The Relationship between Sports Participation History and Golf-Related General Physical Skills of Collegiate Golfers

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Abstract

The purpose of this study was to identify if there were initial differences between NCAA Division III male and female collegiate golfers who were early specialists (n=5) and those who were sports samplers (n=10)in the overall proficiency in golf-related physical skills, as measured by the Titleist Performance Institute (TPI) golf-specific functional movement screening (GSFMS), and also to identify if there were differences in extent of improvement in golf-related general physical skills, after a targeted training program that addressed areas of weakness. The study used a convenience sample and combined aspects of different experimental designs, namely causal comparative and quasi-experimental pretest-posttest nonequivalent group elements. There was no significant difference between the mean GSFMS scores prior to the training program between sports samplers (Mean = 12.50, SD = 5.60) and early specialists (Mean = 11.20, SD = 4.32) [t(13) = .45, p =.66]. There was no significant difference between the mean gain GSFMS scores between sports samplers (Mean = 3.30, SD = 2.45) and early specialists (Mean = 4.40, SD = 2.70) [t(13) = .79, p =.44]. The experimental design used in this study provides the potential for further research in this area. Results suggest that the GSFMS can be used in a virtual environment to assess physical skills and to guide training. Further academic work needs to be done to improve the understanding of these concepts in the context of competitive golf and to guide decision making about the specialization of young athletes.

CHAPTER I

INTRODUCTION

Sports play a significant role in the American society of the 21st century. In a world where professional athletes are among the best-known and wealthiest celebrities, the vision of athletic success is an attractive one. Hence, children are put under a lot of pressure – from parents, coaches, and peers – to start training hard in their sport early to gain an edge over the competition. The desire to outwork other young athletes is one of the driving forces behind an increasingly early age of sports specialization, a phenomenon in which an athlete selects one sport and excludes participation in others (Myer et al., 2015). The belief that specializing in one sport early improves chances of success is common among youth. Corso (2018) cites a study of 12- to 18-year-old club team athletes; the research found that "approximately 91% of athletes believed that specialization in one sport increased their chances of improving in that sport, (…) 66% and 81% thought it would increase their chance of making college or high school teams, respectively" (p. 151). Unfortunately, the positive effects of early sports specialization are not proven. In fact, some sports experts argue that specializing in one sport early might negatively impact youth athletes with effects including "overuse injuries, burnout, and dropping out of sports" (Myer et al., 2015, p. 437). It is also still unclear whether choosing to focus on only one sport is beneficial for the development of sports skills or whether a more diverse sports participation model could provide a more balanced environment for the physical development of athletes.

The researcher's anecdotal experience with coaching junior golfers aligns with the skeptical view on early sports specialization. Dropouts and burnouts seem to be more common for children and adolescents who do not participate in other sports, while young athletes with a

diverse sports participation history often display more balanced and developed general athletic skills. These impressions ultimately inspired this study and its aspiration to gather more information on the impacts of different models of youth sports participation on golfers. The logical place to start researching the value of early specialization for success on the elite stage is the most competitive sports levels: professional and collegiate athletics. The motivation behind this research was to find out whether collegiate golfers who specialized in golf early had developed their physical skills in a different way than those golfers with more balanced sports participation past. The long term goal is to determine the best way to optimize skills development for golfers while preventing burnout and creating a healthy relationship with physical activity in general.

Statement of the Problem

The purpose of this study was to identify if there were initial differences between NCAA Division III collegiate golfers who were early specialists and those who were sports samplers in the overall proficiency in golf-related physical skills, and also to identify if there were differences in extent of improvement in golf-related general physical skills after a targeted training program.

Research Hypotheses

The study had two null hypotheses. The first was that there was no significant difference in proficiency of golf-related general physical skills between early specialists and sports samplers among Division III collegiate level golfers. The second was that there was no significant difference between early specialists and sports samplers in the extent of improvement in golf-related general physical skills after participating in an individualized training regimen that addresses their areas of weaknesses.

Operational Definitions

Golf-related general physical skills:

The subjects' physical strength, flexibility, mobility, stability, and balance in areas that affect the subjects' golf performance. For this study, the proficiency in golf-related general physical skills was measured by the Titleist Performance Institute (TPI) golf-specific functional movement screening (GSFMS) (Speariett & Armstrong, 2020). The screening rates the golf-related general physical skills on a 43-point scale.

Titleist Performance Institute's golf-specific functional movement screening (TPI GSMFS):

A test of an individual's golf-related physical skills. This screening instrument consists of 17 distinct physical tests that measure movement skills such as flexibility, balance, and strength, all chosen for their importance to golf performance.

Sports participation history:

The subjects' past athletic activities, especially during childhood and early adolescence. The study considered two sports participation models: early specialization and sports sampling.

Specialization in one sport:

Participation in a sport that meets at least one of the following three criteria: choosing a single primary sport for competition purposes, quitting competition in all other sports, and training in the sport for over eight months per year.

Early specialists:

Subjects who exhibited specialization in golf (judged by the criteria above) at the age of 13 or younger.

Sports samplers:

Subjects that were not early specialists. Instead, sports samplers exhibited no specialization in golf at age 13 or younger while participating in multiple sports.

NCAA Division III athletics:

One of the three levels of intercollegiate sports competitions organized by the National Collegiate Athletic Association (NCAA). Colleges competing on the Division III level cannot give out athletic scholarships to student-athletes, hence attracting students with a stronger academic focus compared to DI and DII student-athletes (National Collegiate Athletic Association, n.d.). Division III encompasses approximately 36.7% of all NCAA athletes.

CHAPTER II

LITERATURE REVIEW

This literature review examines the two main current viewpoints on sports participation in childhood (early sport specialization and sports sampling) and relates the theories to golf. The first section describes early sport specialization, including its benefits and drawbacks. The second section similarly analyzes the positive and negative sides of sports sampling. The third section discusses the physical demands of golf. Lastly, the fourth section applies the debate between sports specialization and sports specifically to the ideal development of golfers.

Early Sport Specialization

Basic Description: What Is Early Sport Specialization?

In recent years, early sport specialization (also referred to as ESS) has become a widely debated topic in the world of sports. While a universal definition of ESS has not been standardized, most researchers describe the phenomenon as intense, year-round training in a specific sport at a young age with the exclusion of other sports (Corso, 2018; Ferguson & Stern, 2014; Jayanthi et al., 2013; Myer et al., 2015). Because one may understand terms such as "intense training" or "young age" in different ways, this characterization offers room for different interpretations. Thus, there has been an effort to classify the central features of ESS more clearly. To define the aspect of "early" or "young age," Jayanthi et al. (2013) proposed that ESS can occur in the “early-to-middle elementary school years,” adding that choosing to focus on one sport at later ages can be considered “common and almost standard” (p. 252). The intensity of the specialization may also vary. An often-used approach is considering three factors to determine whether or not an athlete is specializing in one sport: first, training in the sport for over eight months per year; second, choosing a single primary sport; and third, quitting all other

sports (Corso, 2018; Myer et al., 2015). An athlete meeting zero or one criterion is classified as having low specialization, while moderate specialization meets two of the three criteria, and high specialization meets all three (Myer et al., 2015). To provide even more guidelines, Ferguson and Stern (2014) added the following aspects to judge when deciding whether ESS occurs in specific cases: "minimal rest or time off, high structured training with emphasis on physical development, may be initiated by parents/coaches/trainer" (p. 378). Even though a combined use of all the previously mentioned factors may help to establish if ESS occurs, it is also necessary to look at the effects of ESS on athletes to understand why this phenomenon is worth investigating.

Benefits & Drawbacks: What Is Good and Bad about ESS?

The justification for having children specialize in one sport at an early age is to optimize the chances of reaching an elite skill level by increasing the volume of training. This ESS-related approach was first observed in the gymnastics, swimming, diving, and figure skating training in Eastern Europe (Myer et al., 2016). In simple terms, proponents of ESS claim that early specializing gives athletes more time to dedicate to refining the specific skills needed for the chosen sport. The idea of accumulating a certain amount of practice time before reaching elite level is perhaps best represented by the 10,000-hour rule developed by Ericsson in 1993 and popularized in Gladwell's book *Outliers.* After studying experts in various fields such as music, mathematics, and chess, Ericsson found that elite professionals often spent over 10,000 hours on deliberate practice of their specific discipline (Corso, 2018; Ferguson & Stern, 2014; Martin et al., 2017). Young athletes are tempted to start accumulating 10,000 hours of practice in one sport as early as possible, often due to influence from parents or coaches, especially with the current increasing levels of competition in athletics, the chance to earn collegiate athletic scholarships, and the attractive image of professional sports (Ferguson & Stern, 2014).

However, using the 10,000-hour rule to justify early sport specialization has been widely criticized in recent studies. Martin et al. (2017) pointed out that Ericsson only mentioned the 10,000 hours as a threshold when discussing the background of professional violinists. His theory did not specify the number of hours needed for expertise in other fields as that depends on "the person, the task, and type of training" (Ferguson & Stern, 2014, p. 380). Applying the 10,000-hour rule in sports contexts is also discredited by research showing that most "elite sports performers" have spent less than 10,000 hours throughout their life practicing their primary sport (Martin et al., 2017, p. 152). In a survey of 1041 NCAA Division I athletes, Martin et al. found that the majority of the student-athletes played more than one sport during their senior year of high school. This finding shows that ESS is not necessary for reaching a high level of proficiency in a sport needed to play at the DI level. Furthermore, Corso (2018) suggested that practicing a task with the sole goal of accumulating hours is "inherently not enjoyable" (p. 151), while Martin et al. (2017) argued that such an approach overlooks the importance of "developmental, psychosocial, and motivational factors" (p. 152). The harmful effects of ESS on the mental and physical development of athletes are at the core of criticizing ESS as a whole.

The drawbacks of ESS include limited overall motor skill development, increased risk of overuse injuries, social isolation with negative social-psychological impacts, burnout or loss of motivation, and quitting sports (Corso, 2018; Myer et al., 2016). While the goal of ESS is to facilitate a superior proficiency in sport-specific skills, Martin et al. (2017) pointed out that there is no direct evidence of ESS being beneficial to the physiological development of an athlete. Myer et al. (2016) stated that ESS might actually lead to overall "reduced motor skill proficiency" because of creating a lopsided movement variety (pp. 66-67). The unbalanced physical stress due to repetitive movement, along with a high training volume, is also the biggest

reason for higher injury rates among young athletes specializing in one sport. Jayanthi et al. (2013) presented the findings of research on injury risks connected to ESS in various sports in the following summary:

> There was a linear relationship between exposure and risk of injury, showing significantly elevated risk once training volume exceeded 16 hours per week. Cumulative match (or competition) exposure also carries a significant risk: medical withdrawals increased in national tennis players after playing >5 matches per year in supernational tournaments. Players who specialized only in tennis were 1.5 times more likely to report an injury. A 10-year prospective analysis of 481 youth baseball pitchers (9-14 years old) found that those who pitched more than 100 innings per year were 3.5 times more likely to be injured. Others have found a significantly increased risk for shoulder or elbow surgery if pitching more than 8 months per year. (p. 255)

Aside from such physical effects, ESS has also been shown to negatively impact the psychological development of athletes by decreasing motivation, causing burnout and dropping out of sports. Causal-comparative research has shown a strong correlation between specializing in one sport and quitting athletics early in sports such as swimming, ice hockey, gymnastics, and tennis (Jayanthi et al., 2013). Since specialized athletes do not have another sport in which to participate, Myer et al. (2016) warned about ESS worsening the athletes' general relationship with physical activity and consequently contributing to a sedentary lifestyle and becoming overweight in adulthood.

Arguably, all the drawbacks of early sport specialization are not outweighed by sufficient benefits to performance or skill development. This net negative impact of ESS on athletes led to position statements against ESS from organizations such as the American Medical Society for

Sports Medicine, American Academy of Pediatrics, International Society for Sports Psychology, World Health Organization, or International Federation of Sports Medicine (Ferguson & Stern, 2014). To find an option that is more beneficial to young athletes, sports experts have proposed an alternative approach to participation in sports at an early age: sports sampling.

Sports Sampling

Basic Description: What Is Sports Sampling?

Sports sampling (also referred to as multiple sports sampling, the sampling approach, or sampling) is a term used to describe the participation in numerous sports during childhood, including more free unstructured play and less deliberate practice (Côté et al., 2009; Martin et al., 2017; Myer et al., 2016). Sports sampling does not necessarily replace specialization for elite athletes, but it delays specialization to later stages of development. Myer et al. (2016) recommend deferring specialization in a single sport until early to late adolescence, depending on the type of the chosen primary sport. This proposed delay results in the entire childhood developmental epoch to become a space for sports sampling. Participating in more than one sport, focusing on unstructured play, and doing sports mainly for enjoyment – all central aspects to sports sampling in childhood – have shown to have a positive impact in most cases. The advantages and possible limitations of sports sampling will be the topic of the following paragraphs.

Benefits & Drawbacks: What Is Good and Bad about Sports Sampling?

Perhaps unsurprisingly, the main argued benefits of sports sampling are a mirror image of the main drawbacks of ESS. Research has shown links between sports sampling in childhood and increased participation in physical activity in adulthood, decreased risk of overuse injuries, and well-rounded development of motor skills (Côté et al., 2009; Myer et al., 2016). Participation in

more than one sport lowers the relative amount of repetitive movements during physical activity, resulting in a reduced risk of overuse injury. Sports sampling also provides the child with balanced motor development when compared to the narrow focus on sport-specific movement skills in ESS. Furthermore, because sports sampling promotes play rather than deliberate practice, children are more likely to find intrinsic joy in the process and develop a life-long keenness for movement. This phenomenon has been proven in studies showing that "sampling numerous sports and physical activities in childhood was associated with being physically active during adulthood" (Côté et al., 2009, p. 8). Compared to the few advantages of ESS, which favor mainly elite athletes, sports sampling can benefit even children who end up participating in sports only on the recreational level. When discussing the effects of sports sampling and ESS on all children participating in sports, Côté et al. wrote the following:

> Although both sampling and early specialization can lead to expertise, there is evidence regarding the developmental benefits of sampling over specialization. (...) Sampling is described as an efficient path because it can lead to expertise but also takes into account the potential costs. As illustrated, a diversified approach to sport participation is linked to positive sport and psychosocial outcomes. (p. 10).

While sports sampling in childhood and delaying specialization until later developmental stages has emerged as one of the possible paths to expertise in a single sport, more research needs to be done comparing the outcomes of ESS and sports sampling in specific sports. To determine which of the two approaches is more effective for developing proficiency in physical skills in the context of collegiate golf, it is first necessary to take a detailed look at the specific physical demands of playing golf at a high level.

Physical Demands of Golf

What Physical Skills Are Needed to Play Golf at a High Level?

Traditionally, golf has not been considered a sport that requires "high levels of physical fitness" (Thomspon & Osness, 2004, p. 145). This view stemmed from the slow-paced nature of the game compared to other sports; although it takes 4-5 hours to complete a round of golf, no jumping or running is required, and even older or less fit individuals can finish playing 18 holes. While it might be true that the physical demands are relatively low for recreational golfers, it is not the case at the highest competitive levels in golf. Compared to movement patterns in other sports, the explosive power demands of the golf swing are among the highest: accelerating the golf club from the top of the backswing into the impact position requires the golfer to "recruit about 15 kg of muscle to generate four horsepower" (Chung et al., 2014, p. 186). Research has shown significant importance of muscular strength, mobility, stability, balance, and other physical traits for players.

The correlation between proficiency in physical skills and golf performance has been the topic of numerous studies in the recent past. A review of studies by Torres-Ronda et al. (2011) found a positive correlation between muscular strength and golf skill, highlighting "leg-hip and trunk power, and grip strength" as some of the most crucial elements for improving golf performance (p. 16). Thompson and Osness (2004) reported a study by Hetu et al. showing a strong positive correlation between improving fitness measurements (strength, flexibility) and increasing clubhead speed of golfers following an 8-week physical training program. Wells et al. (2018) found a significant link between golfers' peak force production and clubhead speed, supporting the hypothesis that "maximal strength has an important relationship with drive distances" (p. 5). Chung et al. (2014) discovered a "different isokinetic strength profile" when

comparing female professional golfers with “non-athletic" young women, although direct correlations between isokinetic strength and golf performance were unclear (p. 189). Weston et al. (2013) found a “small beneficial effect” of isolated core training on golf performance (p. 2296). With numerous different physical traits considered to have an impact on golf performance, it is worth attempting to outline the physical demands of the golf swing in a more comprehensive way.

In their book *Golf Anatomy*, golf fitness experts Craig Davies and Vince DiSaia (2013) divided the physical demands of golf into seven categories: mobility, stability, strength, power, endurance, balance, and proprioception. Because of being a whole-body movement, Davies and DiSaia argued that an efficient golf swing requires the correct functioning of nearly all muscles and joints in the human body. Discussing each of the necessary physical traits in detail would go beyond the scope of this paper, but it is worth to at least list some of the most crucial skills needed for golf. They include core strength, lower body power, sufficient rotation in hips and thoracic spine, flexion and extension of the pelvis and shoulders, and single-leg balance. All of the necessary physical traits contribute to creating an efficient alternating pattern of stable body parts (foot, knee, pelvis, scapular/thoracic complex, elbow) connected by mobile joints (ankle, hip, thoracic spine, shoulder, wrist). Due to the complex nature of the skills needed for an efficient golf swing, experts have employed different approaches in measuring physical traits impacting golf performance.

How Can Proficiency in Physical Skills Needed for Golf Be Tested?

Previous research has attempted different ways of measuring physical traits affecting golf performance ranging from simple general tests to complex golf-specific assessments. Wells et al. (2018) used vertical jumps, squat jumps, countermovement jumps, drop-jumps, and isometric

pulls to measure one of the crucial physical traits for golf, lower body strength and power. In a similar attempt to focus on measuring strength, Chung et al. (2014) decided to use isokinetic testing for adduction, abduction, and rotation of the shoulder and extension and flexion of knee and elbow. While such narrowly focused tests are well-suited for measuring specific physical traits independently, they do not provide a complete picture of the subjects' overall physical proficiency related to the golf swing. To study the effects of ESS and sports sampling on the comprehensive physical skills of golfers, a better-rounded test is needed. One assessment frequently used by golf coaches to determine the physical abilities and limitations of their players is the Titleist Performance Institute golf-specific functional movement screening (GSFMS). The GSFMS measures "flexibility, strength, and balance using 17 different tests in golf-specific postures to identify physical limitations which may influence swing performance" (Speariett & Armstrong, 2020, p. 425). They investigated the link between GSFMS results and golf performance and found the following:

> The study demonstrated that GSFMS composite scores were correlated with lower handicaps, greater ball speed, clubhead speed, and peak pelvis rotation speed which have been linked to increased golf performance. The GSFMS could potentially be used as an assessment tool to aid the development of strength and conditioning programs which could aid the correction of movement deficiencies and potentially improve golf performance by developing certain physiological characteristics. (p.433)

With reliability validated both in research and in golf coaching around the world, the GSFMS is well-suited for studying the overall proficiency in golf-related physical skills. Because the 17 included tests measure most of the aforementioned physical abilities needed for an efficient golf

swing, the GSFMS should provide a complete picture of the differences in general physical skills between golfers who specialized early in golf and those who have a history of sports sampling.

Golf and the ESS vs. Sports Sampling Debate

What is the Ideal Timing for Specialization in Golf?

Experts have argued that choosing between specializing early or sports sampling in childhood should depend on the circumstances of the specific sport in question (Ferguson &Stern, 2014; Jayanthi et al., 2013). Highly technical sports such as gymnastics or figure skating require specializing sooner, while the recommendation for endurance sports is to delay specialization until late adolescence (Myer et al., 2016). The following section will attempt to use this sport-specific approach directly for golf.

There is some anecdotal evidence of ESS being an effective method for achieving elite skill in golf; perhaps the best-known example of a successful early specialist is Tiger Woods. Under the guidance of his father, Woods was intensely and deliberately training to become a champion golfer from an extremely early age (Normand et al., 2017). At two years old, Woods was invited to appear on the Mike Douglas TV show to demonstrate his already impressive golf swing (Overbirdie, 2009). By the age of 12, he was shooting under-par rounds on regulation golf courses (Normand et al., 2017). His illustrious career in professional golf appears to prove the success of early specialization for Woods; as of 2020, his 81 total PGA Tour victories and 15 major championships are both the second-highest totals in history (Mulcahy, 2019). However, there has also been criticism of using Woods' example as a justification for ESS. Mulcahy pointed out that in his early 30s, Woods suffered from serious injuries to his back, knee, and Achilles, which forced him to undergo a spinal fusion surgery just to be able to walk without pain. Such overuse injuries have been correlated with ESS and perhaps could have been

prevented by a more diverse sports participation in Woods' childhood. Furthermore, Normand et al. (2017) warned against using extraordinary cases like Woods in the context of general childhood participation in sports:

> Sport specialization might be necessary for those in search of becoming an elite athlete, yet appropriate timing and training is vital for long-term success. A child's desire to become the next Tiger Woods is a naive, unrealistic goal. Recognizing the marginal chance of obtaining elite status, yet still striving for excellence and acquiring knowledge to support a life of healthy physical activity is a more realistic perspective. (p. 40)

The suggestions of experts regarding the ideal timing of specialization in golf are not uniform, mostly because golf has not been the topic of much research in this field so far. Golf and tennis have been grouped as sports with the ideal stage of specialization in middle adolescence (Corso, 2018; Myer et al., 2016). Ferguson and Stern (2014) argue that because the age of peak performance for golfers can extend into the 40s and 50s, specialization can be postponed until even later than middle adolescence. Another argument for delaying specialization and promoting sports sampling for junior golfers is in the Developmental Model of Sports Participation. The Model's fifth postulate states that sports sampling may help in developing a wide range of physical and motor skills, which are later in life more easily transferred into the "principal sport of interest"(Myer et al., 2016, p. 66). As a result, golfers with a history of sports sampling could have superior proficiency in general physical skills compared to those who specialized in golf early.

Summary

This literature review discussed the two major theories on sports participation in childhood (early sport specialization and sports sampling) and their application specifically to

golf. Overall, the majority of the current literature suggests that early sports specialization should be more beneficial to a balanced mental and physical development of young athletes. However, because a relatively large variety of physical skills needs to be developed for golf players to reach elite levels of competition, further research should examine the relationship between golfers' sports participation history and their proficiency in physical skills. Such examination was the goal of this study.

CHAPTER III

METHODS

Design

The study combined aspects of different experimental designs. It had a causal comparative element in examining whether there were differences in initial overall proficiency in golf-related general physical skills between collegiate golfers who were early specialists and those who were sports samplers. It had a quasi-experimental pretest-posttest nonequivalent group element when it compared the amount of improvement in physical skills between the two groups after participating in a training regimen individualized to address weaknesses. The independent variable was the sports participation history of the subjects, namely whether each subject was an early specialist or a sports sampler. The subjects were divided into the two groups based on a survey administered during the pretest phase. The dependent variable in this study was the subjects' proficiency in golf-related general physical skills. The pretest and posttest assessments were separated by an individualized three-week exercise program aiming to improve the subjects' golf-related general physical skills. The pretest scores were used to compare the starting proficiency in the golf-related general physical skills between the two groups. The gain scores between pretest and posttest results were compared to assess the extent of improvement in the golf-related general physical skills between the two groups.

Participants

The study used convenience sampling for the selection of participants. The participants were selected from a small, private, liberal arts college located in the Mid-Atlantic region of the United States. The researcher was the current graduate assistant coach for the college's golf program; all the participants were current members of the college's golf teams competing on

NCAA Division III level. Six of the participants played for the women's golf team, while nine of the participants played for the men's team. The age range of the participants was 19 to 23 years old; both underclassmen and upperclassmen were represented.

Instruments

The proficiency in golf-related general physical skills was measured using the TPIGSFMS. The TPI GSFMS gives an overall score in the form of *a golf fitness handicap*, where a perfect assessment is awarded a +7 handicap, while the worst possible assessment gets a -36 handicap. For this study, the TPI GSFMS 43-point scale was adjusted to range from a score of 0 (worst possible result) to a score of 43 (best possible result). The TPI GSFMS is commonly used in golf instruction at all levels; the screening's reliability and validity are supported by the certification required for administrating the assessment (Titleist Performance Institute, 2021). The researcher completed the TPI seminar and got certified to administer the GSFMS three months before the start of this study. Furthermore, as was discussed in Chapter 2, the TPI GSFMS was previously used in scientific studies and showed "excellent intrarater reliability" (Speariett & Armstrong, 2020, p. 426), as well as a strong link to technical faults in the golf swing and overall golf performance (Gulgin et al., 2014; Speariett & Armstrong, 2020).

The instrument used to determine whether each subject was an early specialist or a sports sampler was a seven-question survey designed specifically for this research (Appendix). The survey consisted of both open-ended and closed-ended questions focused on factors that the literature considered to be the crucial components of early sports specialization. Namely, the factors were the age when subjects started to focus mainly on golf, the nature of their participation in golf at different ages, and the number of sports they played before choosing golf

as their primary concentration. There is no reliability or validity data for this instrument since it was developed by the researcher.

Procedure

The data collection process took place during a five-week period in the early spring of 2021. Because of the impacts of the COVID-19 pandemic, the in-person golf training and competitions were both delayed for all of the study participants at that time. All of the team activities were done fully online, as was the case for this research. During week 1, pretests and sports participation history surveys were administered. Based on the pretest results, the researcher determined the three most severe limitations in each subject's individual golf-related general physical skills and chose two exercises aimed to improve each of the three limitations. Both the determination of most severe limitations and the exercise selection followed procedures taught in the TPI certification seminar and were based on the number, type, and severity of failed movement screens in the TPI GSFMS. The types and frequency of the limitations and the corrective exercises are summarized in Table 1.

Table 1

Types of Physical Limitations, Frequency of Physical Limitations among Subjects, and Corrective Exercises Prescribed to Each Type of Limitation

Type of limitation	Frequency	Corrective exercises
Ankle mobility	1/15 subjects	Search and destroy with calf stretch
		Toe touch, toes up squeezing legs
Glute/core strength	10/15 subjects	Bridge (palms up, focus on neutral pelvis)
		Bird-dog hip extension w/ feedback (knee bent)
		Bridge with leg extension
		Figure 4 vertical bridge
		Frog leg bridges
Hip mobility	11/15 subjects	Ankle windshield wipers
		Figure 4 vertical bridge
		Frog leg bridges
		Hip mobility matrix
		Starfish rolling pattern 1
Pelvic mobility	6/15 subjects	Bridge (palms up, focus on neutral pelvis)
		Bridge with leg extension
		Reverse toe touches
		Supine pelvic tilts
		Toe touch, toes up squeezing legs
Shoulder mobility	13/15 subjects	90/90 box presses
		Bird-dog with shoulder flexion
		Palm-forearm presses
		Reach, roll & lift
		Tall kneeling shoulder flexion-extension
Single leg balance	1/15 subjects	Ankle windshield wipers
		Single leg balance matrix
Thoracic mobility	1/15 subjects	Reachbacks (half prayer, external rotation)
		Reachbacks (lumbar lock, internal rotation)
Wrist/forearm mobility	2/15 subjects	Palm-forearm presses
		Wrist mobility matrix

Note. Frequency refers to how many times each type of limitation appeared among the top 3 biggest physical limitations for the subjects.

By the end of the first week, each subject received an individualized exercise program featuring six exercises (two exercises per each of three most severe limitations). The specific

administered exercises are listed in Table 1; the selection was again in accord with the recommendations from TPI certification. Each of the program's exercise sessions featured all six individually chosen exercises repeated in three sets; every exercise session could be completed in 30 minutes or less. None of the exercises required any equipment; therefore, they could be performed by all subjects even if they did not have access to a weight room. The programs were designed with four weekly exercise sessions during a three-week period (weeks 2-4), giving a total of 12 sessions. There was no progression in sets or repetitions from session to session, but the subjects were encouraged to increase the range of motion and/or force and speed as they got more comfortable with each exercise. In week 5, the posttest scores were collected.

Due to health and safety considerations during the COVID-19 pandemic, all the research procedures were conducted online without any in-person contact. The pretest and posttest of the dependable variable (using the TPI GSFMS) and the survey of the independent variable were conducted during individual video calls with each subject. The three-week exercise program was also explained to the subjects during a video call, and each subject had access to a spreadsheet with their specific program. The spreadsheet included a brief description of the subject's three most severe physical limitations and six exercises designed to improve the limitations. Instructional videos for each exercise were also attached to the spreadsheet. Each subject's progress in the exercise program was monitored using texts, emails, and calls multiple times during the three weeks.

The first hypothesis was evaluated by comparing the initial fitness scores by an independent samples t-test. The second hypothesis was tested by calculating the difference score for each athlete between post- individualized training and pre-individualized training scores. The difference scores were compared by an independent samples t-test.

CHAPTER IV

RESULTS

This study aimed to identify if there were initial differences between NCAA Division III collegiate golfers who were early specialists and those who were sports samplers in overall proficiency in golf-related physical skills and also to identify if there are differences in extent of improvement in golf-related general physical skills after a targeted training program.

To compare the overall proficiency in golf-related physical skills before the training program, an independent samples t-test was conducted with the independent variable being the sports participation history of the subjects (whether they were sports samplers or early specialists) and the dependent variable being the subjects' GSFMS score before the start of the training program. There was no significant difference between the mean GSFMS scores prior to the training program between sports samplers (Mean = 12.50, SD = 5.60) and early specialists (Mean = 11.20, SD = 4.32) [$t(13) = .45$, $p = .66$]. Please see Table 2. Consequently, the first null hypothesis that there is no significant difference in the proficiency of golf-related general physical skills between early specialists and sports samplers among Division III collegiate level golfers was retained.

Table 2

Means, Standard Deviations, and t-statistic for GSFMS Scores prior to the Training Program for Sports Samplers and Early Specialists

Group	N	Mean	SD	t-statistic
Sports samplers	10	12.50	5.60	0.45 (NS)
Early specialists	5	11.20	4.32	

Note. NS = non-significant at $p \leq .05$

To compare the extent of improvement in golf-related physical skills after the training program, a second independent samples t-test was conducted with the independent variable being

the sports participation history of the subjects and the dependent variable being the gain scores between pretest and posttest GSMFS results. There was no significant difference between the mean gain GSFMS scores between sports samplers (Mean = 3.30, SD = 2.45) and early specialists (Mean = 4.40, SD = 2.70) [t(13) = .79, p =.44]. Please see Table 3. Consequently, the second null hypothesis that there is no significant difference between early specialists and sports samplers in the extent of improvement in golf-related general physical skills after participating in an individualized training regimen that addresses their areas of weakness was retained.

Table 3

Means, Standard Deviations, and t-statistic for Gain Scores between Pretest and Posttest GSFMS Results for Sports Samplers and Early Specialists

Group	**N**	**Mean**	**SD**	**t-statistic**
Sports samplers	10	3.30	2.45	0.79 (NS)
Early specialists	5	4.40	2.70	

Note. NS = non-significant at $p \leq .05$

CHAPTER V

DISCUSSION

The objectives of the study were to identify if there were initial differences in the overall proficiency in golf-related physical skills between NCAA Division III collegiate golfers who were early specialists and those who were sports samplers and also to identify if there were differences between the two groups in the extent of improvement in golf-related general physical skills after a targeted training program. Statistical analysis using independent samples t-tests showed no significant differences between early specialists and sports samplers in initial proficiency or extent of improvement of golf-related physical skills, and both of the null hypotheses were retained.

Implications of Results

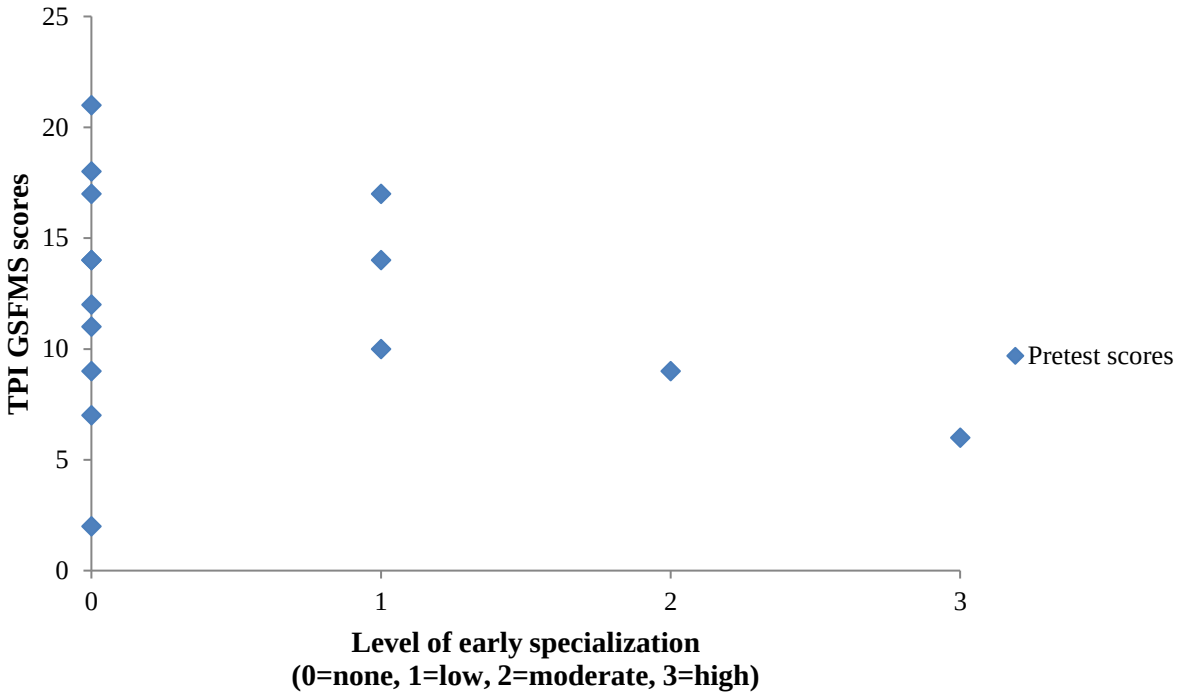
The analysis of the collected data implied that the differences between early specialists and sports samplers in proficiency and improvement of golf-related physical skills were not statistically significant. While there were minor differences in the average pretest scores (with sports samplers scoring better) and the gain scores (with early specialists improving more), the disparity was not greater than what might occur by chance. With the TPI GSFMS scores not significantly different between the two groups, coaches on the collegiate level should build similar screening and training programs for their golfers no matter the individual player's sports participation history. In other words, a well-designed training program should positively impact sports samplers and early specialists in a similar way.

The insignificance in differences between the two groups was at least in part caused by the failure to obtain a large and balanced sample. The convenience sampling method resulted in an uneven sample; 10 out of 15 subjects had no early specialization, and only two subjects

showed moderate or high specialization (Figure 1). Although the pretest scores of the two moderately- and highly-specialized participants were among the lowest, there were not enough subjects in these categories to make firm conclusions about the relationship or to analyze statistically. However, the scatterplot suggests that a higher degree of specialization may be related to lower TPI GSFMS scores (Figure 1).

Figure 1

Pretest TPI GSFMS Scores of All Subjects Related to Their Levels of Early Specialization



If the pattern suggested in Figure 1 represents the overall trend among collegiate golfers, junior coaches and parents should be aware of the negative effect of higher degrees of early specialization on golf-related physical skills. Striving for more balanced and less specialized sports participation before the age of 13 could benefit the golfers' physical skills later in their playing career, along with bringing other benefits of sports sampling discussed in Chapter 2, such as a decreased risk of overuse injuries. While the data on injuries collected in this research

did not provide a conclusive answer, most of the subjects who reported chronic or overuse injuries had at least a low level of early specialization, which again implies that the long-term health of young athletes might benefit from playing multiple sports in childhood. Even for young players who compete primarily in golf, at least recreational participation in other sports may help their long-term development.

The low frequency of moderate and high specialization among the subjects indicates that early specialization in golf might not be too common among collegiate golfers at the Division III level. There are multiple possible implications of this finding. It is possible that moderate or high specialization might be unnecessary or even counterproductive for making it into collegiate golf; however, it could also mean that the early specialists actually often reach even higher competitive levels like NCAA Division I. Further research comparing golfers from different divisions of collegiate golf would be necessary to provide more clarity.

Threats to Validity

As discussed above, the convenience sampling with a low number of subjects, particularly in the highly specialized categories, limited the power of the study. The participants for this study were selected from only one Division III college golf team. Results cannot be generalized to all college athletes, which is a threat to external validity. The results may vary based on sport or level of collegiate competition.

The compromised format of the research caused by the COVID-19 pandemic jeopardized the internal validity of this study. Because of the pandemic, all of the research procedures had to be done remotely, which resulted in a decreased degree of control over the data collection and execution of the individualized training programs. Although the researcher contacted the subjects frequently during the five-week research period, much of the consistency and effort in

performing the prescribed exercises were still controlled purely by the participants. Therefore, some of the differences between pretest and posttest gain scores among the subjects could be explained by varying levels of individual motivation and diligence in following the appointed training plans.

Theoretical Consequences and Connections to Existing Literature

As was discussed in Chapter 2, Gulging et al. (2014) and Speariett and Armstrong (2020) previously found that TPI GSFMS scores were directly related to golf swing faults and overall golf performance. Because of this link, using individualized training programs to improve golfers' TPI GSFMS scores should theoretically have a beneficial impact on the athletes' golf performance. In this study, 12 out of 15 subjects improved their TPI GSFMS score after the three-week exercise program; the average gain score for the entire sample was 3.67 points on the 43-point TPI GSFMS scale. Consistently achieving such an improvement for the vast majority of subjects despite the compromised circumstances and the short duration of the training plan is one of the promising results of this study. If physical conditioning is as important for golf performance as previous research suggests, the TPI-based movement screens and training programs have a significant potential to be used within Division III collegiate golf coaching as a tool for assessing and improving the golf-related physical skills of student-athletes.

Implications for Future Research

Although both of the null hypotheses in this study were retained, the relationship between the sports participation history of golfers and their physical skills remains a topic for further research. One way to obtain more definite takeaways would be conducting studies with bigger sample sizes. The framework laid out in this study confirmed the reliability and validity of the TPI GSFMS as a tool for measuring golf-related physical skills and could be scaled for use with

bigger sample sizes. Moreover, the study also showed that the TPI GSFMS may be used for screening via video calls, provided correct camera angles and clear instructions. The video screening could open possibilities for including student-athletes across the USA in a single study while reducing the research cost. In future research with bigger sample sizes, the degree of control during the remote collection of data could be increased by requiring the subjects to send videos or images as proof of completing their assigned exercises on the training days.

One of the main goals of future research should lie in collecting and comparing data on the sports participation history and golf-related physical skills of student-athletes across various levels of collegiate athletics (all three NCAA divisions, NAIA, and NJCAA). Such an approach could show the differences in sports participation history across different tiers of collegiate golf, such as whether early specialization or sports sampling might be among the factors that separate the very best young golfers from the rest of their peers. This process could also provide more information on the benefits and drawbacks of both approaches to sports participation in childhood. Because of the potentially more harmful impact of moderate and high levels of early specialization, it should be a priority for future studies to focus on early specialists in detail.

Conclusions

To summarize, the inconclusive results of this study have not clarified which model of childhood sports participation is optimal for enhancing the development of golfers' physical skills. However, the experimental design provides the potential for further research in this area. The choice between early specialization and sports sampling in childhood can have a significant impact on the physical, emotional, and social development of young athletes. Further academic work needs to be done to improve the understanding of these concepts in the context of competitive golf.

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Appendix

Sports Participation History Survey

You have been asked to participate in this action research project, which is focused on identifying and equalizing differences in general physical skills (strength, power, flexibility) between collegiate golfers who specialized early in golf and those who have a history of multiple sports sampling.

To be eligible for the study, you must be at least 18 years old and a collegiate golfer. During the study, you will fill out a survey asking about your sports participation history and go through two separate assessments of your golf-related physical skills. Between the two assessments, you will do an individualized three-week exercise program designed to improve your golf-related physical skills specifically based on the results of your first assessment. The researcher will guide you through the survey part of the research, as well as the two assessments of your golf-related physical skills, during video calls.

Your participation in the study indicates your understanding of the study and agreement to participate to the best of your ability. There are no specific benefits to you as an individual for participating in this study outside of the possible improvement of your golf-related physical skills. The risks to healthy participants are not beyond those of typical training activities for collegiate athletes. Please ask the researcher any questions you may have. You will not be identified in the reporting of results; only subject numbers will be used. Your individual identity will remain anonymous. You may withdraw from participating in the study at any time without penalty. If you choose not to participate, please inform the researcher.

Researcher:

Jan Jedlicka, Jan.Jedlicka@goucher.edu, graduate student at Goucher College

1. What is your **current age**?

   _____ years old

2. Which of the following sports do you **currently play on the collegiate level**?

   Y/N: Men's golf

   Y/N: Women's golf

   Y/N: Other (please list in the following space): _____

3. Which of the following are true for your **current participation in golf**?

   Y/N: Golf is your primary sport on the competitive level

   Y/N: You compete/train/practice golf for 8 months per year or more

   Y/N: You have stopped competing in other sports to focus on competing in golf

4. At what age did you first start playing golf (recreationally or competitively)?

   _____ years old

5. Which of the following were true for your **participation in golf at age 13**?

   Y/N: Golf was your primary sport on the competitive level

   Y/N: You competed/trained/practiced golf for 8 months per year or more

   Y/N: You had stopped participating in other sports to focus on participating in golf

6. Which sports did you participate in (recreationally or competitively) at age 18 or before? Please, list the sports in the following space:

   _____

7. Have you had any serious muscular, skeletal or nerve injuries in the past (broken bones, torn ligaments/tendons, dislocated joints)? If so, please list them in the following space:

   _____