The Relationship Between Sport Participation, Perceived Athletic Competence and Performance in University Sprinters

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Abstract

Purpose: There is a need for research that investigates confidence, performance, and previous sports involvement among particular sports such as in track and field sprinters. The objective of this study was to investigate relations between previous sport participation, perceived athletic competence, and performance results in university track and field sprinters. **Methods:** The perceived athletic competence scale and previous sport participation questionnaire were implemented in the form of an online survey. The best performance times were collected from an online results database. All of the participants were enrolled in university and were members of their respective school's track and field team. Measures of variability and descriptive statistics were calculated, and Analysis of Variance and t-tests were implemented to analyze potential differences amongst the variables of this study. **Results:** There were a total of 42 university track and field sprinters between the age of 18 and 23. The highest participated sports (sum) were track and field sprints (624), soccer (234), hockey (189), and basketball (164). A repeated measure ANOVA revealed a significant decrease in sports participation across all and between each of the three age groups (ages 8 to 13, 14 to 17, and 18+). Sports participation was the highest in the 8 to 13 age group. A bivariate correlation and linear regression analyses showed statistical insignificance between sport participation and perceived athletic competence. There was a low positive, but not statistically significant relationship from the 8 to 13 age group. Lastly, there was a statistically non-significant positive correlation for the first age (8 to 13) group and sprint performance times. **Conclusion:** The findings of the study contribute to the areas of sport participation, sport specialization, and athlete development by confirming what is already presently known while adding new support for track and field sprinting as a late

specialization sport and the need for further analysis and investigation in the future with a more diverse sample and a larger sample size.

Keywords: Physical Literacy, Sports Participation, Perceived Athletic Competence, Long-Term Athlete Development, Developmental Model for Sport Participation.

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Chapter One: Introduction

Despite the considerable research and evaluation that has been implemented to help developing athletes reach their performance potential, there is still much uncertainty as to how that is to be accomplished most appropriately. Several factors should be considered when facilitating the athletic development of young athletes. These optimally include the sport and type of sport (e.g., individual or team, court or field) the child or adolescent wants to participate in, the age that participation should begin, the age athletes typically peak in the sport, and finally the physical maturation status that is required for full potential. All of these factors should be considered when implementing an athlete development model, as they may dictate whether a sport requires a child to begin to specialize early or later. Neglecting these factors could have negative repercussions (e.g., injuries or early drop out age) on an athlete's development and success.

The two typical routes available in the development of athletes are early specialization and late specialization. There are some sports that are recommended to begin specialization at a later age (Balyi, 2004). Late specialization sports typically require participants to be more physically developed (i.e., height, weight, strength, power, etc.) to reach peak performance and is the opposite of early specializing sports wherein it tends to be a disadvantage to be more physically developed (Côté et al., 2009). Sports such as, track and field, cycling, combative (i.e., contact sports) sports, racquet sports and all team sports are considered late specialization sports.

The theory of taking a long-term approach to training and development has become increasingly popular and is known as Long-Term Athlete Development (LTAD) (Balyi, 2004). This theory focuses on the progression and teaching of general athletic and sport skills to

children before specializing in one specific sport. Similarly, Côté and colleagues (2009) created the Developmental Model for Sport Participation (DMSP), encouraging participants to engage in variations of sports through childhood and adolescence, which is referred to as sampling.

The reason LTAD and DMSP frameworks suggest taking a more developmental approach through sampling a variety of sports and activities, taking a late specialization approach to build upon fundamental movement skills that could serve a benefit throughout life or even carry over to a late-specialization sport (Côté et al., 2009). Physical competence, a component of physical literacy, is ones' ability to hone a variety of movement skills that will allow them to participate in many different contexts (Physical Literacy, 2015, p. 1). For this study, the self-perception of ones' athletic competence will be assessed, using Susan Harter's (2012) *Self-Perception Profile for College Students*. The competency that will be analyzed for this research will be athletic competence, subsequently referred to as perceived athletic competence (PAC) because it is a self-rating rather than ones' actual athletic competence.

This study will be focusing on the literature and suggestions from development models like the LTAD and the DMSP, and concepts like physical literacy, athlete development, specialization, participation and PAC. The aim of this research study is to investigate relationships between previous participation in organized sports, sprinting performance (i.e., race times), and current PAC in university track and field sprinters. Currently, there is no literature that specifically investigates previous sport participation throughout different ages of development and the relationship to PAC and current performance results in track and field sprinters. The study will contribute to existing theory by uncovering whether two important components of physical literacy (diverse sport participation and athletic competence) correlate

and predict track and field sprinting performance at the university level. Another core aim is to explore levels of previous sports participation and how this differs across three developmental levels (8 to 13; 14 to 17; and 18 and over).

Chapter Two: Literature Review

Physical Literacy

"Literacy in movement is as vital to every person as literacy in verbal expression itself" (Whitehead, 2001, p. 127). Physical literacy is a term that is similar to regular literary skills, but physically focussed. Edwards et al (2018) explains physical literacy as "physical literacy has been referred to, in a metaphorical sense, as developing literacy within a physical setting, synonymous to reading and writing, and specific to the culture in which individuals live" (p. 114). The most common current definition of physical literacy is defined as, "the motivation, confidence, physical competence, knowledge, and understanding to value and take responsibility for engagement in physical activities for life" (Whitehead, 2001, p. 127). However, it is noted that the construct of physical literacy is broader than what is led to be understood from the current definitions and encompasses many different disciplines and contexts (Cairney et al., 2019). Over the years there have been different interpretations and notions of physical literacy and how they are perceived and utilized. One notion is more related to sport, using physical literacy as a foundation for athletic development and success. Under this notion, physical literacy is explained as something that one achieves: "Individuals are physically literate when they have acquired the movement skills and confidence to enjoy a variety of sports and physical activities" (Kreillars, 2013, p.4). The other notion of physical literacy is based on a more holistic and embodied concept that presents itself in lived embodiment and improving one's overall quality

of life that incorporates the mind and body as one (Whitehead, 2007). This current study will focus on physical literacy from the sport and athlete development notion.

Similar to physical literacy, most people may be more familiar with the term athleticism, which is defined as, "the ability to repeatedly perform a range of movements with precision and confidence in a variety of environments, which require competent levels of motor skills, strength, power, speed, agility, balance, coordination, and endurance" (Lloyd et al., 2016, p. 1491). The main difference between physical literacy and athleticism is that the former incorporates a more psychosocial component whereas athleticism focuses predominately on physical components.

Olszewski (2007) reports that physical literacy is vital for success in sport before specialization and important for attaining excellence in sport and for living a healthy and well-rounded life of physical activity and sports. There are four contributing elements that comprise the concept of physical literacy, namely: motivation and confidence (affective), physical competence (physical), knowledge and understanding (cognitive), and engagement in physical activities for life (behavioural). Out of these four elements, physical competence will be the highlighted element throughout this portion of the review. Actual physical competence is a construct that is a component of physical literacy (Whitehead, 2001). Canada's physical literacy consensus statement defines physical competence as: *"*An individual's ability to develop movement skills and patterns, and the capacity to experience a variety of movement intensities and durations. Enhanced physical competence enables an individual to participate in a wide range of physical activities and settings" (ParticpACTION et al., 2015, para. 3).

It is important to clarify that being physically literate is not merely participating in various physical activities or being a good athlete in one sport. It comprises of showing

confidence and competence in abilities over a wide range of physical activity contexts through development and utilizing those skills throughout life. There are athlete development models (LTAD and DMSP) that focus on and include the concept of physical literacy in the models, as physical literacy supports the concept of development. The LTAD implements a strong focus of physical literacy to help develop athletes through childhood and adolescents, and into adulthood with the goal of being involved in sport and physical activity for a lifetime. The *Passport for Life* provides an aspect of physical literacy that goes further than just the physical aspect, including "motivation, confidence to participate, and perceived competence" (Robinson & Randall, 2016, p. 13).

Self-Perception

Self-perceptions are critical elements of human behaviours and function (Noordstar et al., 2016). Self-perception is also known as self-concept and can be defined as "a complex, organized and dynamic system of features that characterizes the ideals, attitudes and behaviours that the individual forms for oneself" (Purkey, 1988, p. 2). Susan Harter's (1985) *Self-Perception Profile for College Students* was designed to assess students' self-perception of their competencies and abilities in five various areas of life for the typical college student that are competencies and abilities (scholastic competence, social competence, athletic competence, physical appearance, and behavioral conduct). There are eight other domains that are analyzed and the questions primarily focus on the importance the participant attaches to success in each domain (Neemann & Harter, 2012). The reason for evaluating both competence and importance is because Neemann & Harter (2012) believe that the combination of the two will strongly influence one's overall self-worth (Harter, 1999). Self-worth is defined as "general feeling about

the self, assessed with items such as liking the kind of person one is, and liking the way one is leading one's life" (Neemann & Harter, 2012, p. 9).

Perceived Athletic Competence

Perceived competence is how well one feels they could complete a certain type of task. Perceived athletic competence (PAC) is whether one feels that he or she is good at sports, physical activities, and athletic movements (Neemann & Harter, 2012). Similar to the construct of physical competence, athletic competence is how well one can complete sport specific tasks or skills. Though actual athletic competence is different than PAC, they are thought to be related, one impacting the other (Harter, 1985; Davison, Downs & Birch, 2006). Self-efficacy is a term that is closely related to PAC; however, it is a different construct. Self-efficacy is defined as "people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives" (Bandura, 1994). In some ways, self-perception is similar in regard to how one perceives themselves or how well someone thinks they can complete a task (Purkey, 1988). Where the two differ, is that self-efficacy emphasizes on the capabilities to produce an effect (Bandura, 1994).

Perceived Athletic Competence and Actual Athletic Competence

There has been some research to determine whether PAC and actual athletic competence (i.e., physical competence), with some research suggesting that the two are related and some research between the two constructs being inconclusive. Actual athletic competence is one's ability to perform certain athletic or motor skills. A systematic review presented by Lubans, Morgan, Cliff, Barnett and Okely (2010) investigated the relationships between fundamental movement skill (FMS) competencies and other health benefits for children and adolescents.

Research using the Motor Perceived Competence Scale revealed that children who scored well in locomotor (standing long jump, 50-yard dash, and shuffle run) and object control (two ball throws short and long-distance) proficiency were more likely to have higher PAC (Rudisill, Mahar, & Meaney, 1993). This shows that children who have strong fundamental movement skills also perceive themselves as athletically competent.

Perceived Athletic Competence and Physical Activity

There has been slightly more research on PAC and physical activity oppose to PAC and actual athletic competence. Physical activity refers to how active one is, whether they are highly active or not active (Agans, Johnson, & Lerner, 2017). It has been suggested that there is a correlation between PAC and physical activity, one impacting the other. There has been research that has compared PAC levels to amounts of physical activity that children and adolescents take part in. Agans, Johnson, & Lerner (2017) compared PAC levels to different levels of physical activity, via a five-year longitudinal study amongst adolescents from grades seven to twelve. Findings from this study indicated that those who had higher levels of physical activity, also had higher levels of PAC (Agans, Johnson, & Learner, 2017). The results showed that PAC scores in high physical activity were higher than moderate physical activity, PAC score from moderate physical activity were higher than low physical activity, and PAC scores in low physical activity were higher than no physical activity (2017). Additionally, Noordstar et al. (2016) found that children who had higher PAC scores, also reported to be more physically active than those who had lower PAC scores. This study showed that boys had higher PAC than girls and were also more physically active than girls (2016). With gender aside, this study showed that those who had higher PAC, also had elevated amounts of physical activity.

Long-Term Athlete Development (LTAD)

When children begin to participate in sports and physical activity, some parents and coaches have been known to introduce children to one specific sport and solely focus on that sport at a young age, assuming success at a young age will mean success in later ages. However, it has been recommended to take a more long-term approach, gradually introducing skills through various activities and sports while looking at the overall future development of the athlete, as opposed to the immediate. This approach is known as Long-Term Athlete Development (LTAD) (Balyi, 2004). The concept and the implementation of LTAD was made popular through sport by Istvan Balyi (Eisenmann & Brewer, 2019). The idea of long-term developmental approaches has been attributed to Eastern European sports science and athletic development during the Cold War Era (Eisenmann & Brewer, 2019; Riordan, 1977). Eastern Bloc countries (e.g., USSR) have been known to develop athletes at young ages and place them into schools to specialize in one sport for training and competition (Riordan, 1997). Balyi's idea resembles the Eastern Bloc approach by having children start at young ages, though his structure focuses on overall development and athleticism rather than specializing in one single sport (until later ages). Olszewski (2007) uses Balyi's LTAD model in a framework to clearly layout the multiple factors, contributions, objectives and stages that focus on training, competition, and recovery to guide the physical development of individuals. Due to not steering too far from what certain sports will require in terms of skill development, it is common that specific sport governing bodies implement their own plan for long-term development, progressing from general skills to skills that are specific to the sport. The stages that are discussed and make up the LTAD begin as young as infancy and as old as retirement age.

The key factors that appear to influence LTAD are physical literacy, specialization, development age, sensitive periods, mental, cognitive and emotional development, periodization, competition, excellence takes time, system alignment and integration, and continuous improvement. LTAD models are predominantly built around physical literacy and focus on developing the whole athlete. Balyi (2004) posited seven stages of development to support and guide the implementation of LTAD. These stages of development are based on apparent physiological principles of development and focus on "windows of opportunity," important periods for development of motor performance built around suitable maturation time periods (Balyi, 2004). The seven stages are: FUNdamental, learning to train, training to train, training to compete, training to win, and active for life.

Seven Stages of Long-Term Athlete Development

In the LTAD Framework there are seven stages that are outlined, with each one designed to guide individuals through age appropriate steps of development, focussing on physical, cognitive and emotional development (Olszewski, 2007). Each of the seven stages are designed to progress from one to the other. The first three stages (active start, FUNdamentals, and learn to train) are designed to develop and encourage physical literacy and introduce sport for all levels of participants. The next three stages (train to train, train to compete, and train to win) are designed and focused on pursuing excellence in sport and athletes begin to put more time and focus into one or two sports. The final stage (active for life) is designed to encourage physical activity throughout life, which is the end goal for LTAD and physical literacy. By highlighting the purpose and objective of each stage, they can be applied to specific sports to better understand an athlete's development.

Active Start. This stage of development is focussed on toddlers and pre-school aged children, encouraging fundamental movements and incorporating them in play. The approximate age for this stage is from 3.2 to 6.2 years of age for both males and females. The recommended amount of physical activity per day is 30-minutes for toddlers and 60-minutes for pre-school aged children. Building the child's cognitive, emotional, physical and social skills through play is a large focus for this stage. Most of the stages of development recommend a training to competition ratio, however, due to the relatively young ages of participants at this stage, there is no suggested training to competition ratio. The overall goal of this stage is to begin to develop the child's physical literacy, a passion for playing and participating in different types of sports or activities, and to have fun. During this stage, it is highly recommended that children engage in activities in safe environments with a variety of toys and equipment. Participation can be done through clubs, community centres, daycare and time at home.

FUNdamentals. A progression from the active start stage, the "FUNdamentals", stage is designed to incorporate well rounded, structured, and fun-oriented play in the pursuit of practicing all fundamental movements and building overall movement skills. The approximate ages for this stage are 6.2 to 9.2 years of age for males and 6.2 to 8.3 years of age for females. At this stage, females begin to develop earlier and faster than males, hence the different range of ages. Similar differences will proceed throughout the remainder of the developmental stages. Like the previous stage, 30 to 60-minutes of physical activity per day is recommended. The "ABCs" (Agility, Balance, Coordination, and speed) are a large component of this stage and meant to be incorporated into a fun, structured format (e.g., playing games and sports of variety, obstacle courses etc.). This allows the children to practice certain skills, but in a fun manner.

Proper and safe techniques of exercises should be taught to prepare children for the next stage, but periodized planning is unnecessary at this stage. Like the active start stage, it is unnecessary to have a training to competition ratio and it is recommended to incorporate some structured competition into the play, with an emphasis on having fun.

Learn to Train. The main purpose of this stage is to learn and develop overall general sport skills that are related to all athletic development (e.g., proper running, jumping, throwing and catching techniques) before adolescent growth spurts take place. Due to adolescent growth spurts, this stage is one of the most important for athletic preparation and can "make or break an athlete". Using a more general training approach will build on broad athletic skills, and potentially contribute to the development of physical literacy, as it continues to be a main objective through this stage. The approximate ages for this stage are 9.2 to 12 years of age for males and 8.3 to 11.3 years of age for females. Formal training concepts should begin to be introduced such as proper warm-up, cool-down, stretching, nutrition/hydration and mental preparation skills. Although competition is not the focus of this stage, this is the first stage where training to competition-specific training and competing ratio is implemented. The ratio for this stage is 70% training and 30% competition specific-training and actual competition. The framework goes on to mention that too much competition and competition-specific training can potentially cause an athlete to lack in basic skills and overall fitness.

Train-to-Train. This stage is a progression from the former stage but is very similar in-regards to importance of athletic development. The approximate ages for this stage are 12 to 16.1 years of age for males and 11.3 to 15 years of age for females. The train-to-train stage will be more specific in terms of sport skills and energy systems (e.g., the phosphagen system for a track

and field sprinter), by practicing and learning basic sport specific techniques through training, as well as building an aerobic base, developing speed and strength, and building towards the next stage. By this stage, athletes are encouraged to focus on one or two main sports, where training is specifically geared towards those sports. It is still important to incorporate general skills and training, as the training ratios only change by 10%, with general training shifting to a 60% focus and competition-specific training and overall competition being 40%. During competition, athletes are encouraged to put forth their best efforts and attempt to win, with a focus on improving skills. This stage is important as it is preparing athletes to enter the next stage where training is focussed on competing against other individuals.

Train to Compete. Progressing from the train-to-train stage, one of the main objectives is that athletes will be able to take the knowledge and practice gained and now direct it towards competing to the best of their ability. The other focus now involves an emphasis on individual and even position specific skills and performing well. The approximate ages for this stage are 16.1 years of age and beyond for males and 15 to 17.9 years of age for females. Training sessions can sometimes cumulate to 9-12 times per week, with a focus on sport specific fitness and skill. The ratio for this stage has a more significant increase with general training only consisting of 40% and competition-specific training and overall training making up 60%. During this stage a full-time, annual training approach is taken towards one specific sport with intentions of moving towards the next stage, training to win.

Train to Win. This stage is very similar to the last, now with the main objective being to beat the competition and strive towards obtaining best performances. There are no age ranges for this stage, but the focuses of this stage will begin after the train to compete stage and will

proceed into adulthood. Training is now a full-time schedule with practice sessions exceeding 15 sessions per week. Training is also periodized annually with specific loading approaches geared towards allowing athletes to "peak" for the most important competitions. The general training ratio is now 25%, with competition-specific training and competition a 75% focus. Athletes that are in this stage are focussing on university and international levels of competition.

Active for Life. The main objective for the final stage of the LTAD is a transition from all the years of developing physical literacy, to a focus on a lifelong physical activity approach. It is theorized by the LTAD framework that those who are more physically literate are more likely to be active for life. Athletes who once reached podium levels of competition now learn to be competitive for life, fit for life or occupy other roles as a leader in sport or physical activity (e.g., coaching). The approximate time and age for this stage begins after retirement when an athlete progresses from the train to win stage and can continue to be physically active or involved in the sport throughout life.

As outlined, each of the seven stages serves a specific purpose with a clear objective. Each stage builds on the next and focuses on developing athletes appropriately. The overarching goal of the three "developmental" stages is to develop physical literacy and prepare for the three "excellence" stages. Likewise, the excellence stages prepare athletes to be active and involved in sport for life.

Considerations of Long-Term Athlete Development

The LTAD approach has been a working framework for many years and serves as a beneficial guide for coaches and educators when working with young developing athletes. There are various parts of the LTAD structure that need to be considered when analyzing or even

implementing these concepts. Credibility and evidence of legitimacy regarding the LTAD has been up for debate amongst researchers for years. Ford et al. (2011) analyzed the physiological evidence and application of the LTAD discussing several contradicting concepts as well as positive sides of the LTAD for coaches and others implementing the model to consider. Ford et al. (2011) addressed many points that may have been overlooked or neglected in the model. The first and perhaps most impacting point would be that the LTAD claims to be following physiological and maturation principles throughout the stages of development, but the stages are based on chronological ages. The concerns inherent here are that everyone physically develops and matures at different ages, suggesting that progression from stage to stage should be individualized.

The Developmental Model for Sport Participation (DMSP)

Similar to the LTAD, the Developmental Model for Sport Participation (DMSP) is a model for athlete development that focuses on participation, performance, and personal development for children and adolescent athletes (Côté & Vierimaa, 2014). The DMSP, which was created by Côté and colleagues (2007), proposes three pathways for participation and development. Two of these promote sampling pathways, with the third pathway taking an early-specialization focus (Côté et al., 2009). All pathways presented begin at the age of seven, one-year after sport entry, which is at age six; and all structured developmental pathways end at 17-years of age.

The two sampling pathways (recreational participation through sampling and elite performance through sampling) are combined as "Sampling Years*"* from ages 6 to 12 (Côté et al., 2009). These sampling years consist of high amounts of deliberate play, low amounts of

deliberate practice, and involvement in many different sports and activities (2009). Starting at age twelve, the pathways then separate to the "recreational pathway", which continues to focus on high amounts of deliberate play and low amounts of deliberate practice (2009). The "elite performance" pathway then enters "specializing years" wherein there is a focus on deliberate play and practice in a select few sports, decreasing involvement in many sports. This stage is implemented between 12 to 14 years of age. From ages 14 to 17, athletes then enter the *"*investment years", consisting of a high amount of deliberate practice, low amounts of deliberate play, and a focus on one individual sport. On the opposing side of sampling, the pathway of elite performance through early specialization involves high amount of deliberate practice, low amounts of deliberate play, and focus on one individual sport starting at the age of seven and continuing this pathway throughout ones' athletic career. All three pathways are designed for "probable outcomes." The first pathway strives towards recreational participation, with pathways two and three designed to obtain elite performance. Research has shown that athletes who have a background of diverse sport and activity participation still tend to reach high performance levels of sport; whereas those who participated in multiple sports as youth (not including their current specialized sport) tend to have longer careers at higher levels of competition (Baker, Côté & Abernethy, 2003; Baker, Côté, & Deakin, 2005; Soberlak & Côté, 2003, as cited by Côté et al., 2009).

Based on the DMSP framework, Côté and colleagues (2009) proposed seven postulates that are associated with the pathways of the DMSP framework. The postulates discuss the multiple reasons and benefits for developmental focus on deliberate play and sampling various sports instead of deliberate practice and specializing in a single sport at a young age. Following

is a brief overview of how each postulate and how it supports sport sampling and the DMSP framework.

The first postulate is that "early sport diversification does not have a negative impact on participation in sports where peak performance is reached in post-maturation" (Coté et al., 2009, p. 11). Prior studies have indicated that sports such as: ice hockey (Soberlak & Côté, 2003; Coté et al., 2009), field hockey, basketball, netball (Baker, Côté & Abernethy, 2003; Coté et al., 2009), baseball (Gilbert et al., 2002; Hill, 1993; Coté et al., 2009), tennis (Carlson, 1988; Côté, 1999; Monsaas, 1985; Coté et al., 2009), triathlon (Baker, Côté, & Deakin, 2005, as cited by Coté et al., 2009), and rowing (Côté, 1999) require athletes to have reached full maturation, which is usually late twenties or early thirties. Studies also indicate that elite performers in these sports were shown to have sampled multiple sports prior to specialization. Athletes will typically specialize in these sports between the ages of 13 to 16 years of age.

Postulate two states that "early diversification and sport sampling are linked to a longer career, as well as long-term involvement in sport" (Coté et al., 2009, p. 11). Studies have shown that in sports such as swimming and tennis, athletes who decided to specialize closer to the end of childhood but before adolescence, had longer careers than those who specialized earlier, with careers lasting into adulthood (Barynina & Vaitsekhovskii, 1992, as cited by Côté et al., 2009). Specializing at slightly older ages has shown lower numbers of drop out, as well as lower numbers of injuries, which could also lead to drop out (Law et al., 2007; Côté et al., 2009).

The third postulate asserts that "early diversification and sport sampling allow athletes to participate in a wide range of activities that will be beneficial to positive youth development" (Coté et al., 2009, p. 12). It is suggested that subjecting youth athletes to multiple sports and

activities during developmental stages will broaden their social development in a variety of contexts. Children who participate in sport, such as soccer or basketball, will be exposed to more social contexts as opposed to a child who plays tennis and spends more one-on-one time with an adult. Studies suggest that participating in a variety of sports will also broaden and expose athletes to different skills that may carry over to future success (Côté et al., 2009). Previous research has also shown that a wide range of sport participation during childhood can foster healthy relationships with peers and strong leadership skills in university level athletes.

Postulate four is that "high amounts of deliberate play during the sampling years will strengthen intrinsic motivation by being involved in sports or activities that are enjoyable" (Coté et al., 2009, p. 13). Deliberate play allows children to participate in activities of their choice and activities that they enjoy, which will contribute to internal motivation, rather than external motivation such as winning (Soberlak & Côté, 2003, as cited by Côté et al., 2009). Early involvement in deliberate play may help children in terms of self-direction, creating intrinsically motivating behaviours and could lead to athlete's wanting to take part in more deliberate practice (Ryan & Deci, 2000; Vallerand, 2001, as cited by Côté et al., 2009). It is also thought that during deliberate play, children will learn and hone skills that could contribute to task mastery. Overall, sampling and deliberate play could positively impact children's future participation in sport, as this process can contribute to building their self-determination and positively impacting their commitment to sport.

The fifth postulate posits that "high amounts of deliberate play during the sampling years can establish various motor and cognitive experiences that children can bring with them to the sport that they decide to specialize in later" (Coté et al., 2009, p. 13). Deliberate play serves as a

way for youth to explore their physical capacities in different contexts, as well as building skill acquisition. Analyses of early involvement in sports like tennis (Carlson, 1988; Côté, 1999; Côté et al. 2009), rowing (Côté, 1999; Côté et al., 2009), and baseball (Hill, 1993; Côté et al., 2009) indicate that deliberate play-like activities were crucial in the beginning years of sport engagement for elite athletes. Research showed that elite level hockey players predominantly engaged in deliberate play, rather than deliberate practice before they turned 20 years of age (Soberlak & Côté, 2003, as cited by Côté et al., 2009). Deliberate play activities are much different than deliberate practice and are often difficult to replicate, as deliberate play can last multiple hours, which provides extensive playing time (e.g., playing one-on-one in the driveway). Thus, it is still not clear if deliberate practice is superior to deliberate play during the earlier developmental years.

Postulate six is that, around the age of 13, "children should be presented with the opportunity to choose whether to specialize in their favourite sport or continue to sample multiple sports at a more recreational level" (Coté et al., 2009, p. 13). Studies suggest that from the ages of 13 – 15, it is an important developmental time for psychological progressions such as identity and competence (Côté et al., 2009). Therefore, it is recommended that ideal ages to consider specialization are between the ages of 12 and 15.

The final postulate is that, around the age of 16 or late adolescence, "individuals have developed physical, cognitive, social, emotional, and motor skills that are necessary to invest in their sport of choice at a highly specialized level" (Coté et al., 2009, p. 14). Soberlak and Côté (2003) note that the total hours of sport-specific practice of professional ice hockey players from ages 6 to 20 was 3,072 hours, with an average of 459 hours (10% of total hours) completed

during years of sampling (Côté et al., 2009). Equally, an average of 2,215 hours (56% of total hours) of sport specific practice occurred during the years devoted to specialized training (investment years). In a study that reviewed developmental factors impacting sport participation, Patel, Pratt, and Greydanus (2002) suggested that late adolescents (around age 16) have the psychological, social, emotional, and physical maturity that is necessary for the next level of competitive sports (Côté et al., 2009). By this age and stage of development, athletes should have the ability to understand the benefits and potential sacrifices that are part of intense focus on a single sport and should be able to make appropriate decisions.

Sports Participation

As mentioned in the LTAD approach, as well as the DMSP approach, development of sport participation is essential for future participation, whether it be high performance sport or life-long participation. There are different levels of participation in sport that athletes can take part in. Typically, beginners will start with fundamental levels of participation where competition and practices are conducted predominantly for learning and developmental motives; this is typically more of a learning setting and any competition may be more recreational. Through developmental stages, athletes can decide to progress to more performance-based participation in sport, following stages of development like the LTAD framework suggests. The DMSP is supported by seven postulates of reasoning for sport sampling and will be discussed later in the review of literature. Like the developmental stages suggested by the LTAD, the DMSP provides three participation phases: sampling years, specializing years and investment years (Côté, 1999).

There are three phases of participation that begin in childhood and progress throughout

late adolescence (Côté, 1999). These phases are intended to gradually and appropriately develop athletes physically, emotionally, socially and psychologically. Sampling is the first phase and is defined as participation in a variety of sports with the intention of deliberate play and less of a focus on deliberate practice (Côté et al., 2009). The recommended ages for the sampling phase are ages 6 to 13 for both boys and girls (Côté, 1999). The sampling phase resembles the LTAD stages of Active Start, FUNdamentals and Learn to Train, by encouraging children to participate in a variety of sports and develop general skills. Sampling suggests that athletes participate in various sports throughout developmental years to build upon fundamental movement skills, as well as general athleticism. The next phase is the specializing years and is recommended for athletes between the ages of 13 and 15 (Côté, 1999). Although the specializing phase is shorter than the sampling phase, this is when athletes begin to gradually decrease the number of sports, focusing instead on one or two specific activities. Fun should still be a main element of the athletes' experience, while sport specific skills will begin to be an important characteristic of their participation. However, the expectations of a high-performance athlete will not yet exist. Investment is the third and final phase, around the age of 15 or over, athletes will move into what is called the investment years (Côté, 1999). In this phase, athletes should be committed to focussing on a single sport and pursuing an elite level. The most important elements of this phase are "strategic, competitive, and skill development characteristics of sport" (Côté, 1999, p. 407).

Deliberate Play and Deliberate Practice

Not only is sport participation divided into different phases for developmental purposes, but there are also varying types of participation and practice that can have different impacts. Deliberate play is defined as "activities in which children participate because they are inherently

enjoyable but could nonetheless contribute to the development of expertise" (Côté et al., 2007; Côté et al., 2009, p. 8). Deliberate play is usually self-directed by children, recreational in nature and often includes some type of adaptation (e.g., one-on-one basketball in the driveway). Deliberate practice can be defined as "practice activities that have the primary goal of improving performance" (Ericsson, 2003; Côté et al., 2009, p. 7). Deliberate practice is largely supervised by an adult or coach, practices and competitions are structured, and are often over seen by organizations. Wiium and Säfvenbom (2019) use the terms "unorganized" or "self-organized" sport participation, which would be equivalent to deliberate play. Also, "organized" sport participation, which would be equivalent to deliberate practice. To utilize these types of participation into the phases of participation, sampling years will consist of more deliberate play for children and the specializing and investment years should consist of more deliberate practice for adolescent ages.

Studies have shown that both the deliberate play and deliberate practice approaches serve their purpose at the appropriate times. For example, research has revealed that many elite athletes engage in high amounts of deliberate play during childhood and provide a diversified background (Baker, Côté, & Abernethy, 2003; Baker, Côté, & Deakin, 2005; Soberlak & Côté, 2003; Côté et al., 2009). Though deliberate practice may not be necessary for children, it will be necessary for adolescents once they reach the specialization and investment phases and will need to build on their skills to carry them through higher levels of sport and into adulthood.

Sport Specialization

The LTAD Framework defines sport specialization as deliberate practice in one specific sport and refining the skills to exceed in that sport, with neglecting any other sport on a year-

round basis (Olszewski, 2007). Sport specialization can then further be divided into early sport specialization and late sport specialization. Each division contains sports that are most applicable and appropriate to either early specialization or late specialization.

Early Sport Specialization. Early sport specialization can be defined as a focussed involvement on one individual sport with the goal to improve on sport skill and competition (Côté et al., 2009; Olszewski, 2007). Feeley et al. (2016) discuss certain sports that are necessary for early specialization, such as golf, tennis and gymnastics, where size and post pubertal development is not a concern. There can also be a benefit to specializing at an early age in a sport that is technically demanding (e.g., gymnastics, diving, dance, etc.). For this reason, Goncalves et al. (2012) discusses how the Soviet Union was one of the first countries to implement "talent identification" wherein biological scientific methods were used to predetermine which sports children should begin early training and which commonly increased participant's chances of later success. However, it has been discovered that there can also be negative effects of early specialization in the form of, for example, physical (i.e., overuse injuries) and psychosocial consequences (i.e., decrease in sport enjoyment), both of which can lead to other detrimental outcomes (Baker, Cobley, & Fraser-Thomas, 2009). It can be argued that there are benefits as well as disadvantages to early sport specialization.

Ferguson and Stern (2014) report that the early specialization stemmed from Ericsson's most popular theory of attaining 10,000 hours or 10 years of practice in order to be an expert in a specific area or task, an approach also taken by the Soviets. Lombardo and Deaner (2014) elaborate on this theory, which is also commonly known as the Deliberate Practice Model or DPM. This model focuses on the importance of deliberate practice, which is defined as "training

that is structured, attentive, maximally effortful, and subject to immediate feedback from a coach" (Ericsson, Krampe & Tesch-Romer, 1993; Ericsson, Prietula & Cokely, 2007; Ericsson, Nandagopal & Roring, 2009; Howe, Davidson & Sloboda, 1998 as cited in Lombardo & Deaner, 2014, p. 2). Using the deliberate practice theory in the context of sport is a misinterpretation of one of his most popular studies which investigated what factors helped predict expert performances within such domains as mathematics and chess. Results of the study showed that high volumes of deliberate practice that were specific and focused on a certain skill set at a young age was a prediction of obtaining expertise over time. Though in theory this approach makes logical sense, due to the high amount of over-repetitive movements, chronic injuries can occur quickly as discovered in adolescent baseball players. During the examinations of early specialization in sport, Ferguson and Stern (2014) highlight reasons for and reasons against early specialization in sport. The main reasons they provide for early specialization include increasing competitive edge, developing skills quickly, recognizing talent, and increasing future opportunities. Reasons advising against sport specialization involve increased risk of overuse injuries, improper rest, maintaining interest in sport, and preventing social isolation, and burnout.

Balyi (2004) discusses early and late sport specialization training and how the two differ in terms of developmental focus and approach. Even though the article focuses on late-specialization sport, it briefly analyzes the approaches that are taken by those specializing in an individual sport at a young age. For early specialization, the four stages that are taken are: training to train, training to compete, training to win, and retirement/retainment. This four-stage format is designed to immediately begin training and building specific skills for a certain sport, skipping generalized fundamental skills. By expressing the advantages to the late specialization

model, the four-stage approach could be a disadvantage due to individuals missing the first two stages (Active Start and FUNdamental Stage) of the whole seven-stage LTAD approach which takes a whole athlete development approach (Balyi, 2004).

Late-Sport Specialization. In contrast to early sport specialization, late sport specialization are known as sports that are not necessary to begin at an early age and can be learned later (Côté et al., 2009). Balyi (2004) mentions that due to the many possible detriments of early specialization previously discussed, it is suggested that a more progressive, long-term approach for certain sports be taken. Typical late specialization sports include combative sports, racquet sports, rowing, and track and field. The LTAD Framework (Olszewski, 2007) overviews "very late specialization" sports (cycling and wakeboarding) and late specialization sports that transfer from one sport to another (rowing, triathlon, volleyball, and bobsleigh). Late specialization sports take a full LTAD approach, which follows all seven stages compared to the approaches taken in early specialization. It is recommended that if physical literacy is acquired prior to maturation, athletes should be able to choose a late specialization sport between the ages of 12 and 15 and have a realistic opportunity to succeed in later years of competition (Olszewski, 2007). Following the seven stage LTAD approach for sports that are considered "late", "very late", or "transfer" sports is beneficial because a developmental approach of the whole athlete is taken and has been shown to increase longevity in athlete's careers.

Track and Field

The sport of track and field consists of multiple events that comprise of different skill sets such as: throwing (shot put, javelin, discus and hammer throw), jumping (high jump, long jump, triple jump and pole vault), sprinting (100m, 200m, 400m, 100/110m hurdles and 400m hurdles)

and distance running events (800m, 1500m, 3000m, 5000m and 10,000m). Track and field is participated in by youth as well as adults and consists of different participation levels ranging from beginner, recreational, and high performance.

Run, Jump, Throw

Since track and field consists of numerous events that span across multiple different types of athletic skills, many have used track and field for general skill development purposes (i.e., learning to run, jump, and throw properly). Athletics Canada (the Canadian track and field governing body) has developed the *Run-Jump-Throw* program (Coyne et al., 2019). The premise of the Run-Jump-Throw program is to develop fundamental movement skills and personal development. Coyne et al. (2019) found that implementing a 10-week run, jump, throw program with youth athletes improved their fundamental movement skills. For their study, the CAPL (Canadian Assessment of Physical Literacy) was conducted pre and post 10-week implementation of the run, jump, throw program. Results found improvements in all the physical literacy domains (physical competence, motivation and confidence, knowledge and understanding, and daily behaviour). Specifically, for the domain of physical competence, out of a possible score of 32, the mean score pre-test was 19.5 (SD = 3.9) and the mean score post-test was 21.4 (SD = 4.7), showing improvements in the physical competence domain.

Sprinting

Sprinting is described as focussing on maximal speed, power and explosiveness (Bushnell & Hunter, 2007). It is commonly thought that running and sprinting are synonymous. When comparing long distance running to short distance running, the main differences between the two are the rates that they are performed at (Bushnell and Hunter, 2007). Another major

difference between sub-maximal effort running and sprinting are the mechanics and technique (Mann, Moran, and Dougherty, 1986; Bushnell and Hunter, 2007). Distance running focuses on a more relaxed mechanical approach due to its longer duration and the arm motion and knee drive is much more lackadaisical and significantly more stressful internally on the lungs and respiratory system. In contrast, sprinting, takes a more forceful mechanical approach, attempting to be as propulsive and explosive as possible as participants attempt to complete a short distance in a minimal amount of time.

Physical Determinants of Sprinting Speed. There could be many factors that contribute to an individual's track and field sprinting speed. Factors such as environment, technology, experience, biomechanics, physical determinants, and genetics play a large role. For example, it appears that approximately 50% of speed and power success is due to genetic factors (Majumdar & Robergs, 2011). In more specific detail, Philips (1997), author of a reputable National Strength and Conditioning Association's textbook, explains that each person will have a natural genetic make-up of either more type II (fast twitch) muscle fibers or type I (slow twitch) muscle fibers; and, that this will have a large impact on an individual's natural ability to move quickly and for their muscles to contract at higher rates. While discussing the involvement of muscle fiber types in different sport events, activities such as the 100-meter sprint and other related activities are classified as "high" type II muscle fiber recruitment dependent.

Strength is another physical determinant that plays a significant role in speed and power performance. Strength is defined by Philips (1997) as one's ability to produce force on an object (implement or surface) at any level of velocity, with power being the product of force production. Strength is a quality that naturally increases as individuals physically mature and as

well as participate in activities that can increase strength (e.g., resistance exercise). It is of high importance to consider a "strength-to-mass ratio" when considering acceleration-based exercises such as sprinting. It is crucial that athlete's muscle mass is strong and able to produce force at optimal levels. In relation to the latter, the LTAD framework (Olszewski, 2007) discusses peak strength velocity) in both females and males and how the onset of their natural peak strength occurs roughly one year after they have reached their peak height velocity. This is typically ~age 13 for females and ~age 15 for males. Therefore, the development of strength could be connected to the development of testosterone production (Gonçalves et al., 2012)

The above information indicates that there are different physical factors attributable to sprinting speed performance due to genetics and physical maturation. The above also supports the previously mentioned suggestion made by Huxley et al., (2017) that it is more beneficial for athletes to specialize in sports that are classified as late specialization after peak physical maturation.

Track and Field Sprinting Events. Sprinting is most commonly known as a discipline in the sport of track and field, although other disciplines such as jumping, throwing and distance running may incorporate aspects of sprinting. Sprinting events are classified as events that are performed in individual lanes and are the distances ranging from 400-meters in length or less, which include the 100-meter, 200-meter and 400-meter sprint events. Within the sprinting disciplines are also the hurdling events, which consist of maneuvering over obstacles while sprinting (i.e., 100-meter, 110-meter and 400-meter hurdles).

Track and Field Sprinting and Team Sport Sprinting. Being able to run at maximal speeds is a necessity in various sports such as soccer, football, basketball, and rugby; however,

there are some differences between track and field sprinting and team sport or field and court sport sprinting. Kawamori, Nosaka, and Newton (2013), investigated ground reactive forces in team sport athletes, noting that track and field athletes have better ground reactive forces for several reasons. One reason is the difference in sprinting techniques (e.g., running posture, height of foot during recovery, etc.). Further, team sport athletes and track sprinters will begin their sprint differently with team sport athletes from a standing position and track and field sprinters typically from starting blocks or from a crouched position. Other biomechanical differences (e.g., step length, knee and hip angles at push-off) between a crouching start and a standing start have been reported during the initial 10-meters of sprinting. The differences between the two types of sprinting are important because unlike track and field specific sprinting, other sports require additional skills, reacting to changes in environment (e.g., a football player does not only sprint, but they also catch a ball or maneuver around other players as well) and making adjustments in short amounts of time (Wdowski, Gittoes & Irwin, 2012). The additional skills that field sport athletes acquire could potentially contribute to different PAC scores compared to track and field specific sprinters.

Specialization in Track and Field Sprinting. As previously mentioned, it is common for children to early specialize in sports that do not require early specialization. Track and field sprinting is a sport that is classified as a late specialization sport and therefore, it is not necessary to begin early specialized training. This is due to peak performances typically requiring maximum strength and power, physiological characteristics that do not appear until after maturation (Huxley et al., 2017). In the LTAD Framework (Olszewski, 2007), it is suggested that during early developmental stages (active start and FUNdamentals), children participate in

athletics (track and field) as the sport provides opportunities for children to learn how to run, jump, and throw, fundamental skills that children should be competent in. This is not suggesting that children make track and field or specific disciplines within track and field their main sport of focus during these developmental stages, but rather use the sport as a tool to build upon skills that are crucial during their development.

A study that surveyed 303 NCAA (National Collegiate Athletic Association) Division 1 athletes across 19 different varsity sports, found that athletes have many different motivations for specializing that determines when elite athletes decide to specialize (Swindell et al., 2019). While analyzing the various contributing factors to specialization, it was found that in the sport of track and field, the average age of specialization was 15.4 ± 2. (Swindell et al., 2019). In a separate study by Malina (2010), it was found that 46% of NCAA Division 1 female track and field athlete's first ever sport interaction was their current sport of specialization with a median age of 10. In contrast, it has been revealed that track and field athletes typically peak between the ages of 24 and 28 years. Huxley et al. (2017) proposed that it is only necessary to begin event specialization between the ages of 18 and 21. In their study of the "Key factors and influences in the development of Australian Olympic and World Championship track and field athletes," several different factors indicated success for Australians at the senior level such as, demographics, background, and physical milestones. Results showed that athletes who specialized in track and field at a later age and continued to participate in additional sports, had better success at the senior level including the World Championships and Olympic Games. These findings support an LTAD approach and the benefits of going through the appropriate age-related stages of development that were previously discussed.

Another point of view to consider in early specialization of track and field sprinting is whether elite youth athletes can maintain or match their ranking to the senior level. Kearney and Hayes (2018) collected data on nationally ranked youth athletes who were ranked top 20 in Australia across age categories of under-13, under-15, under-17, and under-20, then analyzed whether the top ranked senior athletes were also ranked during their earlier stages. It was found that a clear majority of top 20 "ranked" under-20 aged athletes were unlisted during the younger ages. The biggest changes in the top 20 list were between the under-13 and under-20 ranking lists for both male and female athletes. These analyses inspected a variety of events that encompassed a run, a jump and a throw, as each of these disciplines are main skill focuses in athlete development and are present in all sports and physical activities to some extent. Analyzing specifically the 100-meter sprint event results showed that 3.1% of males and 21.2% females retained their top 20 ranking from the under-13 rankings to their under-20 rankings. In contrast, it was also found that 32.6% of males and 50% of females retained their ranking from under-17 to their under-20 rankings. These statistics suggest that athletes are more likely to maintain their "elite" status into older age categories.

In a related finding, Hollings, Hopkins and Hume (2014) reported that the ages of peak performances in a 100-meter sprint for males was 24.5 years of age with a 4.3-year window of peak performance, whereas, for females it was 25.4 years of age with a 4.2-year window of peak performance. Based on this data, most athletes that compete in sprinting events will peak at older ages, supporting the benefits of Huxley's suggestion that track and field sprint athletes should begin specializing in events three to four years prior to their expected peak age.

Study Rationale

As previously mentioned in the literature, it's suggested that physical literacy is imperative for success as an athlete and to be active for life (Olszewski, 2007). Built upon the concept of physical, the LTAD model provides age categorized stages that focus on age-appropriate development to guide child and adolescent athletes to success and longevity (Balyi, 2004). The LTAD is designed to guide young athletes through stages of certain sports that will progressively and appropriately teach the skills needed to succeed in sports. The DMSP is a model that provides developmental pathways that focus on participation, performance, and personal development for young athletes (Côté & Vierimaa, 2014). The pathway for elite sport performance that is recommended from the DMSP begins with participating in a broad spectrum of sports and high amounts of play participation (i.e., sampling) at young ages, eventually specializing and investing in one specific sport at older ages (Côté et al., 2009). These models are designed for broad sport participation and later specialization in a given sport, giving child and adolescent athletes the opportunity to build athletic skills through other sports and to foster physical literacy.

There are studies that have investigated the benefits of sport participation and involvement levels in children and adolescents. It has been noted that many elite athletes engaged in high amounts of deliberate play in different sports and activities (Baker, Côté, & Abernethy, 2003; Baker, Côté, & Deakin, 2005; Soberlak & Côté, 2003; Côté et al., 2009). Huxley et al. (2017) mention that being involved in other sports at younger ages was beneficial for later success at the senior levels. Specifically, track and field athletes specialized in the sport and in their main event, later than the recommended ages of specialization from the DMSP

model. To investigate the suggestions from the two athlete development models and other research, this current study analyzed the overall sport participation (involvement levels and years of involvement) and types of previous sport participation that current university track and field sprinters took part in throughout developmental ages.

This analysis examined whether current university track and field sprinters followed a similar developmental pathway as suggested by athlete development models. The analyses also investigated the sport participation in regard to the different developmental levels the athletes were previously in and compared any differences or changes through development to their current age. This analysis was also able to examine when athletes began to specialize in track and field sprinting. There is unknown research that has specifically analyzed previous sport participation in university track and field sprinters.

Harter (2012) proposes that PAC is whether someone feels that they are good at physical activities or sports where actual athletic competence is how well someone can actually perform a certain athletic task (Whitehead, 2018). There have been several studies that have compared PAC to physical activity in children and adolescents. Agans, Johnson, & Lerner (2017) investigated PAC levels across different levels of previous physical activity from young adults during their adolescent ages (grades seven to twelve). The overall findings indicated that those who had higher levels of physical activity, also had higher levels of PAC (Agans, Johnson, & Learner, 2017). Additionally, Noordstar et al (2016) found that boys had higher PAC than girls, but they also were reportedly more physically active than girls as well. With gender aside, this study showed that those who had higher PAC, also had higher amounts of physical activity. To investigate whether previous sport participation was related to PAC scores in university track

and field sprinters, this current study utilized the self-reported previous sports participation from the participants and implemented a section of Suzanne Harter's (1985) Self-Perception Profile, that specifically analyzed PAC.

It would make sense to assume that the better someone is an athletic skill or sport, the more competent they will believe they are or perceive themselves at that given task. However, there is limited research on direct comparison of PAC to performance outcomes, using Harter's PAC scale from the *Self-Perception Profile*. Forsman et al (2016), found that there was a positive association between levels of perceived competence and speed and agility characteristics amongst youth level soccer players. It should be noted that the perceived competence scale that was used for Forsman et al (2016) study was not the same PAC that has been well utilized and recognized. The final analysis from this current study examined the PAC scores and compared them to performance results in university track and field sprinters. The overall purpose of this study was to make the connection between athlete development, sport participation, and perceived athletic competence in university track and field sprinters, and to examine if any of these constructs were related to performance results.

Research Questions

The current study applied a developmental framework in addressing four research questions in university track and field sprinters. The main constructs throughout the literature review that support the reasoning and rationale for the questions being asked were physical literacy, athlete development, sport participation, sport specialization and perceived athletic competence. All of these constructs were the foundation for the research questions of this study,

all relating to and supporting one another. The following four research questions were proposed for this study. First, what are the levels of participation in previously participated sports throughout three developmental age groups (8 to 13; 14 to 17; and 18 and over)? Second, does sports participation differ as a function of developmental level? Third, does previous sport participation correlate with and predict perceived athletic competence? Fourth, does previous sport participation relate to and predict participants' university sprinting performance times?

Chapter Three: Methodology

Participants

Upon receiving consent approval from Brock University's Research Ethics Board, this questionnaire-based study pursued recruitment of university athletes who specialized in track and field sprinting disciplines. To recruit participants, coaches of Canadian university track and field programs were contacted via email, athletes were then sent the information for the study and could then voluntarily participate in the online questionnaire-based study. Events within the sprinting disciplines included distances between 60-meters and 400-meters in length. For this study, athletes that competed in and held performance results in the 60-meter, 60-meter hurdles, and 300-meter sprints were recruited. All participants were a part of a university track and field program that competes within U-Sports divisions, which is the national sport governing body of university sport in Canada. There were some schools from the United States (U.S.) and some schools from Canada that competed in U.S. conferences that were contacted for recruitment interest. The decision to utilize participants from the U.S. was due to the limited number of participants from the U-Sport schools, with hopes of increasing the sample size of the study. However, only *five* participants from U.S. schools completed the sport participation and PAC

portions of the questionnaire, and only *one* participant competed in event(s) that were utilized for performance results (60-meter and 60-meter hurdles). The other participants from U.S. schools and conferences competed in events that were not included in the performance results from this study, therefore only their sport participation and PAC scores were used in the study.

There were a total of 42 university track and field sprinters in the study between ages 18 to 23 (M =19.90, SD=1.41). There were 17 (40.4%) women and 25 (59.6%) men that participated. Of those participants, 38 completed both the PAC (perceived athletic competence) sport participation sections of the online survey. Additionally, the best university sprint times were collected from an online results database (trackie.ca and track & field results reporting system for U.S. athletes). All of the participants were enrolled in university and were members of their respective school's track and field team. Participant's academic years ranged from *first* to *fifth* year (M = 2.19, SD = 1.21) and year of eligibility ranged from *one* to *five* years (M = 1.95, SD = 1.03).

For this study, the minimum desired age of the participants was 18 years of age and a maximum age of 23 years. The reasoning for this is because 18 is the minimum age where parental consent is not necessary and typically by age 23, athletes are not competing at the university level. The coach(s) from each university team were contacted via email to attain consent prior to sending the questionnaire to the athletes. Before beginning the questionnaire, participants were required to complete a consent form that was provided by the Research Ethics Board (Appendix A).

Measures

Athletes were asked to complete a prepared electronic questionnaire that was provided online that the participants were able to access via cell phone or computer. The questionnaire

was created and dispersed using ‘Qualtrics’, a software program used to create surveys, questionnaires and reports. Access to this program was provided by Brock University. The questionnaire took approximately five-minutes to complete and there were be 16 items to complete. The first series of questions that participants were asked reflected demographics, requesting their age, sex, and year of study (Appendix B). The first measure in the questionnaire asked questions regarding their PAC using the domain “Athletic Competence”, a subscale from Susan Harter’s Self-Profile for College Students and consisted of four questions. The second measure will be collecting the information regarding the participant’s previous and current sport participation during prior age categories.

Perceived Athletic Competence

The “Athletic Competence” domain is a subscale that consisted of questions from Susan Harter’s Self-Perception Profile for College Students (2012). This measure was asking questions that focussed on whether participants think they are good at physical activities and sport, or not. This domain was taken from the “what I am like” section of the profile as its statements were focussed on the perception of one’s athletic competences. There were four questions that were asked for this measure regarding athletic competence. The questions were delivered in a way that asked the participants to identify with one or another reference group (Appendix C). To indicate which type of athlete they viewed themselves as, they were presented with four options for them to select, and they chose the one that was most appropriate to them. Each question was either keyed positively or negatively, meaning that the statement was in a positive context or negative context (Appendix D). Each item was scored according to the scoring sheet provided by Harter (Appendix E). A score of four represented what the athlete is most like and a score of one

represented what the athlete is least like. Depending on whether the question was keyed negatively or positively, a participant could have a high or low score of negative self-perceived competence. They could also have a high or low score positive self-perceived competence.

Like the Self-Perception Profile for College Students, Harter has created various profiles specific to different ages and populations. These include Self-Perception Profiles for children, adolescents, learning disabled students, emerging adults, college students, adults, and older adults. Harter's profile has been used by many researchers, implemented through many different studies and research over the past three decades. Harter provides previous alpha (internal consistency) reliability coefficients for each of the scales of the *Self-Perception Profile for College Students*. Throughout all 12 scales, the reliability scores ranged from .76 to .92, with athletic competence having the highest value. Masciuch, Mcrae, and Young (1990) analyzed Harter's perception profile by distributing the questionnaires to both male and female Canadian university students. Results revealed alpha reliability coefficients of two sub-sections of the athletic competence scale were .95 for the "What I am Like" sub-scale and .87 for the "Importance" sub-scale. The scores from Maschiuch et al., (1990) indicate that the scales are above acceptable for internal consistency, since they are above .70.

Sport Participation

The second section of the questionnaire used in this study collected information regarding each athlete's sport participation history (Appendix D). The sport participation variables are a sum of the participant's involvement level and the number of years of participation. The questions to this section inquired the duration of participation, which sports they participated in, and the levels of participation on a scale of 1 to 5 (1 being low participation; 5 being high

participation). These inquiries were based on information and suggestions from the LTAD framework presented by Balyi (2004) and the DMSP, presented by Côté (2014). The questionnaire for this section consisted of a collaboration of two studies that investigated previous sport participation by Richman and Shaffer (2000) and the other by Martin (2014).

For this study, the sport participation portion of the questionnaire solely analyzed previous and current organized sports that the participants took part in. Organized sports are structured and organized by a governing body of a certain level (i.e., national, provincial or local) that oversees the organization of the sport (Wiium & Säfvenbom, 2019). These sports are often monitored by a coach or someone in a coaching role and consists of structured practices, scheduled games, and training. Unorganized sports and physical activity or "self-organized physical activity" (Wiium & Säfvenbom, 2019, p.1) will not be included. For example, playing badminton in a backyard or a game of pick-up soccer on the school yard.

A list of sports was provided and consisted of both individual and team sports. Similar to a study by Richman and Shaffer (2000), there were three different age groups presented. *Group 1*: ages 0-13 (grade eight or under), *Group 2*: ages 13-18 (high school), and *Group 3*: ages 18-23 (college/university). For each age group, participants indicated which sports they participated in and selected their level of involvement. The involvement level was scored using a 5-scale Likert. The scoring worked as followed: 1 = Not Very Involved and 5 = Very Involved. The scores were added up as a total (sports participated, number of years and level of involvement) as well as separately. The final portion asked participants to indicate the number of years of participation in each sport selected, for each age group; like the format used by Martin et al (2020), there were three groups presented. For each group, participants indicated which sports they participated in

within the range for each group (e.g., which sports they participated in during high school). They then scored each sport from 0 – 6 for years of participation within each age group. The scoring was as followed: 0 = less than one year, 1 = one year, 2 = two years, 3 = three years, 4 = four years, 5 = 5 years, and 6 = six years or more.

Sprinting Performance

Each athlete's performance results were accessed from the U-Sport ranking database, provided by the public database 'Trackie' (Appendix E). Results consisted of performance results from sanctioned U-Sport competitions in the 60-meter sprint, 60-meter hurdles, and 300-meter sprint for both males and females separately. Only the 60-meter and 60-meter hurdles results were used because these two events are most similar to one another in terms of physiological demands and best represent the definition of sprinting. The Sprinting Performance results were converted into Percentiles. These scores represent the top and bottom performance with the lower percentages representing the fastest performance time and the higher percentages representing the slower performance time. Kearney and Hayes (2018) utilized a database to assess performances and analyzed 134,313 performances. With this they tracked the progressions or regressions of each athlete's performances over several years. However, for this study only the athlete's best performance was utilized, as well as their ranking position. Collecting solely the athlete's top individual performance time showed the athlete's personal best and where they ranked amongst other athletes.

Statistical Analysis

For the analysis of this quantitative data, descriptive statistics and a correlational analysis was used. Descriptive statistics were used to organize the data to show differences (i.e.,

symmetry and skewness). In information such as age, sex, and year of study were analyzed using descriptive statistics. Using Statistical Package for the Social Sciences (SPSS; Version 25), measures of central tendency were formulated and categorized (i.e., mean) where the sample and population mean were calculated. Measures of variability were also formulated and categorized (i.e., standard deviation and variance). ANOVAs and t-tests were implemented to analyze potential differences amongst the variables of this study. There were three variables, one of which was an independent variable and two dependent variables. The independent variable was the athlete's prior sport participation, and the dependent variables were the athlete's self-perceived athletic competence, as well as performance results.

Once the data was collected, bivariate correlation and linear regression analyses were conducted to assess the predictive relationships between the variables. This study analyzed correlations between PAC and performance results; previous sport participation and performance results; previous sport participation and PAC. Data was analyzed using the Statistical Package for the Social Sciences (SPSS; Version 25). To prepare the data, the scores from the questionnaires were thoroughly reviewed to ensure that there was no participant error (i.e., participants selecting more than one option in the sport participation sections).

Chapter Four: Results

There were a total of 42 university track and field sprinters between the age of 18 and 23 (M =19.90, SD=1.41) in the study. Of these, 17 (40.4%) women and 25 (59.6%) men participated and 37 completed both the PAC (Perceived Athletic Competence) and sport participation sections of the online survey. The best university sprint times were collected from an online results database (trackie.ca and track & field results reporting system). All of the participants

were enrolled in university and were members of their respective school's track and field team. Participants' academic years ranged from *first* to *fifth* year (M = 2.19, SD = 1.21) whereas year of eligibility ranged from *one* to *five* years (M = 1.95, SD = 1.03).

The sport participation data for each participant was categorized into several variables. The first being "Sport", which is the sport(s) they participated in during their specified age group. Second, was the "frequency", which is number of sports that they participated in during each age group. Next is the "Sum of Involvement Level", which is total score of their level of involvement that they indicated on a one to five scale. Last was "Sport Participation Sum", which is the combined sum scores of involvement level and the sum of number of years of involvement for their sport participation for each age group.

The data was prepared by first analyzing and screening for any outliers or missing data and sections of the questionnaire. There were five participants that were unable to be found in the sprint times database so there was no sprint performance data for these individuals in this study. There was one outlier found that recorded six years of sport participation in the second age group, when only four years of participation was possible. This value was adjusted to the nearest valid data point (four years). Screening for responses to the perceived athletic competence scale relative to the sample size of this study through Mahalanobis distance values (critical values of Chi square > 45.0, p = .05) revealed no outliers (Tabachnick & Fidell, 1996). There were no violations of normality (i.e., skew and kurtosis) except for sports participation in the 18+ age group with a kurtosis of 7.72 which was likely due to the kurtosis of 8.40 in the years of participation sub-component of this variable. These values signal that many in this sample participated in sports for 1-3 years and very few did for longer. Including this variable will be

done with caution. The alpha reliability coefficient for the four-item perceived athletic competence scale was below acceptable levels (.49) so item correlations were analyzed and revealed that one item ("Some students feel that they are better than others at sports but other students don't feel they can play as well") did not appear to have been aligned to the others indicating that perhaps it was too general and not perceived by participants to be as relevant as the other three items to track and field sprinting. Since this scale has yet to be applied specifically to track and field sprinting, this item was omitted resulting in an acceptable alpha reliability coefficient of .62 for scales with less than 10 items (Loewenthal & Lewis, 2021).

In review, the present study applied a developmental framework to address the following four research questions in university track and field sprinters. First, what were the descriptive statistics for each of the variables? Of particular interest was noting the levels of participation in various sports overall, and during each of the three developmental periods (8 to 13; 14 to 17; 18+). Second, did sports participation differ as a function of developmental level? Third, did previous sport participation correlate with and predict self-perceived athletic competence? Fourth, did previous sport participation relate to and predict participants' university sprinting performance times?

The results of the first research question (descriptive statistics for each of the variables) revealed that the mean sprint time percentile was 44.84 (*SD* = 27.71) with a range of 1.25 - 95.01. The mean of PAC was 3.38 (*SD* = .64). Table 1 provides the frequencies of the number (and name) of sports, involvement level, and number of years participated in each of the sports. The sports with the highest participation frequency from ages 8 to 13 were: soccer (20), track and field sprints (14), basketball (13), and hockey (11). From ages 14 to 17, they were track and

field sprints (32), volleyball (11), basketball (10), and soccer (10). For ages 18+, participation in other sports decreased more dramatically, with track and field sprints being most of the participation frequency during university. Overall, the highest participated sports (sum) were track and field sprints (624), soccer (234), hockey (189), and basketball (164).

The results for the overall sports participation (sum of involvement and number of years) during each developmental stage were $M = 27.41$, $SD = 14.17$ for pre-14 with a range of 6 – 59; $M = 20.86$, $SD = 10.00$ for ages 14-17 with a range of 7 – 42; and $M = 8.29$, $SD = 3.86$ with a range of 3 – 24 for those in the 18+ age group. These scores show a visible decrease in the participant's total sport participation across the three developmental levels. To illustrate this further by percentage of participation, the percentages of years involved were approximately 25% in ages 8-13, 16% in ages 14-17, and 5% and after age 17. Their overall involvement level in sports also decreased as they got older as the percentages involved were 23% in ages 8 to 13, 21% in ages 14-17, and 10% after age 17. These results showed that when the frequency of sport participation decreased, the sums of involvement and years of participation decreased as well.

Table 1

Sports Participation by Developmental Level

Sport	Frequency			Sum of Involvement (1-5)			Sum # of Years (0-6)			SP Sum
	8-13	14-17	18+	0-13	14-17	18+	0-13	14-17	18+	
Archery	1	0	0	1	0	0	1	0	0	2
Badminton	4	3	0	8	8	0	10	5	0	31
Baseball	9	2	1	28	10	3	32	7	3	83
Basketball	13	10	0	50	39	0	49	26	0	164
Beach VB	0	1	0	0	4	0	0	3	0	7
Cheerleading	1	0	0	5	0	0	3	0	0	8
Cricket	1	1	0	3	2	0	5	2	0	12
X-Country	9	6	0	29	19	0	38	16	0	102

Curling	2	0	0	4	0	0	4	0	0	8
Dance	2	0	0	9	0	0	9	0	0	18
Diving	1	1	0	3	4	0	2	1	0	10
Fastball	1	0	0	4	0	0	6	0	0	10
Field Hockey	2	2	0	7	6	0	10	7	0	30
Football	6	5	1	23	20	4	20	9	4	80
Golf	3	3	0	9	8	0	13	8	0	38
Gymnastics	2	2	0	10	10	0	12	8	0	40
Hockey	11	9	3	48	37	10	59	30	5	189
Judo	1	1	0	3	3	0	5	2	0	13
Karate	1	1	0	2	3	0	6	1	0	12
Lacrosse	3	0	0	10	0	0	7	0	0	17
MMA	1	0	0	5	0	0	6	0	0	11
Rock Climb	1	0	0	2	0	0	2	0	0	4
Rugby	3	7	0	12	27	0	8	18	0	65
Skeleton	0	0	1	0	0	5	0	0	2	7
SN Ski/Board	1	1	1	4	4	2	6	4	2	22
Soccer	20	10	1	69	36	3	92	29	5	234
Softball	1	1	0	2	2	0	1	1	0	6
Swimming	4	1	0	12	2	0	18	3	0	35
Table Tennis	1	0	0	3	0	0	4	0	0	7
Tennis	2	0	0	4	0	0	3	0	0	7
T&F Jumps	1	2	1	5	7	4	6	6	1	29
T&F Sprints	14	32	38	59	145	179	46	117	78	624
Triathlon	2	0	0	9	0	0	8	0	0	17
Tai Kwan Do	1	0	0	3	0	0	4	0	0	7
Volleyball	10	11	1	35	41	2	31	32	3	144
Wrestling	2	0	0	4	0	0	4	0	0	8
Column Sum	137	112	48	484	437	212	530	335	103	2101
Column %	-	-	-	23.04	20.80	10.1	25.23	15.95	4.90	100

Notes. SP Sum = Sports Participation Sum (Sum of Involvement and Years)

The next analysis involved discovering whether sports participation differed between the three developmental age groups. Results of the repeated measures analysis of variance revealed a significant decrease in sports participation across the three developmental ages groups, F (2, 34) = 43.52, $p < .001$, $\eta^2 = .719$; however, Mauchley's test of sphericity signaled the violation of assumption of sphericity ($p = .013$) so the Huynh-Feldt values adjusted for this were used instead. These results also indicated a significant decrease in sports participation across the three

ages groups, F (1.70, 34) = 49.48, $p < .001$, $\eta^2 = .586$. Post hoc t-tests assessing statistical differences between each of the individual age groups revealed significant differences between the 8 to 13 and 14 to 17 age groups [t (35) = 3.11, $p = .004$]; between the 14 to 17 and 18+ age groups [t (36) = 8.46, $p < .001$]; and, between the 8 to 13 and 18+ age groups [t (36) = 8.44, $p < .001$].

The third research question of this study was to assess whether previous sports participation correlated with and predicted perceived athletic competence. To test for this, bivariate (Pearson) correlations and linear regression analyses were computed by using the sum of sport participation (involvement level and years of involvement) for the developmental age groups and the mean of the perceived athletic competence scale. The Pearson bivariate correlation between perceived athletic competence and overall sports participation was .18 and not statistically significant ($p < .05$). As presented in Table 2, these correlations relative to sports participation at each of the three developmental levels were: .20 from 8 to 13, .11 for 14 to 17, and -.01 for 18+. These indicate little to no relationship between these variables for the 14 to 17 and the 18+ groups. There was also a low positive and not statistically significant relationship in the 8 to 13 age group. Results of the regression analyses with previous sport participation and PAC, showed minimal prediction. The sum of involvement for each individual age group were not correlated (ages 8 to 13, 14 to 17, 18+) [$R^2 = .07$, $F = .78$; $p < .001$]. As a combined sum of the three age groups, there was also a minimal correlation [$R^2 = .03$, $F = 1.24$; $p < .001$] between sport participation and PAC.

Table 2

Descriptive Statistics and Scale Correlations

Scales	*n*	*M (SD)*	SprPerf	PAC	SpoPart	SpoPart	SpoPart
SprPerf	34	44.84 (27.71)	-				
PAC	42	3.38 (.64)	-.20	-			
SpoPart 8-13	37	27.41 (14.17)	.12	.20	-		
SpoPart 14-17	37	20.86 (10.00)	-.11	.11	.61**	-	
SpoPart 18-23	38	8.29 (3.86)	-.25	-.01	.24	.44**	-

Notes. * $p < .05$; ** $p < .01$. PAC = Perceived athletic competence; SprPerf = Sprinting (60m or 60m hurdles) Performance; SpoPart = Sports Participation (Sum of Involvement and Years).

The fourth and final research question of this study was whether previous sport background related to and predicted participants' university sprint performance times. As in the previous two research questions, bivariate Pearson correlations and linear regression analyses were conducted to answer this question. These tests used the sum of sport participation (involvement level and years of involvement) for the developmental age groups and the 60-meter sprint or sprint hurdles performance percentiles. The correlation between sports participation and sampling of multiple sports (that is, the sum of the number of sports participated in groups 1 to 3) was .92 and therefore, multicollinear. For that reason, analysis of sport sampling was assumed to be close to that of sports participation in this study. A linear regression was done for the sprint performance percentiles (M = 44.84, SD = 27.71) and the sum of sport participation (M = 56.60, SD = 25.07) for all age groups combined. The linear regression was p = .821, showing that there

is no prediction between sport participation (ages 8 to 25) and sprint performance times [R^2 = .002, F = .052; p = <.001].

Another linear regression analysis was done between the individual sums of sport participation for each age group and sprint performance percentiles. The results for each developmental age were M = 27.41, SD = 14.17 for the 8 to 13 age group, M = 20.86, SD = 10.76 for the 14 to 17 age group, and M = 8.29, SD = 3.86 for the 18+ age group. The results for the sprint performance percentiles were M = 44.84, SD = 27.71. The correlation results showed for ages 8 to 13 (.12), ages 14 to 17 (-.11), and ages 18+ (-.25) that there was a statistical non-significant positive correlation for the first age group. It should be noted that though the results are not statistically significant (p = <.005), they show that compared to the other age groups the more sports participated in during ages 8 to 13, show greater (i.e., they get slower) sprint performance times. The results also indicate that participating in sports during the second and third age groups, performance times go down (i.e., they get faster), though these results are not statistically significant and should only be noted.

To summarize, the results of this study primarily revealed that there is a significant decrease in the sum of sport involvement (involvement level and years of involvement) as the participants got older. In other words, as athletes got older in age, they participated in less sports and began to focus on track and field sprinting. The results also indicated that there is no significant correlation between previous sport participation throughout development and PAC scores.

Chapter Five: Discussion

Track and field sprinting is a sport that does not require the same variety of movements or skills that sports such as soccer, hockey or basketball require (e.g., playing with teammates, manipulating objects, and moving in a variety of different ways). Being physically competent and engaging in a variety of physical activities or sports, can contribute to ones' "physical literacy" (Whitehead, 2017). Physical literacy has been thought to be a main contributing factor to an athlete's success in their given sport (Olszewski, 2007). Enhanced physical competence, which is a component of physical literacy, is ones' ability to show confidence and competency in a broad range of physical activities in various settings (2007). Though there is not a lot of research to connect the two, it has also been suggested that having enhanced competencies in different forms of movements, activities or sports, can enhance how athletically competent one views themselves (Harter, 1985).

The current study proposed four research questions that investigated the potential relationships between sport participation, PAC, and sprint performance times in university track and field sprinters. The first objective of this study was to investigate which types of sports track and field sprinters participated in during their developmental years and whether they possessed high or low levels of PAC. The second research objective was to discover the potential difference in sport participation as a function of developmental level. The third research objective was to examine if previous sport participation correlated with and predicted PAC. The fourth and final objective was to determine if previous sport participation related to and predicted participants' sprinting performance times.

The first research objective was, more specifically, to investigate the descriptive statistics for sport participation and PAC, while notably analyzing the levels of participation in various

sports overall, and throughout each developmental age group (8 to 13; 14 to 17; 18+). The findings showed that throughout the three developmental age groups, there was an evident decrease in overall sport participation as the participants got older. These results similarly follow other developmental models that suggest children and adolescents participate in multiple sports and activities when they are younger and decrease the variety of sports they participate in as they get older. Throughout all three age groups when the frequency of sport participation decreased, so did the sums of involvement and years of participation. Similarly, when the frequency of sport participation was high, so were the sums of involvement and years of participation. The data shows that when the frequency of sports participated in (i.e., sampling) is high, so are the involvement levels and years of involvement that make up total sport participation.

The DMSP (Developmental Model of Sport Participation), created by Côté and colleagues (2007), recommends that youth athletes begin sport participation by taking part in multiple sports and activities, which is called sampling. After sampling multiple sports and activities during childhood, they should progressively eliminate the number of sports and the amount of sport involvement during adolescents, eventually picking one sport to focus on, which is called specialization (Côté, 1999). The findings from this first research question could suggest that the participants followed a similar developmental framework as proposed by Côté's (2007) DMSP. More specifically, the second postulate of the DMSP proposes that early diversification in sports and activities could be linked to longer sport careers and involvement (Côté & Vierimaa, 2014). The findings of this current study showed that there were high frequencies of sport participation in the earliest age group (8 to 13) and all participants continue to participate in a sport (track and field sprinting) between the ages of 18 and 23. These findings suggest that

there was a similar pattern followed to Côté's second postulate of the DMSP. However, the DMSP model refers to sports and activities in general, not specifically track and field sprinters. It was noted that track and field athletes specialize later than proposed by the DMSP, showing that track and field athlete's specialization ages differ compared to athletes of general sports and may also differ in other aspects of the DMSP model (Huxley et al., 2017).

From ages 8 to 13, the top four most participated sports in this study were soccer, track and field sprints, basketball, and hockey. From ages 14 to 17, the top four most participated sports were track and field sprints, volleyball, basketball, and soccer. For ages 18+ the participation in other sports decreased significantly, with track and field sprints being a vast majority of the participation frequencies during university. A notable finding from this specific analysis is that hockey was among the top four sports participated in for the youngest age group (8 to 13) and was not in the top four in ages 14 to 17. However, volleyball replaced it as one of the more frequently participated in sports during the 14 to 17 age group. Overall, throughout all age groups, the highest participated sports were track and field sprints, soccer, hockey, and basketball. Track and field sprinting was the highest participated sport due to the recruitment of solely track and field sprinters. There has not been a lot of research on specific sport participation for children over the past 15 years. In 2005, Statistics Canada analyzed the most participated sports by children aged 5 to 14. It was found that the four most participated sports in the country for children aged 5 to 14 were, soccer (44.1%), ice hockey (26.1%), swimming (24.8%), and basketball (18.9%). This current study found that the top four sports participated in ages 8 to 13 by current track and field sprinters, were similar to those found by statistics Canada

in 2005, showing that track and field sprinters' sport participation through developmental ages, is not much different.

Another finding that should be noted from this current study results is that 36% of participants were already participating in their main sport (track and field sprinting) between ages of 8 to 13, with low involvement levels. In addition, 84% of participants at the ages of 14 to 17, were involved in track and field sprinting with high levels of involvement, indicating that track and field sprinting was one of the sports that the participants were specializing in during that age group. This is likely due to the fact that specializing in sports from ages 13 to 18 (high school) is common amongst adolescents. Researchers have found that it is common for high school aged athletes to begin specialization in some capacity (Bell et al., 2016). In the study conducted by Bell et al (2016), they analyzed the prevalence of sport specialization in high school athletes and discovered that 25% - 48% of student athletes had high specialization levels. Their study also showed that 26% - 32% of students had moderate specialization levels and 26% - 43% of high school students had low specialization levels. In another study by Swindell et al (2019), it was reported that out of 281 NCAA athletes, 92.7% had a history of sport specialization. It was also found that those who participated in individual sports, began specialization at younger ages appose to those who participated in team sports (Swindell et al., 2019). Out of 19 different NCAA sports, track and field athletes reported to specialize at an average age of 15 (2019). The aforementioned research, alongside this current study show that it is a common tendency for athletes to begin specialization or focus on a specific sport during high school (ages 14 to 17).

The second research question was to examine the potential difference in sport participation as a function of developmental level. In other words, did sports participation differ between the three developmental age groups. The findings revealed a significant decrease in sports participation across the three developmental periods. The highest frequency of sport participation was found in the youngest age group (8 to 13), with the second most participation frequency being the 14 to 17 age group. The least amount of sport participation was found in the oldest age group (18+). These results indicate that as the participants transitioned through the age groups, their sport participation (sum of involvement level and years of involvement) decreased substantially. It has been suggested from sport development models, as well as found in other research studies, that adolescents should and do participate in multiple sports when they are younger. As children and adolescents get older, they tend to participate in less sports, but their involvement and investment levels increase, specializing in fewer or sometimes one individual sport (Côté, 1999; Balyi, 2004; Huxley et al., 2017)

Both the DMSP (2007) and the LTAD (Long-Term Athlete Development; Balyi, 2004) models provide guidelines for how much participation children and adolescents should be taking part in, as well as what types, and involvement levels. The DMSP (2007) focusses on a progression of involvement and participation for adolescents. The model comprises of sampling (deliberate play and involvement in several sports); ages 7 to 12, specializing (deliberate play and practice are balanced, reduce involvement in several sports); ages 12 to 14, and investing (high amounts of deliberate practice, focus on one sport); ages 14 to 17. Similarly, the LTAD (Balyi, 2004) is a model that provides developmental stages to guide children and adolescents to progressively increase their investment, skill development, and training involvement as they

progress in age. The LTAD also encourages participation in a variety of activities, sports, and movements when they are younger, gradually focussing on one sport. The categories in the LTAD are FUNdamentals (variety of sports, activities, and general skills); ages 6 to 9, learn-to-train (develop sport skills related to athletic development); ages 9 to 12, and train-to-train (importance of sport specific athlete development); ages 12 to 16.

Findings from this current research question follow a similar path as the DMSP and LTAD by showing a high amount of participation during the 8 to 13 age group, then participation decreasing during the 14 to 17 age group, and eventually showing specialization in sprinting during the 18+ age group. The difference between the two models and the current findings is that the participants from this study began to specialize in their sport of choice far beyond the recommended age for specialization from the two developmental models (DMSP and LTAD). In other research, it has been found that a majority of athletes specialized in track and field between the ages of 12 and 16 and specialized in their primary event around the age of 18 (Huxley et al., 2017). Similarly, in a study that analyzed reasons for sport specialization amongst Irish athletes, it was noted that "athletics" (i.e., track and field) athletes specialized at a mean age of 17.4, with a specialization age range of 12 to 30 (Duffy et al., 2012). These finding indicate that track and field athletes are specializing even later than recommended. In comparison to other sports, the ages of those who participate in track and field differ, indicating that each sport is unique as to which age athletes specialize. For example, rowing had a mean age of 14.9 with a specialization age range of 10 to 19 years of age and boxing had a mean age of 12.7 with a specialization age range of 10 to 23 years of age (2012). These comparisons show that each sport is different in terms of when athletes specialize, and the findings also signal that individual (non-

team sports) sports could also differ from one another and that it may be better not to categorize them all together as individual sports. Additionally, Huxley et al (2017) found that athletes were specializing and investing later than the recommended investment and specialization ages from the DMSP, which supports that later specialization is the best route for later success. There could be several contributing factors as to why the participants from the particular study seemed to have specialized later than recommended by the previous models. However, the sport of track and field is commonly known to be a late specialization sport, seemingly due to the physiological demands the sport requires (Huxley et al., 2017). Further investigations to discover why track and field sprinters specialized later than recommended would be beneficial and could contribute to a better understanding of athlete development for track and field sprinters.

To contribute to the findings of a decline in sport participation frequency from this current study, an investigation by Hyde et al (2020) analyzed sport participation in different demographic settings and noted the overall sport participation rates. In the United States, 61.1% of youth aged 10 to 13 participated in sports and 55% of youth aged 14 to 17 participated in sports. These participation rates show that older youth tend to have lower participation rates in sports. Since this finding relates to the suggestions from developmental models like the DMSP and LTAD, as well as findings from this current study, it seems to be typical that youth will decrease their sport participation as they get older. However, the specific age at which specialization will and should begin, is unclear and will vary between sports.

The third research objective of this study was to investigate whether or not previous sport participation correlated with and predicted PAC. The findings for this research question showed that there was no statistical significance between sport participation across the three age groups

and PAC scores. The analysis showed that there was a positive but non-significant relationship with sport participation and PAC in the 8 to 13 age group. The analysis also showed that there was no relationship between sport participation and PAC for the other two age groups. Looking at all age groups as a total sum, there was a minimal correlation between sport participation and PAC.

Currently, there is little research that compares previous sport participation through developmental ages and PAC. However, some researchers suggest that PAC and actual athletic competence could be directly related to one another (Harter, 1985; Davison, Downs & Birch, 2006). Some researchers have suggested that having a foundation in FMS (Fundamental Movement Skills) could impact one's PAC. For example, Lubans et al., (2010) investigated relationships between FMS and other health benefits for children and adolescents. When analyzing locomotor and object control, children who scored well were more likely to score higher on the PAC scale (Rudisell et al., 1993; Lubans et al., 2010). These indications suggest that being well-versed in different movement skills could potentially impact ones' PAC. With suggestions from models like the DMSP and LTAD, and concepts like physical literacy, more diverse sport participation during childhood and adolescents could have a positive impact on competency, potentially contributing to ones' PAC. This is an area that should be further researched in the future with direct comparisons between sport participation, athletic competence, and PAC. A needed extension of this particular research area and research question would be to compare ones' actual athletic competence and to their PAC scores to find out the strength of their relationship.

The fourth and final research objective was to investigate whether or not previous sport participation related to and predicted participants' sprinting performance times. In other words, this objective involved uncovering the correlation and predictive strength of the sum of sport participation (involvement level and years of involvement) for each of the developmental age groups relative to sprint performance times (60-meter sprint and 60-meter sprint hurdles). The analyses showed a high bivariate correlation between sampling (number of sports participated in) throughout the age groups and sport participation (level of involvement and years of involvement).

From the data analyses that were conducted for this question, the bivariate correlations between previous sport participation and sprint performance times in university sprinters were low and not statistically significant. However, even though the findings were statistically non-significant, it should be noted that there was a positive correlation between sport participation in the 8 to 13 age group and sprint performance times. These findings indicated that those who participated in more sports during the 8 to 13 age group had slower sprint performance times although the strength of this relationship did not reach statistical significance. However, Huxley et al (2017) reported that between the ages of 13 and 15 training time dedicated to sports was 5.13 hours per week and training time dedicated to track and field specific training was 5.63 hours per week, indicating very similar involvement levels. While investigating influential factors and possible pathways to success, Huxley et al (2017) noted that specializing later and continuing to be involved in other sports later into adolescence, was beneficial to success at the senior level. The results also showed a negative correlation with the other two age groups and sprint performance times, indicating that sprint times go down when athletes participate in less

sports during those the 14 to 17 and 18+ age groups. Repeating this study with a much larger sample size might better illuminate these relationships.

Limitations and Future Directions

As with any research, the current study had several limitations. The sport of track and field at the university level in Canada is not as popular compared to sports such as soccer, basketball, and hockey where almost every Canadian university has a team. Since this study investigated a very specific and small population of participants (i.e., university track and field sprinters), there were difficulties in recruiting a sizable sample pool during the data collection process to assuredly meet levels of significance that could have been presented with the greater numbers. The sample size of this study (n = 42) was smaller than anticipated and decreased the potential power of the study. Including more or all of the track and field disciplines may have increased the sample size and potentially added more data and findings to the study. The benefit of including all other track and field disciplines, is that there would be opportunity to analyze and compare other individual (non-team) events. It would also be beneficial to analyze all disciplines as track and field events consist of running, jumping, and throwing, which are the foundations of all athletic movements and sports. The potential detriment to analyzing all track and field disciplines is that they are all different and possess different skill sets, therefore they would still not be able to be grouped together but only compared.

Another limitation was the recruiting process for this study that consisted of contacting university coaches and having them invite their athletes to participate in the study if they were interested. During this process, however, a majority of coaches that were contacted did not respond to the invitation or their athletes did not show interest. Some coaches responded to the

invitation and expressed that they did not want their athletes participating in the study due to the additional stressors of the Covid-19 Global Pandemic.

A relevant future research direction stemming from this study could be to compare previous sport participation and PAC amongst athletes who specialize in different sports. For example, comparing individual sport athletes (e.g., running, rowing, gymnastics, cycling, and/or racquet sports) and team sport athletes (e.g., soccer, hockey, basketball, volleyball, and/or football). This could provide more insight and background information on how different types of athletes developed for different sports. This could provide information on how to better incorporate developmental strategies for young athletes to better their PAC, overall athletic competence, and physical literacy. Similarly, conducting the same study that includes the other track and field disciplines (i.e., distance running and field events), could provide a comparison amongst other events and informative data that could benefit athlete development for the sport of track and field as a whole.

Practical Implications

The findings from this research study provide information that could potentially contribute in a practical way to the discipline of track and field sprinting. The first practical implication using these findings would be the contribution to long-term athlete development, specifically with track and field sprinters. The findings from this study that indicate later sport specialization and the broad sport participation during younger ages (8-13 years-of-age) should be acknowledged by those involved in the sport of track and field (i.e., coaches) in order to train and develop younger athletes appropriately. Acknowledging that early specialization for track

and field sprinting may not be necessary and diversification in other sports may be appropriate for overall athletic development, could be an attribute to athletes.

Acknowledging the findings that early specialization may not be necessary for track and field sprinters, does not mean that the sport cannot be introduced to children or adolescents in a developmental and introductory based format. The results showed that a majority of the participants took part in track and field sprinting events in the younger age group (8-13), but at lower levels of participation in comparison to the other age groups. Taking aspects of the sport of track and field and utilizing them in a format that allows introduction to the sport and various disciplines, as well as developing a variety of skills (running, jumping, and throwing) that may also be useful for other sports. Run, jump, and throw programs are beneficial ways to introduce the sport of track and field, as well as building fundamental movement skills for children and adolescents (Coyne et al., 2019).

Conclusion

The findings of this current research study showed to contribute to the existing literature in the areas of sport participation, sport specialization, and athlete development by confirming some of the information that is already known and present. These findings and other literature raise some interest in comparison to the DMSP, LTAD and the concept of physical literacy that recommends high volumes of sport participation (i.e., sampling) and deliberate play during younger developmental ages to contribute to later success and perhaps longer careers (Côté & Vierimaa, 2014; Olszewski, 2007; Balyi, 2004). One of the critical findings from this current research study was the confirmation of track and field athletes following similar participation levels and specialization paths that are generally recommended. However, there were some

differences in terms of specific ages of participation and specialization. It is also important to note that these findings confirm that track and field sprinting is a late specialization sport and should continue to be treated as such. Though some of the findings from some of the research questions were shown to be non-significant and inconclusive, they highlight the need for further analysis with a larger demographic and sample size. This study also confirmed findings of other research while highlighting areas needing further investigation for improved understanding and practice.

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Appendices

Appendix A

Consent Form

Information-Consent Letter

Project Title: The Relationship Between Sport Participation, Perceived Athletic Competence and Performance in University Sprinters

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INVITATION

You are invited to participate in a short research study that explores the relationship between previous sport participation, perceived athletic competence and performance results. There has been extensive research investigating the different reasons for athlete's self-perceived athletic competence, as well as different reasons associated with athlete's performance and success in their sport. However, currently there is no research that specifically investigates the relationship of previous sport participation, self-perception of athletic competence and performance results for track and field sprinters. The purpose of this research is to investigate any potential relationships within those areas.

WHAT'S INVOLVED

As a participant, you will be asked to complete an online questionnaire. You (the participant) will receive an e-mail with a link to the questionnaire and will then be asked a series of questions. The questionnaire will include demographic questions (name, age, sex, year of study, year of eligibility, and university attending), previous sport participation, and perceived athletic competence questions. Participation will take approximately 10-minutesof your time. Participation for this study will be a one-time session with no follow up questionnaires or surveys.

CONFIDENTIALITY

Any personal information obtained through the questionnaire and recruiting processes that could be linked back to the participants (e.g. names and university attended) will be removed once the performance results are found from track and field results database (e.g., trackie.org). Information such as age, will be used to categorize the results (e.g. participants of 20 years of age). All research documents (consent forms and questionnaires) will be kept separate from the master list of participants.

Consent forms and questionnaire results will be saved to password-protected computer that only primary and primary student investigator will have access to. Separately, the master list of participants will always also be stored on personal password-protected computer. Once original information in transferred to de-identified data and the study is complete, it will be deleted. The de-identified data will be saved separately from the original data and will be maintained for 5 years as means of verification for potential publications in the future.

Access to this data will be restricted to the Dr. Ken Lodewyk (primary investigator) and Trevor Moore (primary student investigator).

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. If you wish, you may decline to answer any questions or participate in any component of the study. Further, you may decide to withdraw from this study at any time and may do so without any penalty or loss of benefits to which you are entitled.

PUBLICATION OF RESULTS

Results of this study may be published in professional journals and presented at conferences. Feedback about this study will be available from the primary and student primary investigators, who can be contacted with the information above. Results will be available in 6 – 12 months.

CONTACT INFORMATION AND ETHICS CLEARANCE

If you have any questions about this study or require further information, please contact Dr. Ken Lodewyk or Trevor Moore using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca.

Thank you for your assistance in this project. Please keep a copy of this form for your records.

CONSENT FORM

I agree to participate in this study described above. I have made this decision based on the information I have read in the Information-Consent Letter. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time.

Thank you for your interest in having your athletes participate in the study.

Appendix B

Personal Background Questions

Q1 What is your sex?

- ○ Male
- ○ Female

Q2 What is your current age (must be 18+)?

▼ 18 (1) ... 23 (6)

Q3 What year of study are you in?

▼ First (1) ... Fifth (5)

Appendix C

Self-Perception of Athletic Competence

Name: _____ Age: _____ Male: __ Female: __ Year of Study: ____
The following are statements that allow college students to describe themselves. There are no right or wrong answers since students differ markedly. Please read the entire sentence across. First decide which one of the two parts of each statement best describes you; then go to that side of the statement and check whether that is just "*sort of true"* for you or "*really true"* for you. You will just check **ONE** of the four boxes for each statement. Think about what you are like in the college environment as you read and answer each one.

Really True for Me	**Sort of True for Me**				**Really True for Me**	**Sort of True for Me**
☐	☐	Some students feel they could do well at just about any new athletic activity they haven't tried before	**BUT**	Other students are afraid they might not do well at athletic activities they haven't ever tried	☐	☐
☐	☐	Some students don't feel that they are very athletic	**BUT**	Other students do feel they are athletic	☐	☐
☐	☐	Some students feel that they are better than others at sports	**BUT**	Other students don't feel they can play as well	☐	☐
☐	☐	Some students don't do well at activities requiring physical skill	**BUT**	Other students are good at activities requiring physical skill	☐	☐

Appendix D

List of questions that are keyed negative and positive.

Item #	Keyed	Athletic Competence
13	+	Some students feel they could do well at just about any new athletic activity they haven't tried before BUT Other students are afraid they might not do well at athletic activities they haven't ever tried
26	-	Some students don't feel that they are very athletic BUT Other students do feel they are athletic
39	+	Some students feel that they are better than others at sports BUT Other students don't feel they can play as well
53	-	Some students don't do well at activities requiring physical skill BUT Other students are good at activities requiring physical skill

Appendix E

Harter's Self-Perception for Athletic Competence Scoring Sheet

13.	4	3	Some students feel they could do well at just about any new athletic activity they haven't tried before	**BUT**	Other students are afraid they might not do well at athletic activities they haven't ever tried	2	1
26.	1	2	Some students don't feel that they are very athletic	**BUT**	Other students do feel they are athletic	3	4
39.	4	3	Some students feel that they are better than others at sports	**BUT**	Other students don't feel they can play as well	2	1
53.	1	2	Some students don't do well at activities requiring physical skill	**BUT**	Other students are good at activities requiring physical skill	3	4

Appendix F

List of sports to refer for sport participation

Archery	Karate
Badminton	Kayaking
Baseball	Lacrosse
Basketball	Mixed Martial Arts
Bowling	Rock Climbing
Boxing	Rowing
Cricket	Rugby
Curling	Skateboarding
Cycling	Snowboarding/Skiing
Diving	Soccer
Fencing	Surfing
Field Hockey	Swimming
Figure skating	Table Tennis
Football (American)	Tennis
Golf	Track and Field (Distance)
Gymnastics	Track and Field (Jumps)
Hang gliding	Track and Field (Sprints)
Hockey	Track and Field (Throws)
Horse Racing	Volleyball
Horseback Riding	Weightlifting (Olympic)
Judo	Wrestling
Jump Rope (skipping)	

Appendix G

Instructions and example of the sport participation section of questionnaire.

From using the reference list of sports above, you will be asked to enter the sports that you have previously participated in during three different age ranges. The sport(s) that you select **should** have been organized participation (e.g., consisted of structured games, practices and coaching). These should **not** include sports of recreational participation (e.g., pick up or backyard participation). Please select **only** the sport(s) that apply to you. If there is not a sport in the recommended list above, please provide it in your selection.

Under "sport" provide the sport that you participated in during the given age range.

Under "Involvement Level" provide the level of involvement for each sport (1= Not Involved, 2 = Somewhat Involved, 3 = Moderately Involved, 4 = Involved, 5 = Very Involved.

Under "Years Participated", indicate how long you participated in your selected sport (0 = Less Than a Year, 1 = One Year, 2 = Two Years, 3 = Three Years, 4 = Four Years, 5 = Five Years, 6 = Six year or More.

EXAMPLE

	Sport	Involvement Level (1-5)	Years of Participation (0-6)
Sport 1	Wrestling	4	3

Appendix H

Questions and questionnaire format for the sport participation answer entry.

Please provide the sport(s) that you participated in, level of involvement, and number of years participated in for each sport from **5 - 13 years of age (Elementary School).**

	Sport	Involvement Level (1-5)	Years of Participation (0-6)
Sport 1			
Sport 2			
Sport 3			
Sport 4			
Sport 5			
Sport 6			

Please provide the sport(s) that you participated in, level of involvement, and number of years participated in for each sport from **14 - 17 years of age (High School).**

	Sport	Involvement Level (1-5)	Years of Participation (0-6)
Sport 1			
Sport 2			
Sport 3			
Sport 4			
Sport 5			
Sport 6			

Please provide the sport(s) that you participated in, level of involvement, and number of years participated in for each sport from **14 - 17 years of age (High School).**

	Sport	Involvement Level (1-5)	Years of Participation (0-6)
Sport 1			
Sport 2			
Sport 3			
Sport 4			
Sport 5			
Sport 6			

Appendix I

Trackie – U-Sports Track and Field Results Database.