal of Sport Behavior, Retos: Nuevas Perspectivas de education fisica, deporte y recreacion, Anxiety, stress and Coping, Journal of Clinical Sport Psychology, and International Journal of Sports Physiology & Performance.*

The number of participants in the selected articles ranged from 28 to 1,544. The total number of participants for all of the selected articles was 6,810. The ages that were included varied. Youth aged seven to 18 were included in the studies included in this synthesis. There were also a number of different sports represented throughout the studies. The different sports represented included, football, track and field, cross country soccer, swimming and diving, baseball, wrestling, basketball, golf, tennis, rowing, gymnastics, volleyball, field hockey, hockey, softball, figure skating and marathons.

Quantitative methods, structured interviews, surveys and questionnaires were utilized in the articles included in this synthesis project. The software utilized to analyze the data from these articles included SPSS, R statistical software and R Studio software. Through these programs, researchers were able to perform a litany of tests. The most frequent test used throughout all of the articles was Chi-square tests. In addition to Chi-square tests, MANOVAs and ANOVAs were also frequently utilized. T-tests were utilized in seven of the studies. Logistic regression was used in two separate studies. The tests that were used only one time throughout all of the studies included McNemar test, MSPA, 2 tailed Fisher test and ANCOVA.

Chapter 3

Literature Review

Chapter three of the synthesis is the literature review. In this chapter, all of the articles included in the critical mass are reviewed. The review is organized into four different themes, *roots of specialization, overuse injuries, burnout and outcomes of specialization.*

Roots of Specialization

Bell, Post, Trigsted, Hetzel, McGuine, & Brooks' (2016) sought to determine whether or not school classification methods, year in school, sex and school size had an impact on an athlete specializing in a sport. Additionally, they wanted to explore whether there was a correlation between highly specialized athletes and injury history. For this study, 302 athletes from two local high schools, ranging from the ages 13 and 18 years old were surveyed. There were two surveys, one was a specialization survey and one was an injury history survey. This study was a cross sectional study. Athletes used a three point scale to determine their level of specialization. The three different categories of specialization consisted of low, moderate and high specialization. The three questions that were asked to determine their level of specialization were, "have you quit other sports to focus on one sport?", "Do you train more than eight months out of the year in one sport?" and "Do you consider your primary sport more important than other sports?" A yes to these questions equaled one, a no equaled zero. If the score totaled three, they were considered high specialization, a score of two was considered moderate and a score of one was considered low specialization. The low group consisted of 105 athletes, moderate had 87 athletes, and the high group had 110 athletes.

This study found that athletes from small schools were more likely to consider themselves multisport athletes than those from larger schools. The athletes from small schools

were categorized more frequently in the low specialization group, 43%, than the high specialization group, 25%. While athletes from the large schools were categorized in the low specialization group at a rate of 26% and the high specialization group at a rate of 48%. The large school had over 2,000 students, while the small school had just over 600 students. The size of the high school influenced the prevalence of specialization. Athletes that specialized were more likely to report hip and knee overuse injuries. Additionally, athletes who trained for eight or more months out of the year reported a higher history of overuse knee, knee and hip injuries. "A better understanding of the prevalence and risk factors of early sport specialization can aid athletes, parents, clinicians, and coaches in making decisions for the long-term benefit of the athlete," (Bell, Post, Trigsted, Hetzel, McGuine, & Brooks, 2016).

Padaki, Popkin, Hodgins, Kovacevic, Lynch, & Ahmad (2017) explored the growing trend of sport specialization despite evidence opposing it from the medical community. A survey was given to 235 patients and athletes between the ages of 7 and 18 to discover the driving factor behind sport specialization.

The study showed that there are many factors outside of the athletes' own aspirations, including coaches and parents pushing them towards specializing. Approximately one-third of the athletes have been told by parents and coaches not to play other sports. Additionally, athletes who were training 11 to 12 months out of the year experienced lower body injuries. There were 174 athletes (75%) who reported a sports related injury. Athletes who played year round accounted for 46% of the injuries, while non-injured athletes accounted for 26%. Athletes started to specialize around eight years old, with 31% playing a single sport, 585 playing multiple sports (but had a preferred sport). More than 70% of athletes had collegiate or professional ambitions. Sixty percent of the athletes played their primary sport for nine or more months per year.

Additionally, overuse injuries were found in athletes who were training 11 to 12 months out of the year in the same sport. These injuries are now accounting for a majority of the youth-sports related injuries.

The purpose of the study by Martin, Ewing, & Oregon (2017) was seeing what the perceptions of division I athletes had on sport specialization. For this study, 1041 athletes from division I universities located in the Midwest were surveyed. Five of the surveys were excluded because they were not finished. The sports included in the survey were football, track and field, soccer, cross country, swimming and diving, baseball, wrestling, basketball, golf, tennis, rowing, gymnastics, volleyball, field hockey, hockey, softball, figure skating. There were 559 males and 466 females and 11 did not specify their sex.

The results of this study showed that athletes started playing sports at different ages or younger ages because of the structure of the sport, but most athletes didn't start specializing until later in the sport. Athletes started playing their main sport around the age of nine years old. They did not start to specialize in those sports until around the age of 12. Gymnasts specialized at earlier than other athletes. They started practicing specialization at the age of 8.41. The study indicates is more beneficial to not specialize. More of the athletes included in the study played multiple sports throughout high school than specialized. This is is significant because all of the athletes in the study were Division I athletes. This indicates that early specialization is not required to reach elite status. Additionally, if an athlete did specialize it was not until around the age of 12.5.

The purpose of the study by Biese, Post, Schaefer, Bell (2018) was to determine what the motivation factors were behind specialization in female volleyball athletes. Additionally, it was to discover what the levels of participation were within those female volleyball athletes. For this

study two high schools were focused on. These high schools had 102 female volleyball athletes between the ages 13 and 18. All these athletes were surveyed. The questions on the survey included participation metrics, influential factors and sport specialization. The survey for sport specialization was used in previous studies and used a three point question system. The questions for this survey were, “have you quit other sports to focus on one sport?”, “Do you train more than eight months out of the year in one sport?” and “Do you consider your primary sport more important than other sports?” One point was assigned for each question that was answered yes. Zero points were assigned for each answer of no. If the athlete’s total score was a three, they were considered high specialization, two was moderate specialization, and one was low specialization. The influential factors survey was based on 11 different factors. A five point Likert scale was assigned for each response from, “did not influence at all” to “was extremely influential.” Based on these responses the athletes were then categorized into three groups, “no influence,” “low influence,” and “high influence.” The participation metrics were gathered by having the players all the months, within the last 12 month period, that they played organized volleyball and all the months they played another sport including volleyball. The results were then calculated to determine the months per year playing volleyball and any other sport. The players were also asked to mark how many hours per week they participated in organized volleyball and any other sport, including volleyball.

The results in this study found that much of the motivation to specialize stemmed for wanting to obtain a collegiate scholarship. When the athletes were asked to rank the influential factors for focusing on volleyball, highly specialized athletes ranked obtaining a college scholarship as “extremely” or “high” at a rate of 39%. Athletes considered low specialization only ranked these two factors at a rate of 6%. Additionally, athletes that would be considered

highly specialized were participating at levels that would be considered unsafe. The specialized volleyball athletes were participating in volleyball for over 18 hours per week. They were also playing volleyball over eight months of the year. Additionally, they were not playing any other sport other than volleyball. This puts them at a much greater risk for overuse injuries. Burnout is another great risk these athletes endure, "early sport specialization and high participation volume, and it can lead to drop-out." (251). Similar to previous research, heavy parental pressure, sibling pressure, lack of sport peers and coaching pressure were all factors for athletes dropping out their sport.

The purpose of the study by Russell (2014) was to examine former youth athletes' motivations, and current sport or exercise participation and whether or not they specialized in youth sports. Undergraduate students from a mid-sized Midwestern University were surveyed. There were 200 participants, with 93 of them being male and 107 being female. The survey questions included demographic questions, whether they participated in a single youth sport, their current sport participation classification (competitive, recreational, do not participate) and questions about current aerobic and resistance training frequency. They also answered a question to why they participated in youth sports and this was tallied using a five point Likert scale from strongly disagreeing (1) to strongly agreeing (5). The nine items on why they participated in youth sports were, (1) to have fun, (2) to win, (3) to do something I was good at, (4) to stay in shape, (5) to learn and improve skills, (6) to play as part of a team, (7) to be recognized as an athlete by my peers, (8) to be promoted to the next level in my sport, and (9) to feel competent about my physical abilities. All of the participants were from general education courses and this was done in order to get a more generalized sample population.

A majority of the athletes that were surveyed reported specializing and 72 of the 113 that considered themselves to have specialized reported specializing before the age of ten. Six years old was the most common age reported for when an athlete began specializing. Also, those athletes that specialized as youth were more likely to report they did not participate in sports as a young adult compared to those that did not specialize as a child. The most common reasons, for athletes who specialized, no longer participating in sports were, lack of time, lost interest and lack of fun. When comparing specializers to non-specializers, specializers reported not participating in sports as an adult at a rate of 59%, while non-specializers reported not participating in sports as an adult at a rate of 41%. Athletes who specialized reported having much higher extrinsic motivation for doing so compared with athletes who did not report themselves as specialized. "Specializers' regulation of sport participation through self-imposed anxiety/guilt over not doing so, as is characteristic of introjected regulation, may have led to burnout and dropout, thus lower sport participation as young adults," (298). The findings that occurred in this study support that sport specialization may have negative effects on long term sport participation.

Overuse Injuries

McGuine, Post, Hetzel, Brooks, Trigsted, & Bell, (2017) did a research study to examine the correlation between lower extremity injuries and sport specialization. Athletes from grades 9-12 in 29 different Wisconsin high school sports were recruited to be in the study. A total of 1,544 high school athletes were surveyed. These athletes completed in 2,843 athletic seasons and competed in 167,349 athletic exposures. These participants completed questionnaire about their sport participation and their history of lower extremity injuries. A 3-point scale that was

previously published was used to determine a specialization level of low, moderate, or high. The questions used to determine the specialization level were, (1) Have you quit another sport to focus on your primary sport? (2) Do you consider your primary sport more important than your other sports? (3) Do you train more than 8 months a year in your primary sport? One point was given to an answer of yes and zero points was given to an answer of no. A total of three points would place an athlete in the high specialization category, two points would be considered moderate, and one point would be considered low.

The results of the study were as follows: Athletes who reported as high sport specialization were 13.4% of total participants, followed by moderate at 27.1% and low at 59.5%. Lower extremity injuries were more prevalent in the moderate group than the low group. Additionally, high specialization participants had more lower extremity injuries than the low specialization participants. Athletes who specialized were more likely to have a lower extremity injuries occur than those that did not. An athlete who was classified as highly specialized had a 85% greater risk of having a lower extremity injury occur. Additionally, an athlete that was classified as moderate specialization, was at a 50% greater risk to have a lower extremity injury occur.

The purpose of the study by Post, Bell, Trigsted, Pfallar, Hetzel, Brooks & McGuine's (2017) study was to look at the impact of sport specialization and club sports on athletes in their high school careers and whether or not they were having lower extremity injuries occur more often. Also, they determined whether or not the sex of the athlete played a role in sport specialization, club participation and competition volume. There was a total of 1,544 high school athletes, 780 girls, from 29 different schools completed a questionnaire before the start of their

competitive season. The questionnaire was in regards to their sport participation and previous injury history.

Of the 1,544 athletes that completed the questionnaire, girls were more likely to specialize, have high competition volume, and participate in a club sport. Of the total participants 16.4% of the females were considered specialized, while 10.4% of the male athletes were considered specialized. Athletes who had high sport volume, played a club sport, or were highly specialized had higher levels of lower extremity injuries. Girls reported having lower extremity injuries at a rate of 36.5% and boys reported having lower extremity injuries at a rate of 27%. Therefore, it was concluded that girls who are engaging in high competition volume, participating in club sports or are highly specialized are placing themselves at greater risk of lower extremity injuries.

The Distefano, Beltz, Root, Martinez, Houghton, Taranto, & Trojian (2018) study was executed to determine whether youth athletes who participated in multiple sports scored better on the LESS (Landing Error Scoring System) test, than those that only played one sport. The LESS analysis is a clinical tool that can accurately analyze lower extremity movements during a jump landing. The higher the score on the test, the more errors have occurred. The more errors in this test can indicate a greater risk for an ACL tear in youth athletes. Research suggests that sport sampling is better for youth than sport specialization due to less chance of injury and burnout and that is why the authors thought this research was important. There were 355 local youth athletes who self-reported their participation levels. They then completed a jump landing task that was evaluated using the LESS test.

The results of the study showed that multi-sport athletes were 2.5 times more likely to be categorized as having a controlled landing compared to their single sport counterparts.

Additionally, participants who had high sampling of sports had 5.8 to 5.4 times more control than those that had moderate to low sampling. Single sport elite athletes that were exposed to at least one sport until the age of nine and athletes who were still participating in more than one sport had less errors and greater control than their counterparts when performing the LESS test. An athlete being exposed to a variety of sports and physical activities in their youth may be associated to better neuromuscular control. This is important because it could determine their risk for future injury and participation in sports throughout their lifetime. Therefore, "sport sampling at a young age is associated with improved neuromuscular control, which may reduce injury risk in youth athletes," (Distefano, Beltz, Root, Martinez, Houghton, Taranto, & Trojian, 2018, p.160).

Burnout

The purpose of the study by Russell & Molina (2018) was to determine if an athlete specialized in a sport and if there was correlation between their motivations and burnout. The study focused strictly on 77 female athletes. To determine the athlete's motivation they used the Sport Motivation Scale-II which had been edited from the original Sport Motivation Scale. This scale measures sport motivation participation and contains 18 items and six types of motivation. The six different types of motivation included are intrinsic regulation, integrated regulation, identified regulation, introjected regulation, external regulation and non-regulation. There was specific question that the athletes answered on a seven point Likert scale. The questions they answered was, "why do you practice sports (or your sport)?" The athletes also completed an Athlete Burnout Questionnaire. These tools measures the 3 subscales of burnout including reduced sense of accomplishment, emotional and physical exhaustion, and sport devaluation. The

athletes used a five point Likert scale to determine the extent to which each of those items pertained to them.

The results of this study found that of the 77 athletes, 53 of them specialized in a single sport. The athletes who specialize and one's who did not had similar motivations and did not experience elevated burnout. Most of the athletes have only been specializing in a single sport for less than four years. The fact the athletes in this study have not specialized for an extended amount of time could be the reason that the results support previous research that suggested specializers and non-specializers were more similar than dissimilar in their experiences and outcomes. The study also found that largest indicator of a sense of lack of accomplishment was amotivation. The study found that there was positive correlations between amotivation reduced sense of accomplishment, exhaustion, and sport devaluation. These results were similar to previous studies that have been completed and support the fact that amotivation is a significant predictor in burnout.

The next study included in the critical mass was performed by Russell & Limle (2013). The purpose of this study was to examine whether the perceptions of physical activity and physical activity patterns in young adults was related to their youth sport experience. This included sport specialization. This study was done with 153 participants, 71 males and 82 females. The participants were selected from general education classes at a mid-size Midwestern University. The participants completed surveys. The demographic survey included questions on the age and gender, whether they specialized in a single sport as a youth and their current participation level in the sport they specialized in (competitive participant, recreational participant, and do not currently participate). Additionally questions included the current frequency of sport participation, aerobic exercise, and resistance training.

Results indicated that 11.1% of athletes specialized, started specializing by the age of eight. Additionally, 9.8% of the athletes that specialized indicated that they began specializing at the age of five. The study found that 21.6% of the participants were competitive participants in the sport they competed in as a youth, 43.1% were recreational participants and 35.3% no longer participated in the sport they participated in as a youth. The results of a Chi-Square test in the study revealed that young adults who specialized in one sport as a youth and did not currently participate in the sport was significant. This indicated that athletes that specialized in one sport as a youth were less likely to participate in that sport as a young adult. There was also indications that if the participant's perceived enjoyment of their experience in sport as a youth was positive, they were more likely to enjoy physical activity as a young adult. This links athletes who specialized to burnout, autonomy and dropout which lowers their participation motivation.

In Garinger, Chow & Luzzeri's study (2018), the purpose was to examine the relationship between perfectionism, concerns about burnout, and perceived stress in DII and DIII specialized and multi-sport athletes. For this study, 522 division II and division III NCAA track field programs were chosen. Data was collected from 522 participants. Due to a lack of data in some of the responses, a total of 351 participants were selected. Of the total participants 38% of them were Division II athletes and 62% of them were Division III athletes. There were a total of 159 athletes that were considered specialized. All of the participants in this study took a demographic questionnaire and regarding measures of perfectionism, stress, and burnout during the latter part of their competitive season. The study used the sport-multidimensional scale-2 to assess the six facets of sports perfectionism. They are perceived coach pressure, perceived parental pressure, concern over mistakes, personal standards, organization and doubts about actions. A five point Likert scale was used to rate each of the facts, one indicating strongly disagree to five indicating

strongly agree. Additionally, a perceived stress scale was used to determine perceived levels of stress on the athletes. The perceived stress scale asses control, overload, and thoughts and feelings of stressful events. An example of a question that would be asked during this portion of study would be, “In the current track and field season, how often have you felt you were on top of things?”. There is then a five point Likert scale assigned for the responses to the question, 0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often, and 4 = very often. Lastly, the athlete burnout questionnaire was utilized. This questionnaire is a tool that measures burnout. The three subscales of burnout included are a reduced sense of accomplishment, sport devaluation, and emotion and physical exhaustion.

There were many implications found in this study in regards to stress, perfectionism and sport specialization. The study revealed that specialized athletes reported greater amounts of stress than multi-sport athletes. “The direct path from COM (i.e., concerns) to burnout was positive and significant ($\beta = .23$, $p < .001$), as well as its total effect ($\beta = .449$, $p < .001$). The path coefficients from COM to perceived stress ($\beta = .48$) and from perceived stress to burnout ($\beta = .47$) were both positive and significant ($p < .001$) as expected,” (p. 719). This study found that there was a positive and direct correlation between perfectionism and burnout. Stress was partially responsible for this relationship. Also, there was a negative direct effect on burnout and specialized athletes. Stress can be described as the factor bonding perfectionistic concerns and burnout.

Outcomes of Specialization

The purpose of the study by Moesch, Elbe, Hauge, & Wikman’s (2011) was to determine whether young athletes need to specialize in order to succeed or if sport sampling is the best path to success. The study examined the differences in practice hours during the early part of athlete’s

career, how many other sports they were involved in, career development, and if these variables can predict whether an athlete reaches elite status. A questionnaire was utilized to gather this information. Included in the questionnaire was biographical information, practice hours in their main sport, involvement in other sports, career development, weekly training schedule and athletic success. For the career development portion of the questionnaire, they included at what age they participated in their first national and international competition, and how many years they were a member of the junior and senior national team. The athletes reported the results from any international competitions at the junior and senior levels for the athletic success portion of the questionnaire. Danish athletes, 148 elite and 95 near-elite, were studied in regard to differences in practice hours during early stages in their career, involvement in other sports and career development. They then determined whether the factors predicted whether or not they were in the elite group. For an athlete to be considered elite, they must have placed in the top-10 at a championship at the world level or won a medal at a championship at the European level.

The results of this study found that the elite athletes specialized at a later age and trained less in their childhood. The near-elite athletes have significantly more training hours before the age of nine than the elite athletes did. Additionally, they continue to accumulate more hours of practice until age 15. When the two groups of athletes reach the age of 18, their practice hours were roughly the same. After the age of 18, however, the elite athletes complete many more hours of practice than non-elite athletes and it is even more significant by the age of 21. This shows that the elite athletes are specializing at a later age than non-elite athletes. This study confirms what other studies have found. That elite athletes training intensifies at a later age compared to their near-elite counterparts. This also indicates that the practices during the mid-teen years are crucial for success.

The study by Baker, Cote, & Abernethy (2003), sought to determine how much deliberate practice was needed to become an expert decision maker in an athlete's respective sport. There were 28 participants in this study. The participants in the group that was considered to be experts consisted of 15 athletes, three from the women's Australian netball team, four from the men's national basketball team, four from the national men's field hockey team and four from the women's national field hockey team. Each of the teams selected here were either world champions or ranked in the top 4 in the world. The coaches from the team chose the athlete as being a great decision maker, and 13 non-experts were chosen as well. All of the athletes did not play past the state or provincial level. All the participants participated in a structured interview. The interview was structured to determine the practice activities of the athletes. The interview was taken one-on-one and lasted between two and three hours was an attempt to create a longitudinal view of the athletes sport involvement and other activity involvement.

The results of this study indicate that participating in a wide variety of activities is a critical element in becoming an expert decision maker. Participating in and practicing in a wide variety of sports, specifically when it comes to generic decision making and pattern recognition, can be substituted for the need of so many hours of sport-specific practice in regards to becoming an expert in team ball sports. The most important determination found was that early specialization is not necessary for expert level performance in decision-making.

The study by Latorre-Roman, Pinolls, & Robles (2018) analyzed the dropout rates of the top 10 athletes in the Royal Spanish Athletics Federation between the ages of 14 and 19 years old, during the time period of 2004-2014. All of the top 10 finishers from 2004 to 2014 were examined off the RFEA website. The categories that were specifically focused on were outdoor

events, including running, jumping and throwing. There were 1,144 participants, 594 males and 550 females.

The results of this study showed that the number of athletes in the top 10 from 2004-2014 dropped dramatically. In the year 2004, 96.5% were considered dropouts from high performance and that number increased in 2014 to 98.72% for women and 94.45% for men. The study suggested that to avoid the risk of injury, and adverse psychological stress, specialization should be not be occurring until late adolescence.

The study by Ginsburg, Danforth, Ceranoglu, Durant, Robin, Smith, Kamin, Babcock, & Masek, (2014) examined two common ideas that lead to sport excellence, early specialization and early sampling. The assumption is that specialization is the best path, but even the research is still unclear. This study was done to add to the current research. This study was a survey of 708 minor league professional baseball players. Each of the participants volunteered to complete a questionnaire. The questionnaire collected information on whether or not they specialized in baseball at a young age or they sampled in sports during their teen years.

The results of this study showed that only 25% of players specialized before age 12 and the median age of specialization was 15. Early specialization did not have a greater impact compared those athletes that specialized later. Ironically, the athletes that specialized later were more likely to receive scholarships. Sport sampling was of greater relevance and more impactful than sport specialization. It was shown that sport sampling lead to more success than sport specialization. “Players who received a baseball scholarship specialized at a significantly later age,” (Ginsburg, Danforth, Ceranoglu, Durant, Robin, Smith, Kamin, Babcock, & Masek, 2014, p. 270).

The study by Rugg, Kadoor, Feeley, & Pandya (2018) examined the effect that early sport specialization has on the length of NBA players' careers and the injuries that occur throughout their career. The researchers studied first round picks from 2008-2015. Overall, 237 participants were included. The information that was acquired for this study was found by searching for available information on the internet, such as major injuries sustained while in the NBA, percentage of games played in the NBA, and whether the players were still active in the NBA at the time of the study. Athletes who competed in sports other than basketball in high school were considered multi-sport athletes. If an athlete competed only in basketball they were considered to be specialized.

The results in this study show that there were only a small percentage of athletes who were multi-sport athletes in high school. However, being a multi-sport athlete can be considered more beneficial than being a single sport athlete because multi-sport athletes played in a much higher percentage of games than the single sport athletes. Also, multi-sport athletes experienced a smaller percentage of major injuries throughout their career. Longevity was also a result of being a multi-sport athlete that many of the NBA players experienced. A large number of multi-sport athletes were still in the league compared to single sport athletes, 94.5% vs 81.1%

Noble and Chapman (2018) examined the differences in elite African and non-African male marathon runners based on age, performance and career length in regards to event-specific specialization was examined. The top 90 African marathon runners were compared to the top 90 non-African marathon runners from 2001-2015. The age of specialization, career length and performance were all used as a means of comparison. R-studio software was used to complete statistical analysis. T-tests were utilized to compare the two groups of marathoners. A 1-way ANOVA was used to assess the differences in rates of improvement and decline and another 1-

way ANOVA was used to assess differences between-group's performance relative to mean performance.

The results of this study found that African marathon runners specialized at ages 1.5 years younger than their counterparts. Additionally, they were able to achieve peak levels of performance and then retire younger than the non-African runners. African runners retired at an age of almost three years earlier than non-African runners. It was also found that the non-African runners were slower in the half-marathon when compared to the African runners at the same point of their career. The athletes who specialized earlier also were found to have greater rates of improvement than those who specialized at a later age.

Chapter 4

Discussion

This chapter of the synthesis will serve as the discussion. This chapter will reflect the results of the review of the literature on if sport specialization is worth the risk: the myths and realities. The research questions in chapter one will serve as guide for the discussion.

Research question #1: What are the statistical trends in sport specialization? How common is specialization among youth?

Specialization among athletes is becoming more and more frequent. Where an athlete grows up can have an influence on whether or not they consider themselves single sport or multi-sport athlete. Athletes from small schools were more likely to consider themselves multi-sport athletes, 86%, than those from larger schools, 56% and the size of the high school influenced the prevalence of specialization (Bell, Post, Trigsted, Hetzel, McGuine, & Brooks 2016). In addition to the difference in trends from larger and smaller school schools, there are variations among how athletes are specializing and at what age.

The age at which athletes are specializing is becoming younger and younger. Athletes who played soccer, basketball, baseball, softball, lacrosse, cross-country, track and field and others, specialized around eight years old in a study by Padaki, Popkin, Hodgins, Kovacevic, Lynch, & Ahmad, (2017). Of all the athletes studied, 31% played a single sport. The same research indicated that, 585 athletes played multiple sports, but had a preferred sport. Also, more than 70% of athletes had collegiate or professional aspirations and 60% of the athletes played their primary sport for 9 or more months per year. Finally, a majority of the athletes that were

surveyed reported specializing and 72 of the 113 that considered themselves to have specialized reported specializing before the age of 10 (Russell, 2014).

Research question #2: What are the roots of specialization? Why do children specialize?

There are a variety of reasons why athletes are increasingly choosing to specialize. Many athletes started playing sports at different ages or younger ages because of the structure of the sport, but most athletes didn't start specializing until later in the sport (Martin, Ewing, & Oregon, 2017). As athletes moved from their freshman year of high school, to their senior year they perceived it to be more and more important to specialize (Martin, Ewing, & Oregon, 2017). Early specialization is not critical for success as most participants did not specialize until after the age of 12.5 (Martin, Ewing, & Oregon, 2017). Additionally, outside motivations greatly influenced athletes and the choice on whether or not they specialized. Much of the motivation to specialize stemmed from wanting to obtain a collegiate scholarship (Biese, Post, Schaefer, Bell, 2018). Athletes who specialized reported having much higher extrinsic motivation for doing so compared to athletes who did not report themselves as specialized (Russell, 2014). The findings that occurred in this study support the idea that sport specialization may have negative effects on long term sport participation (Russell, 2014). "Specializers' regulation of sport participation through self-imposed anxiety/guilt over not doing so, as is characteristic of interjected regulation, may have led to burnout and dropout, thus lower sport participation as young adults," (Russell, 2014, p. 298).

Research question #3: What are the potential benefits of early specialization? What are the potential benefits of late specialization?

Most of the benefits can be found from specializing later in life. It was found that the elite athletes specialized at a later age and trained less in their childhood (Moesch, Elbe, Hauge, &

Wikman, 2011). In the later stages in their career, around the age 21, their training did intensify compared to their near-elite athlete counterparts (Moesch, Elbe, Hauge, & Wikman, 2011). It was found that the practices during the mid-teen years were crucial for success (Moesch, Elbe, Hauge, & Wikman, 2011). Participating in a wide variety of activities is a critical element in becoming an expert decision maker (Baker, Cote, Abernethy, 2003). Expert athletes ranged from seven to 20 years of practice time before being selected for a national team and all but one had a minimum of 10 years of involvement before being selected (Baker, Cote, Abernethy, 2003). Participating in and practicing a wide variety of sports, specifically when it comes to generic decision making and pattern recognition, can be substituted for the need of so many hours of sport-specific practice in regard to becoming an expert in team ball sports (Baker, Cote, Abernethy, 2003). The most important determination found from this study was that early specialization is not necessary for expert level performance in decision-making (Baker, Cote, Abernethy, 2003).

Research question #4: What are the potential risks of specialization vs diversification?

There are many potential risks involved with specializing, particularly when specializing at an early age. Some of the risks are similar in nature while others are very different. The results of one study found that athletes who specialize and one's who did not had similar motivations and did not experience elevated burnout (Russell & Molina, 2018). The one way MANOVA score, examining the effect of sport specialization on sport motivation, had a score of .945- indicating no strong significance (Russell & Molina, 2018). The findings in this research supported previous research that suggested specializers and non-specializers were more similar than dissimilar in their experiences and outcomes (Russell & Molina, 2018). While there was a large sample of athletes who specialized, 53 out of the 77, many of them had specialized for less

than four years. Researchers surmised this could the reason for the similarities between the specializers and non-specializers in regards to motivation (Russell & Molina, 2018). However, even though there was some similarities, it was found that the largest indicator of a sense of lack of accomplishment was amotivation (Russell & Molina, 2018). Amotivation being a significant predictor in burnout was a result of this study and it supports previous studies (Russell & Molina, 2018). The study found that there was positive correlations between amotivation reduced sense of accomplishment, exhaustion, and sport devaluation (Russell & Molina, 2018).

Overuse injury is one of the largest concerns when it comes to specialization. Based on a three point scale that was previously used to determine the level of an athletes specialization, low, moderate, or high, 9 through 12 grade athletes from Wisconsin completed the survey and it was reported that the high sport specialization was the lowest rate at 13%, followed by moderate at 27.1% and low at 59.5% (McGuine, Post, Hetzel, Brooks, Trigsted, & Bell, 2017). Lower extremity injuries were more prevalent in the moderate sport specialization group than the low sport specialization group (McGuine, Post, Hetzel, Brooks, Trigsted, & Bell, 2017). Additionally, high sport specialization participants had more lower extremity injuries than the low sport specialization participants (McGuine, Post, Hetzel, Brooks, Trigsted, & Bell, 2017). In conclusion, athletes who specialized are more likely to have lower extremity injuries occur than those that did not (McGuine, Post, Hetzel, Brooks, Trigsted, & Bell, 2017).

Post, et. al found that girls were more likely to specialize, have high competition volume, and participate in a club sport. High competition volume can be defined as having more than 60 competitions in a year (Post, Bell, Trigsted, Pfallar, Hetzel, Brooks & McGuine, 2017). Athletes who had high sport volume, played a club sport, or were highly specialized had higher levels of lower extremity injuries (Post, Bell, Trigsted, Pfallar, Hetzel, Brooks & McGuine, 2017). The

odds ratio number for competition volume, club sport participation, sport specialization, and previous lower extremity injury was higher in athletes who reported high competition volume, p-value of 2.08, than those with moderate competition, p value of 1.68 (Post, Bell, Trigsted, Pfallar, Hetzel, Brooks & McGuine, 2017). Also, the odds ratio for high specialization had a higher p value, 2.58, than those with moderate specialization, p value of 2.38 (Post, Bell, Trigsted, Pfallar, Hetzel, Brooks & McGuine, 2017).

Being a multi-sport athlete also helped develop techniques and skills to prevent future injuries. Multi-sport athletes were 2.5 times more likely to be categorized as having a controlled landing compared to their single sport counterparts (Distefano, Beltz, Root, Martinez, Houghton, Taranto, & Trojian, 2018). Additionally, participants who had high sampling of sports had 5.8 to 5.4 times more control than those that had moderate to low sampling (Distefano, Beltz, Root, Martinez, Houghton, Taranto, & Trojian, 2018). Therefore, "sport sampling at a young age is associated with improved neuromuscular control, which may reduce injury risk in youth athletes," (p. 160).

The authors Bell, et. al (2016) found that athletes that were highly specialized were more likely to report hip and knee overuse injuries. Additionally, athletes who trained for eight or more months of the year reported a higher history of overuse knee, knee and hip injuries. Athletes who were highly specialized were 2.74 to 2.93 times more likely to have a lower extremity injury occur and Padaki, et. al (2017) also found that athletes who were training 11 to 12 months out of the year experienced more lower body injuries. Overuse injuries are very serious and all to frequent in today's athletic culture. Overuse injuries are now the majority of sports related injuries in youth (Padaki, Popkin, Hodgins, Kovacevic, Lynch & Ahmad, 2017). Additionally, athletes that would be considered highly specialized were participating at levels

that would be considered unsafe. It was found that athletes who participated in 16 hours or more of training a week were three times as susceptible to overuse injuries (Biese, Post, Schaefer & Bell, 2018).

Burnout is another great risk specializing athletes experience, "early sport specialization and high participation volume can lead to drop-out," (Biese, Post, Schaefer & Bell, 2018, p. 251). Athletes that specialized as youth were more likely to report they did not participate in sports as a young adult compared to those that did not specialize (Russell, 2014). "Separate independent i-tests comparing current exercise frequency based on specialization classification were nonsignificant for both aerobic exercise frequency (t=.\0\, p>.05) and strength training frequency (t=\.74, p>.05) as young adults," (Russell & Limle, 2013, p. 90). The athletes' exercise habits were also unrelated to whether or not they specialized or played multiple sports in their youth (Russell & Limle, 2013). The largest implication for the athletes who specialized in sport as youth was that they were less likely to participate in sports as young adults (Russell & Limle, 2013). This links athletes who specialized to burnout, autonomy and dropout which lowers their participation motivation (Russell & Limle, 2013). There was also a positive and direct correlation between perfectionism and burnout (Garinger, Chow & Luzzeri, 2018). The path coefficients from COM to perceived stress ($\beta = .48$) and from perceived stress to burnout ($\beta = .47$) were both positive and significant ($p < .001$) as expected," (p. 719). Stress was partially responsible for this relationship. Also, there was a negative direct effect on burnout and specialized athletes. Therefore, specialized athletes are more likely to burnout than non-specialized athletes. Stress can be described as the factor bonding perfectionistic concerns and burnout. In conclusion, specialized athletes reported higher amounts of stress than their multi-sport counterparts (Garinger, Chow & Luzzeri, 2018).

The number of athletes in the top 10 in the world rankings on the RFEA, Royal Spanish Athletics Federations) website from 2004-2014 dropped dramatically (Latorre-Roman, Pinolls & Robles, 2018). In the year 2004, 96.5% were considered dropouts from high performance and that number increased in 2014 to 98.72% for women and 94.45% for men. Women had a much higher dropout rate compared to men. The reasons cited for dropping out were the athletes, "had other things to do" (211) and "it was less interesting to them," (211). Other reasons included women reaching their peak athletic performance earlier than men (Latorre-Roman, Pinolls & Robles, 2018). The conclusion was that to avoid the risk of injury and adverse psychological stress, specialization should be not be occurring until late adolescence (Latorre-Roman, Pinolls & Robles, 2018).

Research question #5: Is specialization more effective in some sports than others?

Specialization is not something can be a utilized to an athlete's advantage in every sport. Some sports find it to be a more effective practice than others. Overall, specialization tends to result in more successful outcomes when done at a later age. In a study of 708 minor league baseball players, only 25% of players specialized before age 12 and the median age of specialization was 15 (Ginsburg, Danforth, Ceranoglu, Durant, Robin, Smith, Kamin, Babcock & Masek, 2014) and the athletes that specialized later were more likely to receive scholarships. Therefore, it was concluded that sport sampling lead to more success than sport specialization. "Players who received a baseball scholarship specialized at a significantly later age," (p. 270).

In another study, it was found that African marathon runners had success when specializing at an earlier age than their counterparts. Successful African marathon runners specialized at ages 1.5 years younger than their counterparts (Noble & Chapman, 2018). Additionally, they were able to achieve peak levels of performance and then retire younger than

the non-African runners. African runners retired at an age of almost three years earlier than non-African runners. It was also found that the non-African runners were slower in the half-marathon when compared to the African runners in the same point of their career (Noble & Chapman, 2018). The athletes who specialized earlier were found to have greater rates of improvement than those who specialized at a later age. African runners were found to have better performances at their first, best and last marathon performance compared to non-African runners (Noble & Chapman, 2018).

However, the type of sport may play a role. In a team sport like in basketball it was more effective for the athlete to be a multi-sport athlete. Multi-sport athletes played a much larger percentage of games than single sport athletes (Rugg, Kadoor, Feeley, & Pandya, 2018). For example, multi-sport athletes played in 78.4% of games compared to 72.8% for single sport athletes. Also, multi-sport athletes endured a smaller percentage of major injuries throughout their career, 25% compared to 42.8%. Finally, a large number of multi-sport athletes (94%) were still in the league compared to SS athletes (81.1%) (Rugg, Kadoor, Feeley, & Pandya, 2018).

Chapter 5

Conclusion and Further Discussion

Conclusion

Sport specialization is becoming a popular trend among youth athletes throughout the country. Each athlete has their own reasons why they are choosing to specialize. However, when making the decision to specialize vs. sport sample it is important for the athlete and their parents to understand whether sport specialization is worth the risk and what the myths and what the realities are behind the growing trend.

Many of the athletes are choosing to specialize because they have aspirations of obtaining collegiate scholarships. They then plan on going even further in their athletic careers by becoming professional athletes. They feel specialization in their sport will give them the best opportunity to achieve these milestones (Latorre-Roman, Pinolls & Robles, 2018). The belief is that they will perfect the skills necessary to achieve what so few athletes are able to, by practicing in one sport for eight or more months out of the year. They are looking for an edge.

While the athlete may have good intentions of wanting to strive to reach peak athletic status, this is often not the outcome. Some athletes are specializing because of extrinsic motivations. Pressure from coaches, parents and other players pushes them towards the path of specializing (Padaki, Popkin, Hodgins, Kovacevic, Lynch, & Ahmad, 2017). Additionally, the structure of some of the sports may cause the athlete to feel pressure to specialize instead of being a multi-sport athlete. The size of the school that attended also plays a role on the status as a single sport or multi-sport athlete. Many athletes from larger schools thought of themselves as single sport athletes or specializers compared to athletes from smaller schools. Unfortunately for

many of the athletes, if they are specializing because they, their coaches or their parents think that is the best way to achieve peak athletic performance and reach top milestones, they are falling into one of the myths of specialization.

While athletic scholarships and professional careers are often the dream, that is often not the outcome. Studies have found that instead of specializing, athletes should be sport sampling to reach these successes and milestones. It may be beneficial in some sports for some athletes, like African marathon runners, where it was found that they specialize earlier than their competitors and do achieve peak performance sooner (Noble & Chapman, 2018), but that is not the case for most sports. In the NBA for example, when compared to single sport athletes, multi-sport athletes in high school were even more successful once they reached the milestone of professionalism (Rugg, Kadoor, Feeley, & Pandya, 2018). Furthermore, studies revealed that it was actually more beneficial for athletes not to specialize to reach peak athletic performance, including attainment of better skill acquisition, collegiate scholarships and professionalism. Additionally, the physical and psychological toll that is found on some single sport athletes can be substantial (Russell & Limle, 2013).

One of the greatest outcomes of sport specialization that has been revealed by studies are overuse injuries (Bell, Post, Trigsted, Hetzel, McGuine, & Brooks, 2016). The constant and repetitive physical training that is occuring for an athlete who specializes is dangerous and can lead to injury. Overuse injuries are now leading the injuries for athletes in youth sports (Padaki, Popkin, Hodgins, Kovacevic, Lynch, & Ahmad, 2017). Athletes who specialize are much more susceptible to these overuse injuries. Lower-extremity injuries are very common for athletes who specialize. It was found that athletes who sport sample have better techniques and motor skills in jumping and landing studies than their single sport counterparts and this can actually help

prevent injuries from occurring (Distefano, Beltz, Root, Martinez, Houghton, Taranto, & Trojian, 2018). By sampling sports youth are able to acquire a wide variety of skills and techniques. They are also using a variety of different muscles, ligaments and structural systems within the body. If an athlete specializes, they are using the same muscles, ligaments and structural systems over and over again. This is what leads to overuse injuries. In addition to physical injury, there is a substantial psychological toll that can be seen on an athlete who specializes, which can lead to burnout. Athletes who specialize are more at risk for burnout than athletes who sport sample (Biese, Post, Schaefer, & Bell, 2018). Burnout can lead to athletes dropping out of their sport later in life. It was found that athletes were less likely to be involved in a sport as a young adult if they specialized in comparison to their sport sampling counterpart (Russell, & Limle, 2013). Also, studies found that women may be a higher risk for burnout than men. They were finding the sport less interesting later in life and had other things to do instead (Latorre-Roman, Pinolls, & Robles, 2018).

In conclusion, sport specialization is not the most effective way to reach peak athletic performance and achieve peak athletic milestones. Athletes dream of achieving athletic scholarships and becoming professionals. The best way to achieve this dream is by being a multi-sport athlete. The reality of sport specialization is not playing college sports or playing professional sports, it is having overuse injury occurs, becoming burned out and watching the multi-sport athletes achieving college scholarships and successful professional careers.

Future Research

In the future, more research needs to be done in a longitudinal structure. Being able to follow athletes from a very young age, seven years old for example, until the time they end their

athletic playing days will give further understanding to motivations and results of both sport sampling and sport specialization. Additionally, focusing on a variety of sports and more sports that tend to have a larger population of specialization, like tennis or gymnastics, can be beneficial in finding positive outcomes of sport specialization. A large variety of athletes must also be focused on in future studies. This will include different sports, geographic locations, socioeconomic statuses, race and sex. This will allow for a large population to be represented.

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Appendix A

Article Grid

Author, Title, Source	Research Question Number	Purpose	Methods & Procedures	Analysis	Findings	Recommendations
Bell, Post, Trigsted, Hetzel, McGuine, & Brooks, (2016). Prevalence of Sport Specialization in High School Athletics. American Journal Of Sports Medicine, Volume 44, Issue 6, pp 1469	One	This article was written to determine whether or not classification methods, year in school, sex and school size had an impact on an athlete specializing. Additionally, to see if there was a correlation between highly specialized athletes and injury history.	302 athletes from 2 local high schools, ranging from the ages 13 and 18 years old, were surveyed. There were 2 surveys, one was a specialization survey and one was an injury history survey. This study was a cross sectional study. Athletes used a 3 point scale to determine their level of specialization. The 3 different	Chi-square test was used to compare classification methods. Additionally, Chi-square tests were used to compare specialization by sex, year in school, school size and injury history. All of the analysis was done using SPSS statistical software.	Athletes from small schools were more likely to consider themselves multi-sport athletes, 86%, than those from larger schools, 56%. The size of the high school influenced the prevalence of specialization. Athletes that were highly specialized were more likely to report hip and knee overuse injuries. Additionally,	Future studies should include a larger number of schools to represent a variety of locations, socioeconomic statuses and sport offerings. Additionally, further studies should be done to narrow the focus onto specific sports.

			categories of specialization consisted of low, moderate and high specialization. The low group consisted of 105 athletes, moderate had 87 athletes, and the high group had 110 athletes		athletes who trained for 8 or more months out of the year reported a higher history of overuse knee, knee and hip injuries. Athletes that were highly specialized were 2.74 to 2.93 times more likely to have a lower extremity injury occur. "A better understanding of the prevalence and risk factors of early sport specialization can aid athletes, parents, clinicians, and coaches in making	

					decisions for the long-term benefit of the athlete," (pp 1469).	
Padaki, Popkin, Hodgins, Kovacevic, Lynch, Ahmad (2017). Factors that drive youth specialization. Sports Health: A multidisciplinary approach, Volume 9, Issue 6, pp 532	One	The purpose of this study was because the trend of sport specialization continues to grow even though the medical community is greatly opposing it.	A survey was given to 235 patients and athletes between the ages of 7 and 18 to discover the driving factor of sport specialization.	Qualtrics, a survey software was used to collect the responses from the surveys. Chi-square tests were used to to compare responses on a 5 point Likert-type scale against player's injury history, age and level of specialization.	Specialized athletes are having many factors outside of their own aspirations, including coaches and parents, pushing them towards specializing. Additionally, athletes who were training 11 to 12 months out of the year experienced lower body injuries. Athletes specialized around 8 years old, 31% played a single sport, 585	Longitudinal studies are recommended for future studies. Being able to follow an athlete from 7 years old and on would give great insight into the full impact that sport specialization has on a child.

					played multiple sports, but had a preferred sport, more than 70% of athletes had collegiate or professional aspirations. 60% of the athletes played their primary sport for 9 or more months per year. Overuse injuries are now the majority of sports related injuries in youth.	
Martin, Ewing, & Oregon, (2017). Sport experiences of Division I collegiate athletes and their perceptions of the	Two	The purpose of this study was to see what perceptions division I athletes had regarding	1041 athletes from division I universities located in the Midwest were surveyed on demograp	MANOVAs were used to assess if there were differences in gender and number of sports played at each level, perceptions of specialization and the actual	Athletes started playing sports at different ages or younger ages because of the structure of the	Some sports may pressure athletes into specializing early because of the structure of them and if that is the case then parents and athletes need to look

importance of specialization. High Ability Studies, Volume 28, Issue 2, pp 149		sport specialization.	hics, prior sport experience, frequency of participation in sport-related activities, and perception of importance for sports activities and specialization. Five of the surveys were excluded because they were not finished. The sports included in the survey included football, track and field, soccer, cross country, swimming and diving, baseball, wrestling, basketball	age when the specialization occurred. ANOVA was used to see if there was a difference in when the athlete started playing the sport and if they received a scholarship. ANOVA was also used to see if there was a difference in the age of the athlete and specific sports. MANOVA was then used again to see if there were differences in their past playing experience and sport, scholarship status and projected playing time. The Chi-square test was utilized to rates of specialization between the groups who indicated when they specialized.	sport, but most athletes didn't start specializing until later in the sport. As athletes moved from their freshman year to their senior year they perceived to be more and more important to specialize. Early specialization is not critical for success as most participants did not specialize until after the age of 12.5.	seriously into them. "If these differences in sport participation are due to the structure of sports, the disappearance of single-sport athletes needs to be more closely investigated from the larger perspective. Further study needs to be done to see if this phenomenon is solely in this sample or is common across the student populations in other collegiate divisions (i.e. Division II, Division III, NAIA)," (pp. 162)

			, golf, tennis, rowing, gymnastics, volleyball, field hockey, hockey, softball, figure skating. There were 559 males and 466 females and 11 did not specify their sex.			
Biese, Post, Schaefer, Bell (2018). Sport specialization and participation characteristics of female high school volleyball athletes. Athletic Training & Sports health Care: The journal for the practicing children, Volume 10, Issue 6, pp 247.	Two	The purpose of this study was to determine what the motivation factors were behind specialization in female volleyball athletes. Additionally, it was to levels of participation within those	Two high schools were focused on that had volleyball athletes, totaling 102 athletes between the ages 13 and 18 were surveyed. The questions on the survey included participation metrics, influential	The analysis for this research project was done using SPSS software. ANOVA was used to compare specialization levels of participation (Months per year and hours per week). Then Chi-square tests were used to analyze associations of specialization and motivational factors.	The results in this study found that much of the motivation to specialize stemmed for wanting to obtain a collegiate scholarship. Additionally, athletes that would be considered highly specialized were	Future research should be done where volleyball is more or less popular. Additionally, studies should be done to analyze injury rates and specialization in female volleyball players.

		female volleyball athletes.	factors and sport specialization. Some of the questions included in the survey were, ‘‘Have you quit other sports to focus on one sport?’’; ‘‘Do you train more than 8 months out of the year in one sport?’’; and ‘‘Do you consider your primary sport more important than other sports?’		participating at levels that would be considered unsafe. It was found that athletes who participated in 16 hours or more of training a week were three times as susceptible to overuse injuries. Burnout is another great risk these athletes endure, “early sport specialization and high participation volume, and it can lead to drop-out,” (pp 251). Per previous research heavy parental pressure,	

					sibling pressure, lack of sport peers and coaching pressure were all factors for athletes dropping out their sport.	
Russell (2014). The Relationship between youth sport specialization, reasons for participation, and youth sport participation motivations: A retrospective study. Journal of Sport Behavior, Volume 37, Issue 3, pp 286.	Two	The purpose of this study was to examine former youth athletes' motivations, and current sport or exercise participation and whether or not they specialized in youth sports.	Undergraduate students from a mid-sized Midwestern University were surveyed. There were 200 participants, with 93 of them being male and 107 being female. All of the participants were from general education courses and this was done in order to get a more generalized sample	The data analysis performed for this study was done using SPSS. T-tests were used to compare those athletes who specialized and those that did not. Chi-squares were used to determine the differences if a young athlete specialized and their current self-reported participation. Additionally, a one way MANOVA was conducted to determine the various reasons youth participated in sports between those that	A majority of the athletes that were surveyed reported specializing and 72 of the 113 that considered themselves to have specialized reported specializing before the age 10. Also, those athletes that specialized as youth were more likely to report they did not participate in sports	"A clearer understanding of specialization influences on long-term participation and motivation may stem from longitudinal studies in which specializers' participation patterns, motivations, and affective outcomes are directly tracked from youth into young adulthood," (pp 300).

			population.	specialized and those that did not. Lastly, a MANOVA was conducted to determine the difference in motivations between specializers' and non-specializers.	as a young adult compared to those that did not. Athletes who specialized reported as having much higher extrinsic motivations for doing so compared to athletes who did not report themselves as specialized. The findings that occurred in this study support that sport specialization may have negative effects on long term sport participation. "Specializers' regulation of sport	

					participation through self-imposed anxiety/guilt over not doing so, as is characteristic of interjected regulation, may have led to burnout and dropout, thus lower sport participation as young adults," (pp 298).	
Moesch, Elbe, Hauge, Wikman, (2011). Late Specialization: the key to success in centimeters, grams or seconds (cgs) sports. Scandinavian Journal of Medicine & Science in Sports, Volumer 21, Issue 6, pp 282.	Three	The purpose of this study was to determine whether young athletes need to specialize or if sport sampling is the path to success. The study examined the differences in	In this study 148 elite and 95 near-elite Danish athletes were studied in regard to differences in practice hours during early stages in their career, involvement in	Two tailed tests were used to determine the differences of the elite and near-elite and their practice hours in their main sport. Logistic regressions were also performed. This was done to determine whether or not there was a difference in practice hours in the main	It was found that the elite athletes specialized at a later age and trained less in their childhood. In the later stages in their career, however, their training did intensify	One of the recommendations for future success included adapting a longitudinal design for finding conclusions.

		practice hours during the early part of athletes career, how many other sports they were involved in, career development, and if this variables can predict them reaching elite status.	other sports, career development, and if this factors predict whether or not they are in the elite group.	sport, involvement in other sports and data on career development predicted elite level athlete status.	compared to their near-elite athlete counterparts. It was found that the practices during the mid-teen years was crucial for success.	
Baker, Cote, Abernethy (2003). Sport-Specific practice and the development of expert decision-making in team ball sports. Journal of Applied Sport Psychology, Volume 15, Issue 1, pp 12-14.	Three	The purpose of this study was to determine how much deliberate practice was needed to become an expert decision maker the athlete's respective sport.	There were 28 participants from this study. The participants in the group that was considered to be experts consisted of 15 athletes- 3 from the women's Australian netball team, 4 from the	ANOVA was used to determine the relationship of practice hours and the effect it had on both elite and non-elite.	Participating in a wide variety of activities is a critical element in becoming an expert decision maker. Expert athletes ranged from seven to 20 years in practice time before being	Future research should be done on sports where expert performance happens at a much younger age. For example, gymnastics, diving and figure skating.

			men's national basketball team, 4 from the national men's field hockey teams and 4 from the women's national field hockey team. Each of the teams selected here were either world champions or ranked in the top 4 in the world. The coaches from the team chose the athlete as being a great decision maker. 13 non-experts were chosen as well. All of the athletes did not		selected for a national team and all but one had a minimum of 10 years years of involvement before expertise. Participating in and practicing a wide variety of sports, specifically when it comes to generic decision making and pattern recognition, can be substituted for the need of so many hours of sport-specific practice in regards to becoming in export in team ball sports. The most important determina	

			play past the state or provincial level. All the participants participated in a structured interview.		tion found from this study was that early specialization is not necessary for expert level performance in decision-making.	
Russell & Molina, (2018). A comparison of female youth sport specializers and non-specializers on sport motivation and athletic burnout. Journal of Sport behavior.	Four	The purpose of this study was to look at female athletes to determine if they specialized in sport and if there was correlation between their motivations and if they experienced burnout.	This study examined 77 high school female athletes. They were surveyed on the following: practice habits, peer satisfaction, sport motivation and burnout.	SPSS for Windows was used to analyze all data. Separate MANOVAs were examined using sport motivations and burnout from within the group that reported that they specialized in sport. Additionally, a stepwise multiple linear regression was performed using the SMS-Intrinsic Motivation score as the criterion and peer satisfaction and self-reported practice habits as predictors	The results of this study found that athletes who specialize and one's who did not had similar motivations and did not experience elevated burnout. The one way MANOVA score, examining the effect of sport specialization on sport motivation, had a score of .945- indicating no strong	This study suggested that future research should be done discussing the motivational climate of both sport specializers and sport samplers.

				(pp 336).	significance. The findings in this research supported previous research that suggested specializers and non-specializers were more similar than dissimilar in their experiences and outcomes. The largest indicator of a sense of lack of accomplishment was amotivation.	
McGuine, Post, Hetzel, Brooks, Trigsted, & Bell (2017). A Prospective Study on the Effect of Sport Specialization on Lower Extremity	Four	The purpose of this study was to examine the correlation between lower extremity injuries	Athletes from grades 9-12 in 29 different Wisconsin high school sports were recruited to be in the study.	The statistical analysis for this research was performed by R foundation for statistical computing. To summarize the data, researchers utilized SDs, frequencies,	Athletes who reported as high sport specialization were the lowest rate at 13.4%, followed by moderate	Parents, coaches and athletes need to be informed by those practicing sports medicine about the risk involved in single sport specialization

Injury Rates in High School Athletes. American Journal Of Sports Medicine.		and sport specialization.	A total of 1544 high school athletes were surveyed. These athletes completed in 2,843 athletic seasons and competed in 167,349 athletic exposures. These participants completed questionnaire about their sport participation and their history of lower extremity injuries. A 3-point scale that was previously published was used to determine a specialization level of low, moderate,	proportions, medians and interquartile ranges, odds ratios, and multivariate Cox hazard ratios.	at 27.1% and low at 59.5%. Lower extremity injuries were more prevalent in the moderate group than the low group. Additionally, high participants had more lower extremity injuries than the low participants. Athletes who specialized are more likely to have a lower extremity injuries occur than those that did not.	

			or high.			
Post, Bell, Trigsted, Pfallar, Hetzel, Brooks & McGuine (2017). Association of Competition Volume, Club Sports and Sport Specialization with Sex and Lower Extremity Injury History in High School Athletes. Sports Health: A multidisciplinary approach.	Four	This study was done to examine the impact of sport specialization and club sports have on athletes in their high school careers. It specifically looked at injury history and sex of the athlete.	1544 high school athletes, 780 girls, from 29 different schools completed a questionnaire before the start of their competitive season. The questionnaire was in regards to their sport participation and previous injury history. The athletes reported all of the participation in interscholastic sports and competition sports. Additionally, they identified their primary sport and the	The data was analyzed using SPSS software. To examine the differences between competition volume, club sport participation and specialization status by sex and school size, Chi-square tests were used. Multivariable logistic regression analyses were performed to find correlations between competition volume, club sport participation, and sport specialization with history of lower extremity injuries.	Girls were more likely to specialize, have high competition volume, and participate in a club sport. Athletes who had high sport volume, played a club sport, or were highly specialized had higher levels of lower extremity injuries. The odds ratio number for competition volume, club sport participation, sport specialization, and previous lower extremity injury was higher in athletes	Athletes, parents and clinicians need to be aware of the potential risk of injury in year round participation in sport

			number of competitions in their primary sport within the past year. They used a three point scale to determine their specialization.		who reported high competition volume, p-value of 2.08, than those with moderate competition, p value of 1.68. Also, the odds ratio for high specialization had a higher p value, 2.58, than those with moderate specialization, p value of 2.38.	
Distefano, Beltz, Root, Martinez, Houghton, Taranto, & Trojian (2018). Sport sampling is associated with improved landing technique in youth athletes. Sports Health: A	Four	To determine if youth athletes who participated in multiple sports scored better on the LESS (Landing Error Scoring System) test, than those that	There was 355 local youth athletes who self-reported their participation level. They then completed a jump landing task that was evaluated using the LESS	"Student *t* tests to evaluate differences in height, age, mass, long-jump distance, and T-test time, and chi-square tests were used to evaluate differences in sex and maturation stage between groups. An independent *t* test was also	Multi-sport athletes were 2.5 times more likely to be categorized as having a controlled landing compared to their single sport counterpa	More research needs to be done to see what the other factors there are that are causing injuries in youth that are specializing.

multidisciplinary approach.		only played 1 sport. Research is out there suggesting that sport sampling is better for youth than sport specialization due to less chance of injury and burnout and that is why the authors thought this research was important.	test.	used to determine whether differences in LESS scores existed between sexes or sport populations." "A chi-square test was performed to evaluate the association between neuromuscular control category (good, poor) and sport participation groups (MS, SS)."	rts. Additionally, participants who had high sampling of sports had 5.8 to 5.4 times more control than those that had moderate to low sampling. Therefore, "sport sampling at a young age is associated with improved neuromuscular control, which may reduce injury risk in youth athletes," (pp 160).	
Russell, Limle (2013). The relationship between youth sport specialization and involvement in sport and physical	Four	The purpose of this study was to examine if the perceptions and physical activity	This study was done with 153 participants-71 male and 82 female. The participants completed	To analyze the data SPSS software was utilized. Chi-square tests were done to examine whether or not there was a relationship between youth	It was found that athletes who specialized and those that did not had no implications on their	Future research needs to be sure include a wide variety of ethnicities and socioeconomic backgrounds. Additionally, more research should be

activity in young adulthood. Journal of Sport Behavior.		patterns in young adults was related to their youth experience. This included sport specialization.	surveys. The surveys asked about their youth sport perceptions and the physical activity enjoyment scale. The perceptions questions were based on previously noted risks of youth sport participation by NASPE (2010) and Wiersma (2000). These scores were graded on a Likert scale of one through five. “An example of a positive-oriented item was	who specialized early in life and whether or not they participated in sports as a young adult. T-tests were also utilized. The first one determined whether or not participants varied in their current enjoyment of physical activity and whether or not they specialized as youth. The second one was used to determine if their positive perceptions of youth sport experience varied based on whether or not they specialized.	physical activity enjoyment or youth sport perceptions. “ Separate independent i-tests comparing current exercise frequency based on specialization classification were nonsignificant for both aerobic exercise frequency (t=.\0\,p>.05) and strength training frequency (t=\.74,p>.05) as young adult,” (pp 90). The athletes exercise habits were also unrelated to whether or not they specialized or	done on sports that are considered to be individual sports.

			"I felt a sense of accomplishment within my sport." An example of a negative-oriented item was "I felt isolated b my own small world of my sport" and negative-oriented items were reverse-scored," (pp 87).		played multiple sports in their youth. The largest implication for the athletes who specialized in sport as youth was they were less likely to participate in sports as young adults. This links athletes who specialized to burnout, autonomy and dropout which lowers their participation motivation.	
Latorre-Roman, Pinolls, Robles (2018).Early sport dropout: High performance	Four	The purpose of this study was to analyze the dropout rates of	All of the top 10 finishes from 2004 to 2014 were examined off the RFEA	For this study, SPSS statistical program for Windows was utilized. The McNemar test was used to analyze the	The number of athletes in the top 10 from 2004-2014 dropped dramatical	The study only looked at athletes in the top 10. Some of the athletes may have been just outside of the top 10 which would

in early years in young athletes is not related with later success. Retos: Nuevas Perspectivas de education fisica, deporte y recreacion.		the top 10 athletes in the Royal Spanish Athletics Federation between the ages of 14 and 19 years old, during the time period of 2004-2014.	website. There were 1,144 participants, 594 males and 550 females.	data between 2004 and 20014.	ly. In the year 2004, 96.5% were considered dropouts from high performance and that number increased in 2014 to 98.72% for women and 94.45% for men. Women had a much higher dropout rate compared to men. The reasons cited for dropping out were they, “had other things to do” and “it was less interesting to them.” Other reasons included woman reaching their peak	then potentially not be considered dropouts. Future studies must take this into consideration.

					athletic performance earlier than men. To avoid the risk of injury, and adverse psychological stress, specialization should be not be occurring until late adolescence.	
Garinger, Chow, Luzzeri (2018). The effect of perceived stress and specialization on the relationship between perfectionism and burnout in collegiate athletes. Anxiety, stress and Coping.	Four	The purpose of this study was to examine the relationship between perfectionism, concerns about burnout, and perceived stress as the bond of those relationships in DII and DIII specialized and multi-sport athletes.	For this study 522 division II and division III NCAA track field programs were chosen. Data was collected from 522 participants. Due to a lack of data in some of the responses, a total of 351 participants were selected. All of the participants in this	MANOVA was performed to determine if specialized athletes had higher levels of perceived stress, COM and burnout. To examine the relationship between specialization and perfectionism, stress and burnout a Multiple, Sample Path Analysis was performed.	There was a positive and direct correlation between perfectionism and burnout. "The direct path from COM (i.e., concerns) to burnout was positive and significant ($\beta = .23$, $p < .001$), as well as its total effect ($\beta = .449$, $p < .001$). The path coefficien	More research needs to be done on the collegiate athletes and the timing of their specialization and whether that is a good option for them or not.

			study took a demographic questionnaire regarding measures of perfectionism, stress, and burnout during the latter part of their competitive season.		ts from COM to perceived stress (β = .48) and from perceived stress to burnout (β = .47) were both positive and significant ($p < .001$) as expected," (pp 719). Stress was partially responsible for this relationship. Also, there was a negative direct effect on burnout and specialized athletes. Stress can be described as the factor bonding perfectionistic concerns and burnout. Specialized athletes reported	

					higher amounts of stress than their multi-sport counterparts.	
Ginsburg, Danforth, Ceranoglu, Durant, Robin, Smith, Kamin, Babcock, Masek, (2014). Patterns of Specialization in Professional Baseball Players. Journal of Clinical Sport Psychology.	Five	There are two common thoughts that lead to sport excellence, early specialization and early sampling. The assumption is that specialization is the best path even the research is still unclear. This study was done to add to the current research.	This study was a survey of 708 minor league professional baseball players. Each of the participants volunteered to complete a questionnaire. The questionnaire collected information on whether or not they specialized in baseball at a young age or they sampled in sports during their teen years.	T-tests were used to show that players over 19 years of age were playing far fewer sports. A one way ANOVA was used to show the differences in ethnicities and age of specialization. Chi-squares were also utilized to show differences in ethnicities and when they started playing baseball. ANCOVAS were performed to show differences between specialization and ethnicity and geography. More ANOVAs and Chi-square tests were done	The results in this study showed that only 25% of players specialized before age 12 and the median age of specialization was 15. The athletes that specialized later were more likely to receive scholarships. Therefore, it was shown that sport sampling lead to more success than sport specialization. "Players who	This article suggests that further research needs to be done to explore specialization factors. Some other factors that should be included in further research about youth sport engagement include economic, academic, psychological and cultural factors.

				comparing North American and non-American players.	received a baseball scholarship specialized at a significantly later age," (pp 270).	
Rugg, Kadoor, Feeley, & Pandya (2018). The Effects of playing multiple high school sports on National Basketball Association Players' propensity for injury and athletic performance. American Journal of Sports Medicine.	Five	This study examines the effect that early sport specialization had on the length of NBA players careers and the injuries that had occur throughout their career	The researchers studied 1st round picks form 2008-2015. Overall for this study 237 participants were included. The information that was acquired for this study was found by searching for available information on the internet. Information that was included in this study was major injuries	T tests, 1 tailed Fisher test, 2 tailed Fisher tests, Chi-square tests. They were testing multiple sport athletes against single sport in injury history, percentage of games played, and whether they were still in the NBA	MS athletes played a much larger percentage of games than the SS athletes. MS athletes played in 78.4% of games compared to 72.8% for SS athletes. Also, MS athletes endured smaller percentage of major injuries throughout career, 25% compared to 42.8%. A large number of MS athletes	The study focused only on NBA players and future research could also focus on collegiate basketball players- both male and female. "Future research could be performed to determine how the impact of games played translates to actual statistical performance, although multiple other confounding factors can determine statistical performance including teammate skill-set, coaching philosophy, and position,"

			sustained while in the NBA, percentage of games played in the NBA, and whether the players were still active in the NBA at the time of the study. In this study, athletes who competed in sports other than basketball in high school were considered multi-sport athletes. If an athlete competed only in basketball they were considered to be specialized.		(94%) were still in the league compared to SS athletes (81.1%).	(pp 406).
Noble and Chapman (2018).	Five	The purpose of this	The top 90 African	R-studio software was used to	The results of this study	

Marathon specialization in elites: A head start for Africans. International Journal of Sports Physiology & Performance		study was to examine the differences in elite African and non-African male marathon runners based on age, performance and career length in regards to event-specific specialization.	marathon runners were compared to the top 90 non-African marathon runners from 2001-2015. The age of specialization, career length and performance were all used as a means of comparison.	complete statistical analysis. T-tests were utilized to compare the two groups of marathoners. A 1-way ANOVA was used to assess the differences in rates of improvement and decline and another 1-way ANOVA was used to assess differences between-group's performance relative to mean performance.	found that African marathon runners specialized at ages 1.5 years younger than their counterparts. Additionally, they were able to achieve peak levels of performance and then retire younger than the non-African runners. African runners retired at an age of almost three years earlier than non-African runners. It was also found that the non-African runners were slower in the half-marathon when	

					compared to the African runners in the same point of their career. The athletes who specialized earlier also were found to have greater rates of improvement than those who specialized at a later age.	