THE ROLE OF GROWTH AND MATURATION DURING ADOLESCENCE ON TEAM SELECTION AND LONG-TERM SPORTS PARTICIPATION

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ABSTRACT

Background: Increases in growth and maturation result in physiological improvements, which influence performance. Older, more mature athletes are often seen as more talented and selected onto teams. Those born early in the selection year (termed relative age (RA)) have an advantage over those born later. Little is known as to whether selection onto a team influences an individual's long-term sports participation. The aims of this study were; (i) to investigate the relationship of RA, anthropometrics, and maturity to team selection and (ii) to investigate the long-term (3 years) consequence of selection on sports participation.

Methods: 851 participants (580 male and 271 female) were recruited at bantam level sport tryouts in six team sports (soccer, hockey, football, basketball, volleyball, and baseball). Individuals' date of birth, date of test, height, sitting height and weight were measured. Parental height was acquired. Age at peak height velocity (APHV) and predicted final height were estimated. Current sports participation was acquired via questionnaire. For analysis, athletes were grouped by team-selection, sex, sport and birth month quartiles. Birth month quartile analysis was done via chi-square goodness of fit test. Growth and maturation differences between selected and not selected groups was done via one-way ANOVA.

Results: In the whole sample, first and second birth month quartiles were overrepresented ($p < 0.05$). Apart from female soccer, male hockey and male basketball players ($p < 0.05$), no relationships were found between birth month and team selection ($p > 0.05$). Male selected soccer players were significantly shorter and male selected hockey players were significantly taller ($p < 0.05$) than their non-selected counterparts. In soccer, basketball, and volleyball, selected athletes are more likely to continue in the sport, and not selected athletes are more likely to change sports.

Discussion: While some differences exist between the growth and maturation of selected and not selected athletes during bantam tryouts, most sports appear not to be influenced. However, it would appear that, as a whole, athletes attending these tryouts already showed some bias in their dates of birth and anthropometrics. Over a 3-year period, sports selection did not appear to have a relationship with sports participation.

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1.0 Introduction

Growth and maturation are concepts central to all studies related to children's sport, as teams are typically banded into groups based on year of birth and age is related to progress of growth and maturation. All children follow the same pattern of growth; however, the timing and tempo varies between and within the sexes, and this variance is most dramatic during adolescence (Baxter-Jones, 1995). At certain chronological ages (CA) (timing) during adolescence, when maximum growth is occurring (tempo), there can be up to five years of difference in maturity status between individuals (Baxter-Jones, 1995). This can have a potentially dramatic effect, particularly on the height of the individual: for example, during adolescence, earlier maturers are taller than average and late maturers (Baxter-Jones, 1995). The amount of growth occurring within a 12 to 24 -month age bands is also a consideration. A child born in the 1st month of the banding will have 11 to 23 months more growth than the child born in the last month of the age band.

Genetic potential of characteristics, such as final adult height, is inherited from parents, and these characteristics also play a key role in sports success. For example, at the 1960 Rome Summer Olympic games, the physique of track and field athletes was assessed and it was found that athletes had anthropometric profiles that best suited their sport, with the author concluding that "athletes were born and made" (Tanner, 1964). Similarly, a study of athletes attending the 1976 Summer Olympics in Montreal found that, on average, Olympians were of above average stature and that the medal winners were the "tallest of the tall" (Khosla, 1983). This bias in favour of tall stature in adult sports has also been found in youth sports (Malina, 1994), with the concern being that there is too much emphasis placed on advanced maturity, indexed by advanced statural growth, during team selection.

It is therefore imperative that any study which investigates the child and adolescent in the sporting environment take into consideration the birth month, growth, maturity status and parental heights of the participant. This is important because morphological parameters and physiological functions such as height, weight, somatotype, heart volume, lung function, aerobic power, and muscular strength, develop with increasing CA and maturity status (or biological age, BA) (Baxter-Jones, 1995). Both CA and BA influence sport performance. Physical fitness parameters (e.g. muscular, motor, and cardiorespiratory) also change with growth and maturation, as does the development of fundamental movements skills and sports skills acquisition. Thus, the effects of growth and maturation may mask or be greater than the sport specific skill under investigation (Armstrong, 2017).

Organised sport for adults and children was first introduced by the ancient Greeks, where boys as young as 12 years of age often participated. These great athletic festivals were known as the Olympic, Pythian, Nemean, and Isthmian Games (Ryan, 1988). Boys and youth were loosely organised into five different age categories, although in Asia Minor boys were allowed to enter men's events if they felt qualified; early evidence of CA versus BA (Ryan, 1988). The games were held regularly until 394 AD and were re-established in 1894 when the modern Olympics aimed "to bring the youth of the world together" (Strenk, 1979). In America in the 1920s and early 1930s, local communities established highly organised CA-banded children's sports, outside the school environment (Berryman, 1982).

Virtually all adolescent sport teams are categorized by CA bands; yet, the question remains as to whether adolescent children should be categorized by CA bands to compete (Baxter-Jones, 1995; Crampton, 1908; Cumming, Garand, & Borysky, 1972; Goldberg & Boiardo, 1984). As previously indicated, adolescents of the same CA can vary significantly in their maturational status or BA (Baxter-Jones, 1995) and advanced maturation brings with it significant gains in size and physiological development, and enhanced performance. All of these developmental milestones can potentially influence which children are chosen to participate in a team. Similarly, children who are in the same CA band but born earlier in the sport-specific cut-off period can be at an advantage. In 1988, researchers Barnsley and Thompson examined the birthdates of 7,313 hockey players and found that those born earlier in the selection year possessed a relative age (RA) advantage and were much more likely to participate in minor hockey and more likely to play for top tier teams than their peers born towards the end of the selection year. The difference in birth month between an athlete born earlier in the selection year and an athlete born later in the selection indicates their age relative to the selection year cut-offs can be advantageous. The consequences of RA on an outcome variable such as team selection is termed the Relative Age Effect (RAE) (Musch & Grondin, 2001). As indicated, athletes who are born earlier in the selection year will have a longer period of growth than those born later and increased growth is closely tied to performance variables. These performance enhancements found in earlier-born athletes and those who mature earlier increase the likelihood that older or more biologically mature athletes will be selected for CA banded sports teams (Baxter-Jones, Eisenmann, & Sherar, 2005).

The recent push for young athletes to specialize in a single sport at a young age in the hopes of achieving elite teams and athletes results in skill tiers for sport teams at younger ages. Striving for elite status at a young age was likely the consequence of the intense screening programs found in Eastern Europe - in the German Democratic Republic and the Soviet Union (Malina, 1994). Talent identification in young children to create Olympic athletes left lasting effects on how the rest of the world develops their youngest athletes by creating skill tiers at young ages. The goal of the skill tiers was to filter out children with the highest skill potential and ideal sport specific body types.

Team tryouts are now being held at younger ages leading to the consequence of more athletes being cut from teams. What is unknown is the consequence of being selected or deselected for a team on long term participation in that sport. Children's sport participation continues to be a subject undergoing intense study in North America. In 1992, Statistics Canada reported that 66% of boys aged 5-14 were participating in sport, although by 2005 sports participation for boys had dropped by ten percent (Statistics Canada, 2005). Similarly, sport participation in girls aged 5-10 dropped from 49 to 45% between 1992 and 2005. More recently, a survey performed in the United States by the Sports & Fitness Industry Association (SFIA) found that in 2015, only 27% of American youth aged 6-12 were active through organized or unstructured sport. These dropping participation numbers highlight the importance of investigating the role of team selection on continued participation.

Since the selection of athletes for a team is predominately determined by an athlete's performance in comparison to their peers in CA bands, the role of birth date, growth, and maturation are important and significant as barriers to adolescent sport participation (Sherar, Baxter-Jones, Faulkner, & Russell, 2007). Since 1995, when Baxter-Jones raised the original question as to whether sports should be categorized by chronological or biological age bands, many studies have come out seeking the pros and cons of each, but this very old question refuses to go away. In this thesis I will look to answer four research questions related to this topic:

1. Is there a relationship between birth date quartile (CA) and selection onto team sports?
2. Is there a relationship between adolescent growth (anthropometric measures, predicted heights) and selection onto a sports team?
3. Is there a relationship between adolescent maturation and selection onto a sports team?
4. What are the long-term (3 years) effects of team selection on continued participation in that sport?

2.0 Literature Review

2.1 – Sports Participation Benefits and Rates

Physical activity (PA) is made up of two components: habitual physical activity and exercise (including sports participation). Since PA has been shown to have many health benefits, it is not surprising that youth participation in sport has also been shown to correlate to many physical health benefits including reductions in the risk of obesity, cardiovascular disease, and osteoporosis (Pate et al., 1995; Sothern, Loftin, Suskind, Udall, & Blecker, 1999; Warburton, Nicol, & Bredin, 2006). In addition to the many physical benefits of sport participation, sport also benefits psychological well-being. For example, participation in sport and physical activity has been shown to increase positive mood (Biddle, 2000), lower anxiety (Taylor, 2000), increase positive self-perceptions (Fox, 2000), and enhance self-esteem (Fox, 2000). Unique to sporting situations is the ability to foster the development of skills in the areas of self-discipline, competitiveness, sportsmanship, leadership, self-confidence, and coping with success as well as adversity (Stryer, Tofler, & Lapchick, 1998).

In 1994, the UK initiated the Training of Young Athletes (TOYA) study investigating the importance of keeping youth involved in sport as well as to combat anecdotal claims that training for sport had more harmful effects than beneficial ones. The study found that the athletic children in the study had much higher levels of aerobic power and muscular power than their non-athletic counterparts. The TOYA study was able to conclude that the improvements to muscular strength were due to training and not due to growth alone (Baxter-Jones & Helms, 1996). Participants in this study also reported lower levels of body fat and had higher grades in school as compared to their peers.

Sport involvement has numerous positive effects during adolescents. For example, active adolescents have been shown to have less somatic complaints, more confidence in their future health, a better body image, a lesser tendency to attempt suicide, a higher frequency of use of the car seat belt, and a lower use of tobacco, wine, and marijuana compared to their non-athletic counterparts (Ferron, Narring, Cauderay, & Michaud, 1999). A study in 2012 found that schools with higher proportions of sports participation reported significantly fewer serious crimes (i.e., violent crimes) and suspensions occurring on school grounds (Veliz & Shakib, 2012). Positive and negative psychological development outcomes of sport involvement have also been investigated; the positive outcomes being related to constructive challenges, meaningful adult and peer relationships, a sense of community, and other life experiences, and the negative outcomes being related to poor coach relationships, negative peer influences, parent pressure, and the challenging psychological environment of competitive sport (Fraser-Thomas & Côté, 2009). Some contrary findings to positive sport involvement also show that adolescents involved in sport may be just as likely as their non-sport counterparts to participate in substance abuse, especially with alcohol (Moore & Chudley, 2005).

The findings regarding the rates of sport and physical activity participation suggest that although boys are more active than girls, both boys and girls decrease the amount of sport and physical activity as they age (Caspersen, Pereira, & Curran, 2000; Van Mechelen, Twisk, Post, Snel, & Kemper, 2000). Some authors have suggested that between the ages of 9-14, there is a significant drop in activity levels (Barnett, O'Loughlin, & Paradis, 2002). This dramatic decline in adolescent sport and physical activity participation is concerning and raises the questions of what is happening during maturation that turns adolescents away from sport and physical activity. There are many suggested negative factors that could contribute to sport drop-out, such as perceived lack of competence, feeling disrespected, poor coach-athlete relationships, and a decline in sport enjoyment. Being cut from a team due to maturational differences is also a negative experience that may be contributing to the rising rates of inactivity. If, however, adolescents are maintaining levels of sport participation or physical activity after being cut, other psychological and social factors must be examined more closely for links to adolescent sport drop-out.

2.2 – Growth, Maturation, and Development

The term growth refers to increases in size and changes in physique or body composition that an individual will experience as they age chronologically (Malina, Bouchard & Bar-Or, 2004). Maturation refers to the progression of the body's skeletal, sexual, and somatic systems toward the adult state (Malina, Bouchard & Bar-Or, 2004). Development refers more to the psychosocial or behavioral development of an individual but is often used interchangeably with maturation (Malina, Bouchard & Bar-Or, 2004); for this research the terms maturation and development will be used synonymously. Biological maturity is how much an athlete has matured at a certain CA and can be represented by the term biological age (BA). Under optimal circumstances, all children will follow the same pattern of growth: linear growth throughout childhood, a rapid period of growth in adolescence, and then finally a slowing of growth that plateaus and then ceases in adulthood (see Appendix A). The final height of an individual can be predicted during adolescence using various methods, including those described by Tanner (Tanner, 1990), the Roche-Wainer-Thissen method and the Khamis-Roche method. These methods estimate final adult stature from current age, stature, weight, and adjusted mean height of the parents.

One of the numerous examples linking growth and maturation to team selection in youth, a recent review of secular trends found that between the years 1978 and 2015, the average height and weight of youth soccer players has steadily increased (Malina, Figueiredo, & Coelho-e-Silva, 2017). While the researchers offered the explanation that this could be due to improved nutritional and health status over time, the more likely explanation is that beginning about 12–13 years of age there is a systematic selection and retention of soccer players advanced in height, weight, and maturity status which excludes players who have later maturity (Malina, Figueiredo, & Coelho-e-Silva, 2017).

The age when a child experiences their greatest velocity and magnitude of growth in stature during adolescence is known as peak height velocity (PHV); this occurs on average at age

12 for girls and age 14 for boys (Baxter-Jones et al., 2005). There is much inter-individual variation in the tempo and timing of growth and development between adolescents (See Appendix B). Maturational milestones, of which age at peak height velocity (APHV) is one, can occur later in an individual due to genetic factors. For example, female age of onset of menarche is correlated with their mother's age of onset of menarche (Damon, Damon, Reed, & Valadian, 1969). Nutritional differences and deficiencies may also account for delayed maturation (Damon et al., 1969). Any child who has a growth spurt greater than one year earlier than the average is classified as early maturing, or as being advanced in BA for their CA (Baxter-Jones, 1995). In contrast, a child with a growth spurt that is more than a year later than the average is classified as late maturing.

2.3 – Effectively Measuring Maturity

There are a variety of different methods used to calculate a BA, each having advantages and disadvantages. For a coach trying to determine the BA of an athlete, accuracy is important but methods with low cost and high practicality are likely prioritized. The method considered most reliable for determining BA is skeletal age (Baxter-Jones et al., 2005). Skeletal age is very effective because it can be used during a child's entire growth period, as opposed to other methods that may only be used around the onset of puberty. Skeletal age typically involves taking an x-ray of the hand and wrist to examine the amount of bone present. Comparisons are then made with a set of known CA based x-rays. As a child matures, there is an increase in bone tissue, decrease in cartilage, and decreasing size of growth plates on the ends of the bone (Baxter-Jones et al., 2005). Skeletal aging is expensive, requires specialised equipment, and exposes participants to radiation. Dental x-rays are also a valid measure of BA, and capture teeth eruption, but have the same challenges and limitations as skeletal aging. There does remain a question as to whether the hands or teeth are a good representation of the maturation of the whole skeleton. Accuracy and precision can be increased by taking x-rays at multiple body parts, but this further decreases the practicality (Baxter-Jones et al., 2005).

A common measure of biological maturity found in the literature is a measure of secondary sex characteristics. Secondary sex characteristics are features that are not present at birth (e.g., breasts for females, genitalia development for males, pubic hair for both) that develop at the onset of puberty when levels of sex hormones increase. Secondary sex characteristics were first documented and described by Reynolds and Wines (1948, 1951) and then thoroughly described by J.M Tanner (Tanner, 1990), now commonly known as Tanner staging. Each secondary sex characteristic is categorized over five developmental stages. Stage one begins at the onset of pubertal development and stage five represents the final adult stage of development. While simplistic in theory, this method has a few disadvantages. This method requires visual inspection which is only really appropriate in the clinical setting. Thus, this invasive test is not ideal in non-clinical settings where the participants or their parents may feel uncomfortable. Having participants self-identify their own development using pictures can be a useful substitute, but youth have been noted to overestimate their development at early stages of puberty and underestimate their development at late stages (Baxter-Jones et al., 2005). The accuracy of secondary sex characteristics can also be questionable because the five stages of development are not continuous variables. Individuals progress through the stages at different rates making this method unreliable for calculating a continuous BA. For example, a young female athlete may proceed through the first four stages of breast development in the span of two years but may take five additional years to reach stage five. Furthermore, the maturity stages are different for boys and girls and are under different hormonal control. A boy who is stage three for genitalia is not necessarily the same maturity level as a girl who is stage three for breast development. The most commonly used secondary sex characteristic is pubic hair because it is present in both sexes and is more closely aligned between sexes. However, the stages of pubic hair development between the sexes do not align with other measures of maturity such as somatic growth.

Somatic maturity is another commonly used method, measured by assessing the timing and tempo of the adolescent growth spurt; namely, the age of attainment of PHV (Baxter-Jones et al., 2005). Once APHV has been attained it is possible to create a continuous measure of maturity by creating a BA expressed as years from APHV. For example, an individual who is 13 years chronologically, who had reached APHV at age 12 would be +1 in BA. This process requires frequent longitudinal data collection of a participant's height during the years of rapid growth. This method can only retrospectively comment on events occurring before APHV. More recently, the development of gender specific multiple-regression equations has allowed for predictions of APHV. This equation, known as the Mirwald Equation (Mirwald, Baxter-Jones, Bailey, & Beunen, 2002), uses anthropometric data of height, sitting height, leg length, body mass, and CA to predict when APHV will occur. These equations have been found to be a reliable, non-invasive, and practical solution for measuring biological maturity; however, given the small error involved in the estimation, the authors of the equation caution that maturity should be considered categorical rather than a continuous assessment, i.e. group individuals as pre, peri, or post APHV.

To predict a young child's genetic potential with regards to growth (stature), it can be useful to use parental height to predict a child's adult stature due to the genetic nature of height (Tanner, 1990). It is likely that the child's predicted height centile will be the average of the centiles of the father and mother (parental height adjusted for the sex of the individual using known mean differences); however, there is large error associated with this method. The Khamis-Roche method was developed in 1994 as a non-intrusive way to predict final adult height without requiring skeletal age data, which is often costly. The Khamis-Roche method uses current age, stature, weight, and the adjusted mean height of the parents as an easy way to predict final adult height, but it does not include measures of biological maturity and is not useful when parental height is unknown. A more recent method to predict final adult height was developed in 2005, which no longer required skeletal age or parental height (Sherar, Mirwald, Baxter-Jones, & Thomis, 2005). Using the Mirwald equation, the child's maturity offset can be calculated. Equations using height, sitting height, weight, and maturity can then be used to predict final adult height and to estimate the amount a child has left to grow.

It is important to understand that no single method of measuring growth and maturity is inerrant. Skeletal age may be the most accurate but is impractical in situations where x-rays are unavailable. The proposed research of this thesis requires easy and non-invasive methods which is why the use of the Mirwald equation is proposed as the best and easiest way for coaches to estimate the current BA of their athletes.

2.4 – Maturity and Performance

As young athletes grow, they will undergo many improvements in their physical fitness. Sometimes the effects of growth on performance are so large that they mask the beneficial effects that exercise and/or training has on the body. For example, as the human body increases in age and body size, there will also be increases in heart volume, lung function, aerobic power, and muscular strength (Baxter-Jones et al, 2005). Theses are all physiological factors that similarly benefit from regular exercise and fitness. The process of team selection often involves methods of measuring speed and strength outcomes in athletes. As such, athletes who are early maturing will frequently appear stronger, faster, and better conditioned regardless of their training background or inherent skill. The alignment of maturation with CA is not the same in all adolescents and, as such, athletes who are biologically advanced for their CA enjoy the benefits of also being physiologically advanced.

Another important consideration is that athletes on the same team using one-year age bands can be up to 11 months different in CA, depending on the month they were born. Older individuals will have had 11 months more growth, irrespective of their maturity status. The growth differences between athletes of the same CA bands who are born in different months during the selection year is termed the relative age effect (RAE).

2.4.1 - The Relative Age Effect

The concept of the RAE (Musch & Grondin, 2001) was first found in public school settings, with the observation that a typical age grouping of one year was associated with significant differences in children’s cognitive development (Bisanz, Morrison, & Dunn, 1995; Morrison, Smith, & Dow-Ehrensberger, 1995). Researchers Musch and Grondin used this concept to explain why CA groupings may be ineffective for use in athletes when there can be almost a full year of growth difference between individuals on the same team.

The difference in CA between the individuals on a team is referred to as relative age (RA) while the concerns arising from RA are termed the RAE. For example, in minor hockey a common cut-off date for birthdates is January 1. As such, the RA difference between two athletes born in January and December respectively would be eleven months. The RAE implies that any children who are born just prior to January 1 have the disadvantage of being placed on a team with a higher CA grouping. An athlete born in January will therefore have almost a full year of extra growth than their teammates born in December. The implications this has on professional sport were observed by Barnsley and Thompson (1988) when they reported that adolescent and professional ice hockey players in the National Hockey League had birthdates that were heavily skewed towards the beginning of the selection year. Since this time there have been many other recent studies looking at RAE in a variety of sports such as: soccer (Figueiredo, Cooelho-E-Silva, Cumming & Malina 2018); basketball (Ibanez, Mazo, Nascimento & Garcia-Rubio, 2018); tennis (Gerdin, Hedberg & Hageskog); hockey (Fumarco, Gibbs, Jarvis & Rossi 2017); and baseball (Beals, Furtado & Fontana 2018)

The main objective of grouping students and athletes based on CA is an attempt to "ensure developmentally appropriate instruction, fair competition, and equal opportunities" (Musch & Grondin, 2001); however, this is idealistic and often what works for students does not always work for athletes. One explanation for this may be differing philosophies between teachers and coaches. While teachers often focus more attention on students who are struggling or falling behind, coaches take the opposite approach of investing their time and energy into athletes who show potential to be star players – to be elite (Musch & Grondin, 2001).

Musch and Grondin (2001) have proposed four mechanisms as to why the RAE exists. The first mechanism is competition as a necessary condition of sport. For example, if a basketball team has fifteen roster spots and fifteen athletes sign up, the RAE is a nonfactor and all athletes will get an opportunity to play; however, if a team with fifteen spots has forty athletes sign up, the coach will typically take the "best" fifteen athletes, or the athletes with the physical qualities deemed most advantageous for the sport. For example, if a sport like basketball favors qualities such as height, the coach will be more likely to use their limited roster spots for older kids who have advanced height due to early maturation.

The physical developmental differences between athletes is the second mechanism underlying the RAE. While the effects of growth and maturation on performance are well established, a study in 1963 showed that the relationship between height/weight and performance in disciplines such as the 50-yard dash, throwing, pull-ups, and sit-ups showed significant correlations even when the age difference was only one year (Espenschade, 1963). This finding was based purely on growth data and suggests that those athletes who have had more growth are better performers. Consider the implications for athletes who reach APHV roughly 5 years ahead of their peers: these athletes will appear to have superior athletic abilities until their teammates mature.

While growth and size differences between athletes should be carefully considered, the third mechanism of an athlete's psychological maturity is also an important factor for athletic success. Sport psychology is an extremely complex and multifaceted topic. Musch and Grondin (2001) offer key sub-factors of sport psychology that should be explored with regards to an athlete's psychological maturation, such as athlete's perceived competence and cognitive-affective models of stress, self-esteem, and motivation. Athletes who are older have had more time to become psychologically mature and are likely to have more efficacy in these areas, thus making them better suited to coping with stressful and demanding situations that often arise during sport (Musch & Grondin, 2001).

The fourth mechanism to explain the RAE is an athlete's experience. An athlete who is a year older than their teammates will not only have an extra year of life experience, but may also have more opportunities for training, sports camps, coaching, and athletic development. Consider that for a ten-year-old child, a difference in age of twelve months represents roughly ten percent of that athlete's total life experience.

Musch and Grondin (2001) suggested that once the RAE can be demonstrated to coaches, then potential strategies can be implemented to minimize its effects. The first solution suggested is to base sport classifications on BA rather than CA. This is unlikely because school groupings and sport teams are closely linked and executing a change of this magnitude would require massive restructuring of the current education system and hundreds of sports leagues. There are some promising experiments currently underway in England youth soccer that are exploring the idea of pairing athletes by BA.

If team age bands must remain based on CA, Musch and Grondin (2001) suggested alternatives to replace the current one-year band, such as making the age band a nine-month period so that the cut-off date is continually rotating and creating a more even distribution of athletes from all calendar months. Different sports could also experiment with having different cut-off dates from one another to give children a chance to be successful in a new sport if they choose to try it. Finally, teams could be required to have children on their team representing all four quarters of the cut-off year.

2.5 – Exit from Sport

It has been observed that some athletes who retire (both voluntary and involuntary) from sport go through a stressful and difficult transition period. Following the termination of sport involvement, athletes reported difficulties with eating disorders, depression, and confusion (Blinde & Stratta, 1992). Loss of status, self-identity, social support, direction and focus have also been identified as issues for athletes leaving sport (Fortunato & Marchant, 1999; Werthner & Orlick, 1986). The loss of status and social support may be especially difficult for high school athletes existing in an environment where friendships and/or social status can be dictated or influenced by self-identification as an athlete (Brewer, Van Raalte, & Linder, 1993).

Conversely, in 1983, it was suggested that "the transition out of intercollegiate sport seems to go hand in hand with the transition from college to work careers, new friendships, marriage, parenthood, and other roles normally associated with early adulthood" (Coakley, 1983). A study of professional female tennis players found that fifty percent of the athletes had feelings of relief after their sport career was terminated (Allison & Meyer, 1988). They viewed athletic retirement as a rebirth and as a chance to leave the athlete life behind and create lifestyles that are more traditional. 75% of the participants remained affiliated with tennis in some form. The authors of these studies view sport retirement in a more positive light and as a transition much like other transitions made in life.

Determining whether exit from sport is a good or bad thing may also depend on other factors. For example, an athlete who retires voluntarily will naturally have a better retirement experience than one who retires involuntarily (Fortunato & Marchant, 1999). Other factors such as adult development, level of athletic identity, loss perspective of retirement, level of sport involvement, gender, pre-retirement planning, support systems, coping resources, and interventions will all have a significant impact on the exit from sport process (Meeker, Stankovich, & Kays, 2000).

When discussing exit from sport, it is important to distinguish the difference between sport drop out, and sport deselection. The majority of current literature looking at youth sport deals specifically with the issue of sport drop out, which is when an athlete decides to discontinue participation in a sport of their own volition. For example, a meta-analysis done in 2017 which examined studies done in Canada and the US looked to identify the many factors suggested from youth as to why they drop out from sport (Monteiro et al., 2017). They included 'conflicts with their trainers', 'other things to do', 'competence improvements', 'failure', 'parents, couples or trainers' pressure', 'lack of enjoyment' and 'get bored'.

Only since 2015 has work been done to begin looking more specifically at the topic of deselection, or when an athlete is not given the autonomous decision to stop participating in sport. Recent research performed in Saskatchewan schools provided insight into rates and amounts of cutting done in adolescent team sports. The preliminary research on student athletes being deselected for high school teams in Saskatchewan, Canada, was done in 2015 by researchers Sulz, Humbert, and Gleddie in a survey titled "Examining Non-Curricular Physical Activity Programs in Saskatchewan Schools".

2.6 – Saskatchewan Team Selection Research

In Sulz, Humbert, and Gleddie's 2015 survey, athletic directors reported that the most common reason that their school made cuts was there were not enough coaches to support more teams (70.7%). The second most common reason was that coaches wish to select the best players available to remain competitive (58.6%).

In the same survey, athletic directors (58) and teacher-coaches (184) sought information on which high school sports (badminton, basketball, cheerleading, cross country, curling, football, golf, hockey, soccer, track and field, and volleyball) had the highest rates of cutting. Of the high school sports, the two that reported the highest amount of cutting were basketball and volleyball. Both sports have large numbers of kids trying out, but a typical team roster may only have ten to fifteen spots. Competition levels between athletes rise because high school is an important time when athletes start to specialize into different sports. 41.4% of athletic directors and 50% of teacher-coaches reported that grade nine is when most cuts begin happening, while elementary and middle schools reported the lowest levels of cutting.

The number of children who get cut from teams in Saskatchewan is similarly large. The teacher-coaches who responded to the survey of Sulz, Humbert, & Gleddie (2015) reported that in regard to the last team they coached, 51% of them had to cut five or fewer students (only 16% of them made no cuts), while the other 49% of teachers had cut more than five student athletes for a team. Five percent of the responding teacher-coaches reported they had to cut more than 30 students on their last team. Due to the prevalence of cutting at the high school level evident from this study, it is indisputable that further research is needed to inform the process and ensure it is done with maximum benefit and minimum trauma to adolescent athletes.

Exit from sport can be traumatic. It is therefore disconcerting that only 13% of teacher-coaches reported that their school division had guidelines in place for properly cutting students from a team. 49% of teacher-coaches (of 152 who answered the question) stated that they thought it would be beneficial for a school division to have guidelines surrounding cutting. Most of the policy for cutting student athletes and selecting team rosters is left to individual schools and teams to self-govern. This preliminary look at Saskatchewan high schools is a small example of the rates of cutting but provides future research with an idea of what to expect when investigating other teams in the same age groups. For example, many provincial level sport teams have no governing body to aid in the process of talent identification and team selection; those roles are left solely as the responsibility of the head coach.

2.7 – Sports Participation Research Initiative

Sherar, Proctor and Baxter-Jones' Sports Participation Research Initiative (SPRI) grant, "The effects of adolescent physical growth and maturation on selection into sport and the long-term effects on sports participation", funded by the Social Sciences and Humanities Research Council (SSHRC) of Canada and Sports Canada, was initiated in 2012 with the intent of examining the effects of adolescent physical growth and maturation on selection into sport and the long-term effects on sports participation. The SPRI was a direct result of a 2007 study by Sherar et al. (2007), which found that Saskatchewan hockey teams preferentially selected early maturing male athletes who had birth dates early in the selection year. The SPRI expands on this question by looking across a broader range of sports (hockey, soccer, basketball, football, volleyball, and baseball) and examining whether growth and maturation were related to selection onto these teams at a provincial level in both males and females and the effect of selection on sport participation.

Adolescent athletes in Saskatchewan from six sports (hockey, soccer, basketball, football, volleyball, and baseball) had a number of measures taken during tryout between 2012-2013. Follow up measures were taken at 6 months and 48 months (2017). At study entry, participants had a number of demographics and anthropometrics measured: date of birth, date of test, height, sitting height, and weight. Parental height was also assessed, as was sports participation via questionnaire (the Sports Participation Activities (SPA) survey (See Appendix C). The SPA module was taken from the 2010 Statistics Canada General Social Survey and addressed questions about participation history, proficiency in sport, and athlete perceptions toward sport. Athletes also completed a Sport Enjoyment Questionnaire (SEQ), the Children and Youth's Physical Self Perception Profile (CY-RSPP), and the Athlete-Perceived Coaching Behaviors (APCB). Following the tryout, sports bodies were contacted and list of athletes who made the team were provided. At 6- and 48-months follow-up participants again completed the SPA, SEQ, CY-RSPP and APCB. The results of the follow-up were not meant to express causality (the idea that cutting athletes is the sole reason that an athlete decides to drop out of a sport) but rather to be an exploratory study which sought to identify factors that may influence an athlete's long-term sport and physical activity participation. I started my Master's program in the College of Graduate and Postdoctoral Studies in the fall of 2015, after the initial data collection had taken place. I was, however, responsible for data collection at the 48-month follow-up phase of the project.

2.8 - Summary

Physical activity is known to be beneficial for adolescents' current and long-term health. One way that adolescents stay physically active is through sports participation, both competitive and recreational. Many sports use chronological age-banded tryouts to select rosters for teams. If athletes are being selected for a team due to the short-term advantages of having advanced growth and maturation, late maturing individuals miss out on opportunities regardless of which athlete has the higher long-term talent potential. New strategies can be implemented so that coaches can better identify talent and to ensure the proper development of all types of athletes. When predominantly early maturers continue to receive higher levels of teams and coaching, it creates a skewness in which cohort of kids continue in sport long-term. What is also unknown is the effect of team selection on sport dropout. Programs and policies can also be modified to ensure that athletes who were not successful during their team tryout are able to find a way to remain active in some form of sport or physical activity.

3.0 Study Outline

3.1 – Study Outline

This research looks to address two specific target areas of the Sport Participation Research Initiative. The first is to identify barriers to participation in sport and determine ways to overcome these barriers. An athlete's growth and maturation will be examined as a key barrier that influences if an athlete is able to participate in a sport. Examining how the growth and maturation of young athletes can be a barrier to their sport participation will aid in the development of infrastructure to assist coaches in making wiser decisions with regards to talent identification. This information will also help ensure that team selection does not negatively effect long-term sport participation. Secondly, this study will look at the observed relationships between growth and maturation and provincial team tryouts at the adolescent level in Saskatchewan. Data from a three-year follow-up will be used to examine whether team selection had any impact on continued sports or physical activity participation. The results of this study will assist coaches in understanding the best ways to enhance youth sport participation while creating strategies and policy changes to reduce the concerning rate of adolescent sport drop outs.

3.2 – Study Goals

The empirical data and information gathered will expectantly foster the design of new programs and policies which seek to overcome barriers while promoting and enhancing long-term participation in sports. For coaches, new education and awareness strategies may aid in improving talent identification and ways to improve the experiences of all participants in team sports to hopefully prevent them from dropping out of sports. Raising awareness to the relationships between growth and maturation and sport participation will be done in partnership with Sask Sport and will lead to further research surrounding sports participation and improving future research collaborations.

3.2.1 – Research Questions

1. The first objective of this study is to observe if there is a relationship between birth date quartile (CA) and selection onto team sports.
2. The second objective is to investigate whether there is a relationship between adolescent growth (anthropometric measures, predicted heights) and selection onto a sports team.
3. The third objective is to investigate whether there is a relationship between adolescent maturation (BA, APHV) and selection onto a sports team.
4. The fourth objective is to identify the long-term (3 years) effects of team selection on continued participation in that sport.

3.3 – Hypotheses

It was hypothesized that:

1) Athletes who were selected for teams will tend to have higher CA and be born in the earlier quartiles of the year than the athletes who were not selected.
2) Athletes who were selected for teams will tend to be taller, heavier, and have greater predicted heights than the athletes who were not selected.
3) Athletes who were selected for teams will tend to be more advanced in BA (earlier maturing) than the athletes who were not selected.
4) Not being selected for a team will result in decreases to long-term sport participation in the tryout sport.

4.0 Methods

4.1 – The Study

In 2012, Drs Sherar and Baxter-Jones (College of Kinesiology, University of Saskatchewan) and Mr Proctor from Sask Sport Inc. received a Social Sciences and Humanities Research Council (SSHRC) of Canada / Sports Canada Sports Participation Research Initiative Insight Grant: The Saskatchewan Sports Participation Study. Through consultation with Sask Sport the following six sporting bodies agreed to participate in the initiative: Sask Volleyball (http://www.saskvolleyball.ca/), Football Saskatchewan (https://www.footballsaskatchewan.ca/), Saskatchewan Soccer Association (http://sasksoccer.com/), Baseball Sask (http://www.baseballsask.ca/), Basketball Saskatchewan (http://www.basketballsask.com/), and the Saskatchewan Hockey Association (https://sha.sk.ca/).

I was unfortunately not present at the baseline data collection for this study which leads to a few limitations. First, I was not personally present to ensure all data measures were done precisely or accurately. Second, because I was not there for the study's inception, I was also not part of the discussion as to which surveys to use or measures to take. Psychosocial measures (Appendices D, E, F, and G) were included in the follow-up data collection for future research studies, but their use is beyond the scope of this project. There were two roles that I had in the collection and analysis of data. The first was to complete the analysis of the birthdate and anthropometric data gathered at study initiation and to compare it to the results of which athletes were selected and not selected during provincial team tryouts. My second role was to perform the 36-month follow-up survey mailout and use data gathered in the Sport Participation Activities (SPA) survey (Appendix C) to observe the trends in short and long-term sport participation after successful and non-successful tryouts. All the surveys were unchanged from baseline to 6-month to 36-month collection times, so although the psychosocial surveys were not used in this data analysis, they have been included in the appendices for reference (Appendices D, E, F, and G).

Between February 2014 and February 2015, participants participating in under 12, under 14, under 16 and under 18 team selection tryouts were recruited. Recruitment and baseline assessment occurred at the selection camps, with online (Redcap), postal or telephone follow-ups at 6 and 36 months: the surveys included the SPA, the Sport Enjoyment Questionnaire (SEQ), the Physical Literacy Assessment for Youth (PLAY) inventory, the Parenting Scale (PSI-II), and the Children and Youth Physical Self Perception Profile (Appendices C, D, E, F, and G). After the selection camps, sporting bodies were contacted and a list of names of those selected for teams was requested.

4.2 – Participants

A total of 895 participants were recruited from the sports tryouts: 279 male and 134 female hockey players, 74 male and 63 female soccer players, 51 male and 36 female basketball players, 81 male football players, 35 male and 66 female volleyball players and 76 male baseball players. Athletes were between the ages of 11-17 years. Child assent and parental consent were obtained for all participants included in the study and all procedures were approved by the University of Saskatchewan Behavioural Research Ethics Board.

4.3 – Anthropometry

During the tryouts anthropometric measurements were taken, including:

1. Standing and sitting height: Standing height was measured using a portable stadiometer (Seca Portable Stadiometer, Hamburg, Germany) with feet no more than shoulder width apart and with the ankles against the back of the stadiometer platform. Sitting height was measured using the same portable stadiometer placed on top of a steel utility bench. Each participant was asked to sit on the bench and torso length was measured from the bench to the top of the head. Leg length was calculated by subtracting the sitting height from the standing height. All measures were performed twice, and a third measurement was issued if there was a difference of more than 0.4 cm for stature or sitting height. If there was still a discrepancy between measurements, the mean of all measurements was recorded.
2. Body mass: Body mass was measured using a portable digital scale (Toledo Scale Company, Thunder Bay, Ontario, Canada). All measures were performed twice, and a third measurement was issued if there was a difference of more than 0.4 kg. If there was still a discrepancy between measurements, the mean of all measurements was recorded.

All research assistants performing measurements attended a familiarization session prior to data collection to ensure measurement methods were consistent. Using reference data from the World Health Organization's 2014 Canadian data, each participant's height and weight were normalised by calculating z-scores.

Parental height was also collected through self-report questionnaires, or direct measurement, by the parents at each tryout; if reported heights were not received, parents were contacted later via email. The parental heights were corrected for the over-estimation commonly seen when reporting height and were used to predict the child's adult stature. The following equation was used to correct parental heights: 2.316+(0.955*reported stature in inches) (Epstein, Valoski, Kalarchian, & McCurley, 1995).

4.3.1 - Predicted Adult Stature

Two methods were used to predict each athlete's final adult height: Khamis and Roche's (1994) method as well as Tanner (1970). Khamis and Roche final predicted height was performed using a programmed syntax on SPSS (version 11.5) and the Tanner equation was as follows: ((mothers height + fathers height/2) + 6.5) for males; ((mothers height + fathers height/2) - 6.5) for females.

4.4 – Chronological age

At the initial data collection, baseline data included date of birth (DOB) as well as date of tryout (DOT). A decimal CA was calculated as DOT-DOB.

4.5 – Relative Age

DOB month was assigned into quartiles, dependant on the sports cut-off months for teams: quartile 1 – month 1 to 3, quartile 2 - months 4 to 6, quartile 3 – months 7 to 9 and quartile 4 – months 10 to 12.

4.6 – Biological Age

Biological maturity was expressed as the individual's CA offset from APHV, a somatic maturational milestone. APHV reflects the period where individuals experience the adolescent growth spurt and is used to identify the BA of the individual. To predict APHV, gender-specific multiple regression equations (Mirwald, Baxter-Jones, Bailey, & Beunen, 2002) were used: these included the following variables: height, weight, sitting height, leg length, CA, and the interactions of these measurements. Maturity offset (BA) indicates how far until or past APHV an individual is. For example, an individual with a BA of -1.0 years is one year from obtaining APHV, a BA of 0 indicates they are currently at APHV and a BA of +1.0 indicates they are one year post-APHV. This method has been shown to estimate maturity status to within ±1.18 year 95% of the time in boys and ±1.14 years 95% of the time in girls (Mirwald, Baxter-Jones, Bailey, & Beunen, 2002).

4.7 – Analysis

Prior to data analysis, the raw data needed was examined and tested to ensure that it had good integrity. Athletes who appeared as duplicates (participated in more than one sport tryout) were asked to select their main sport and then were excluded from the other sport analysis to ensure data was independent. Athletes with incomplete data were removed from the baseline tryout analysis. The data sample for parametric tests set was tested for normality by first constructing histograms to identify a normal probability curve and identify outliers (> 3 SD). Normality was further tested using Kolmogorov-Smirnov tests.

To test the first hypothesis, birth months across the quartiles was analyzed using a chi-square goodness of fit test. The test was run first on the entire sample to determine if the study sample was representative of a normal population. The sample was then split by sex, sport, and success at tryouts to further examine the trends in birthdate quartiles.

To test the second and third hypotheses, the sample was split by sex, sport and success at tryouts. Descriptive statistics and ANOVA were used to assess mean differences between sports, sex and success at tryout groups. ANOVA was used because we have a categorical variable with different groups (selected and not selected). Using ANOVA allowed us to determine whether there is a significant difference between our groups. Regression was not used because we are not trying to use our variables as predictors. All data was analysed using IBM SPSS Statistics (version 24) and alpha was set at 0.05.

For the final hypothesis, long-term sport participation analysis was done via 36 month follow-up surveys. Using the results of the SPA survey, current sport involvement was compared between selected and not selected groups to observe differences in sport participation changes from study initiation.

5.0 Results

5.1 – Birth Month Distribution

The first hypothesis was that athletes who were selected for teams will tend to have higher CA and be born in the earlier quartiles of the year than the athletes who were not selected. When the whole sample was analysed, it was found that the first and second quartiles of the year were significantly over-represented for date of birth in all athletes ($p < 0.05$). Figures 5.1-5.10 show the distribution of players' birth months split by sport, sex and selection into teams. In the general population, months of birth are equal by quartile. For the majority of sport and sex pairings there were no significant differences from the expected general population distribution ($p > 0.05$) (Figure 5.1, 5.3, 5.4, 5.6, 5.8, 5.9, 5.10). Significant differences were found in three of the sport by sex pairings: female soccer (Figure 5.2), male hockey (Figure 5.5), and male basketball (Figure 5.7) ($p < 0.05$). When looking at quartile representation regarding sport by sex by selection groups, only two groups showed significant differences ($p < 0.05$) from the general population: not selected male hockey players (Figure 5.5), and not selected male basketball players (Figure 5.7).

Figure 5.1 – Birth month quartile distribution of male soccer players (n = 74)

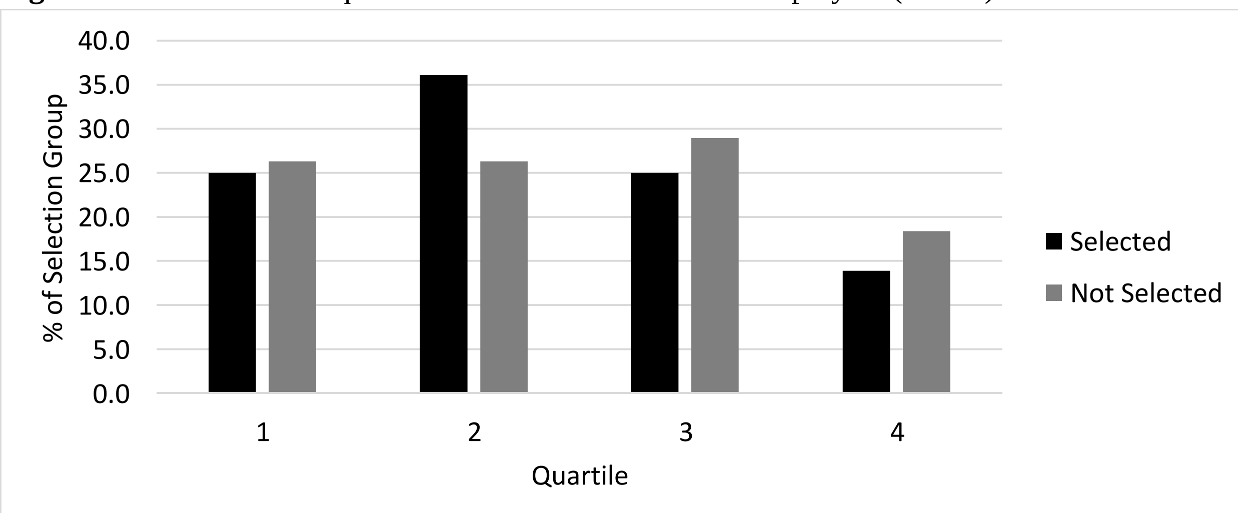
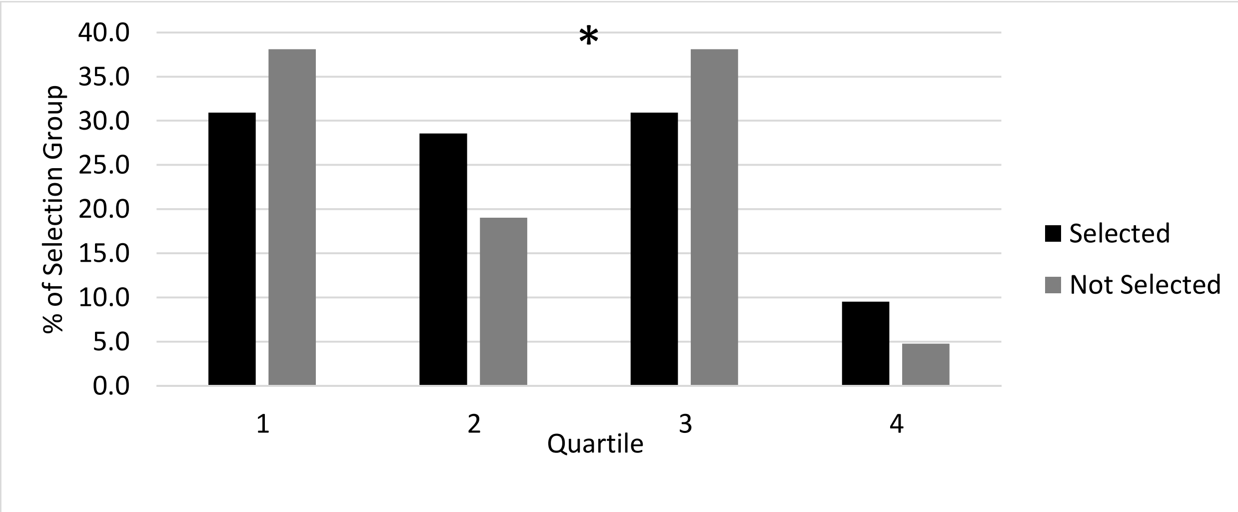


Figure 5.1 shows the quartile distribution of male soccer players within the study. Within this sample, there was no difference from the general population for birth quartile distribution ($p > 0.05$).

Figure 5.2 – Birth month quartile distribution of female soccer players (n = 63)



* = Chi-Square Goodness of fit test was significant $p < 0.05$ for this sample

Figure 5.2 shows the quartile distribution of female soccer players within the study. Within this sample, only 7.9% (5 of 63) athletes were born in the fourth quartile of the year. Note however the relatively balanced representation between the first three quartiles.

Figure 5.3 – Birth month quartile distribution of male volleyball players (n = 35)

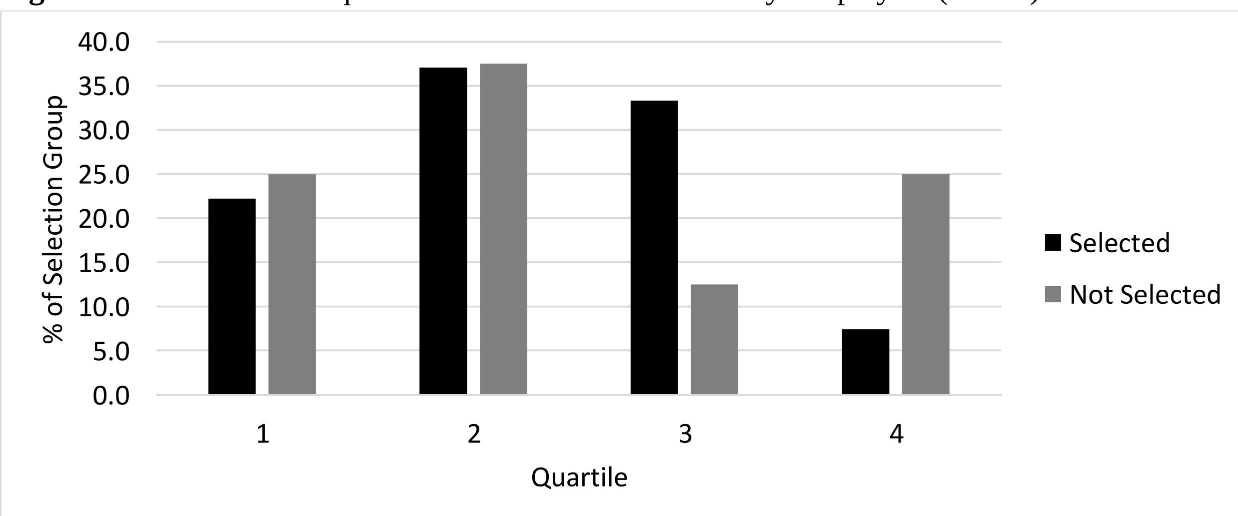


Figure 5.3 shows the quartile distribution of male volleyball players within the study. Within this sample, there was no difference from the general population for birth quartile distribution ($p > 0.05$).

Figure 5.4 – Birth month quartile distribution of female volleyball players (*n* = 66)

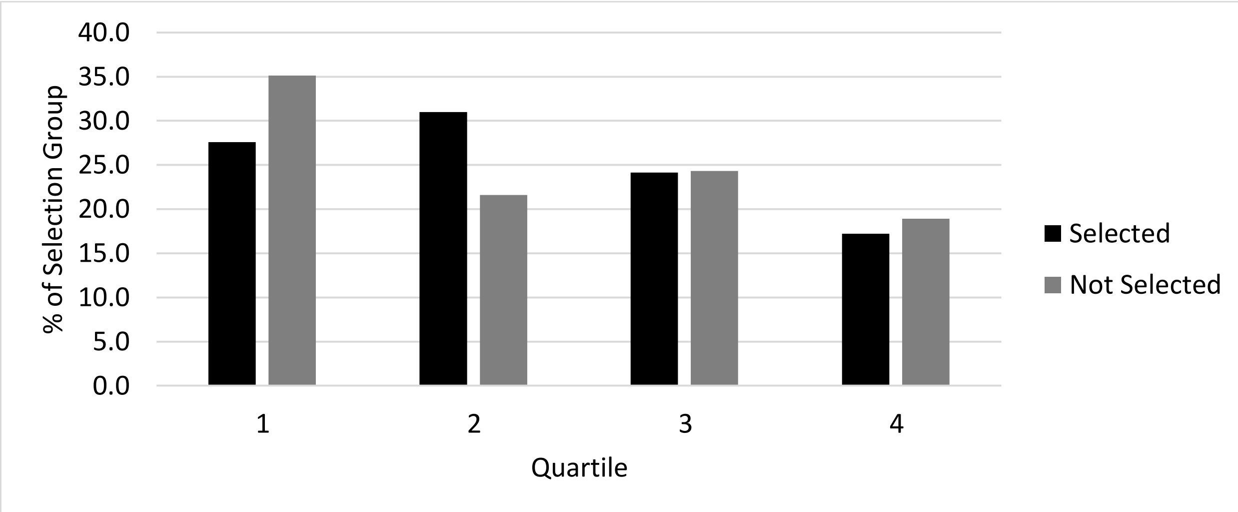
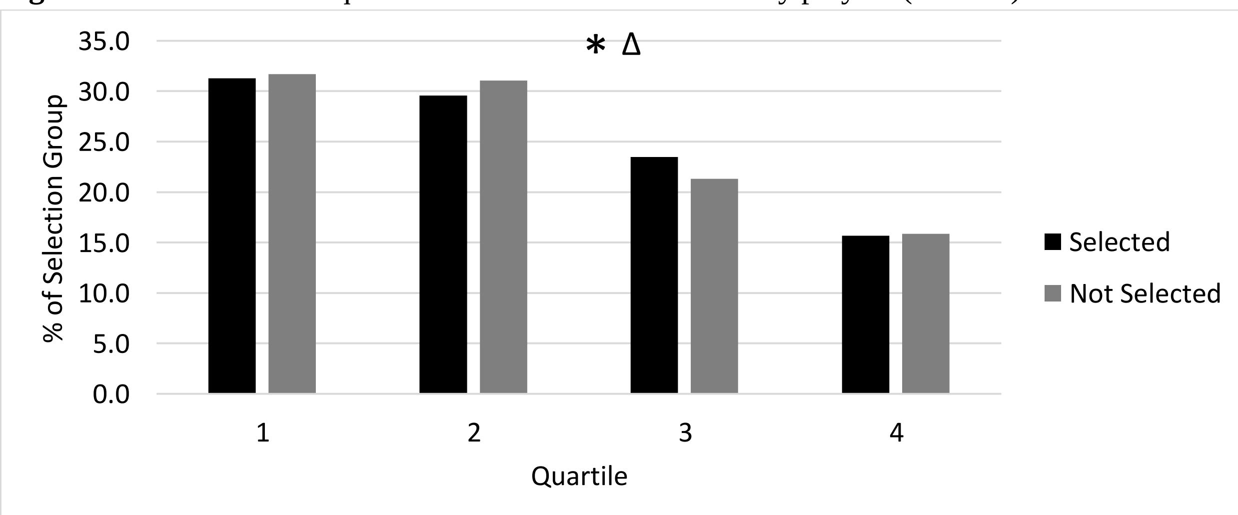


Figure 5.4 shows the quartile distribution of female volleyball players within the study. Within this sample, there was no difference from the general population for birth quartile distribution ($p > 0.05$).

Figure 5.5 – Birth month quartile distribution of male hockey players (*n* = 279)



* = Chi-Square Goodness of fit test was significant p < 0.05 for this sample
Δ = Chi-Square Goodness of fit test was significant p < 0.05 for Not Selected athletes

Figure 5.5 shows the quartile distribution of male hockey players. The first two quartiles of the year are overrepresented, with the fourth quartile being largely underrepresented ($p < 0.05$). This was true for the whole sample of male hockey players ($n = 279$) as well as the male hockey players who were not selected ($n = 164$).

Figure 5.6 – Birth month quartile distribution of female hockey players (*n* = 134)

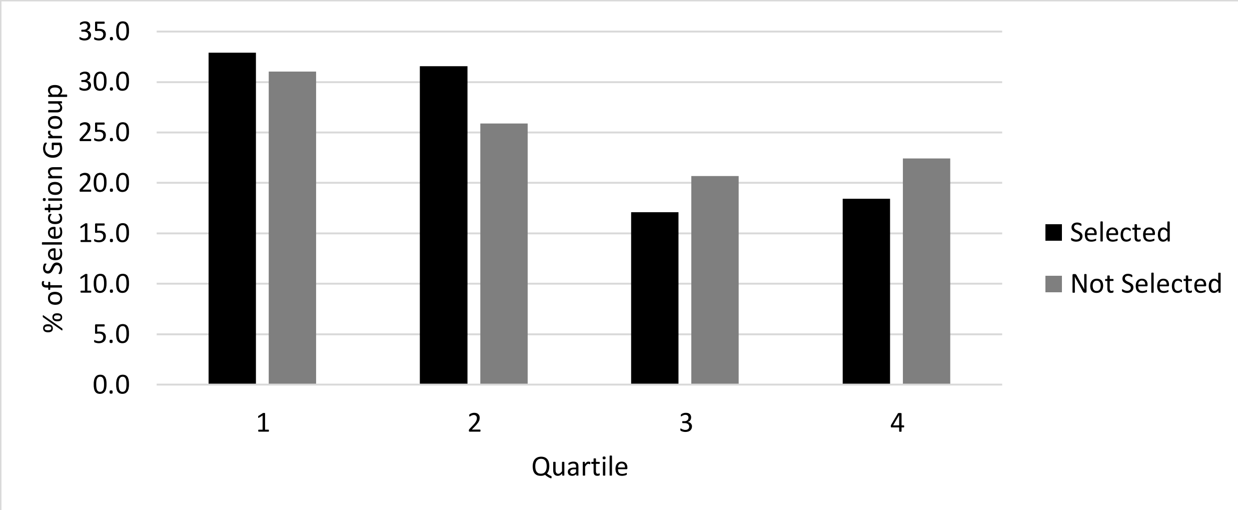
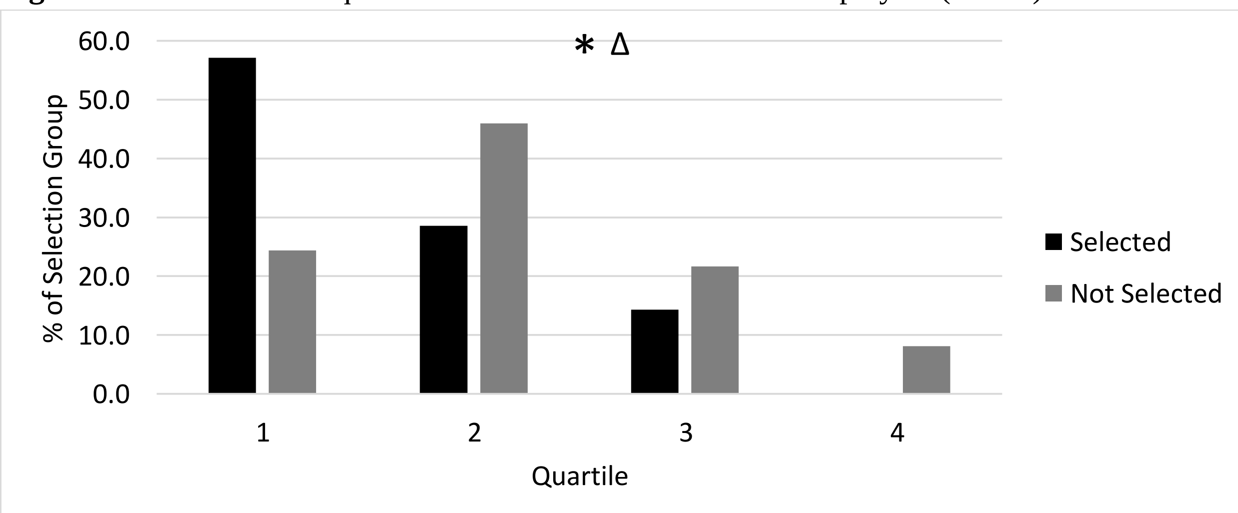


Figure 5.6 shows the quartile distribution of female hockey players within the study. Within this sample, there was no difference from the general population for birth quartile distribution ($p > 0.05$).

Figure 5.7 – Birth month quartile distribution of male basketball players (*n* = 51)



* = Chi-Square Goodness of fit test was significant p < 0.05 for this sample
Δ = Chi-Square Goodness of fit test was significant p < 0.05 for Not Selected athletes

Figure 5.7 shows the quartile distribution of male basketball players. Note that not a single player on the final roster was born in the fourth quartile of the year, with the first quartile representing over half of the athletes selected. According to the chi-square analysis, the whole sample of male basketball players (*n* = 51) was not representative of a normal population, as well as the quartile distribution for the athletes who were not selected (*n* = 37).

Figure 5.8 – Birth month quartile distribution of female basketball players (n = 36)

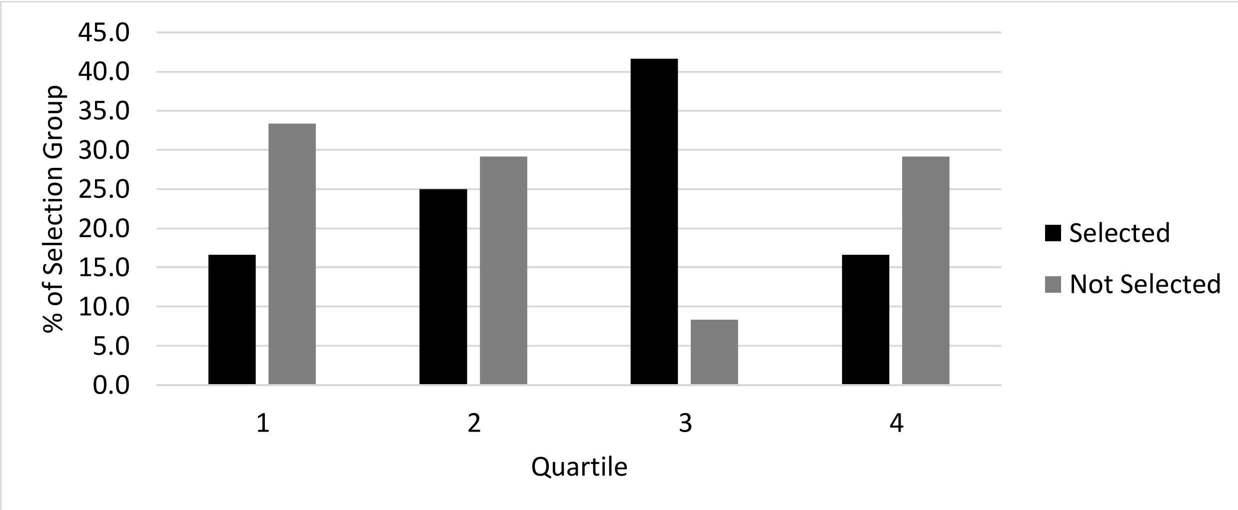


Figure 5.8 shows the quartile distribution of female basketball players within the study. Within this sample, there was no difference from the general population for birth quartile distribution ($p > 0.05$).

Figure 5.9 – Birth month quartile distribution of male baseball players (n = 76)

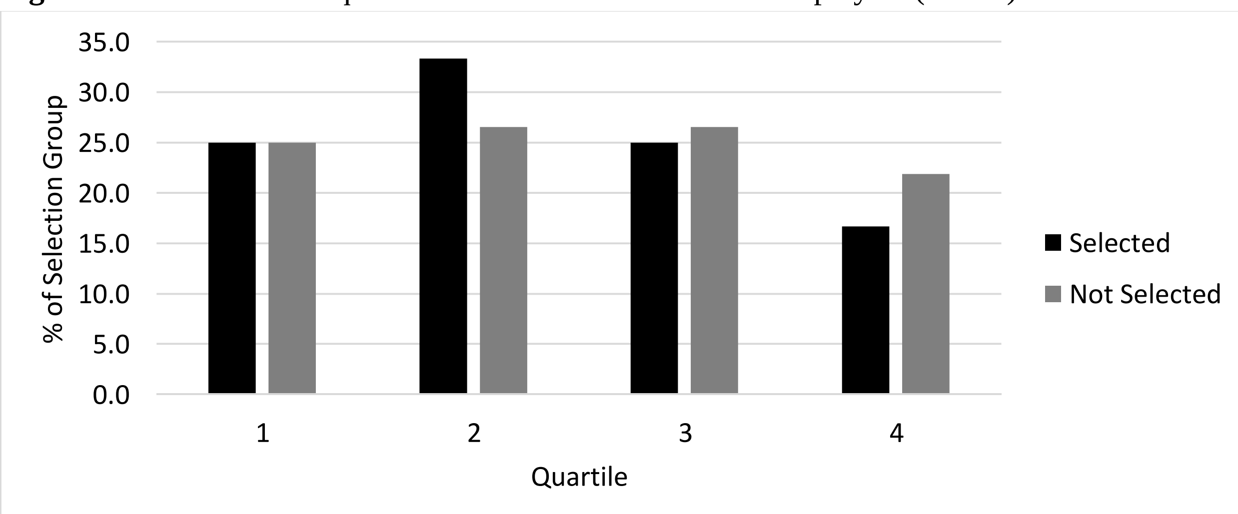


Figure 5.9 shows the quartile distribution of male baseball players within the study. Within this sample, there was no difference from the general population for birth quartile distribution ($p > 0.05$).

Figure 5.10 – Birth month quartile distribution of male football players (n = 81)

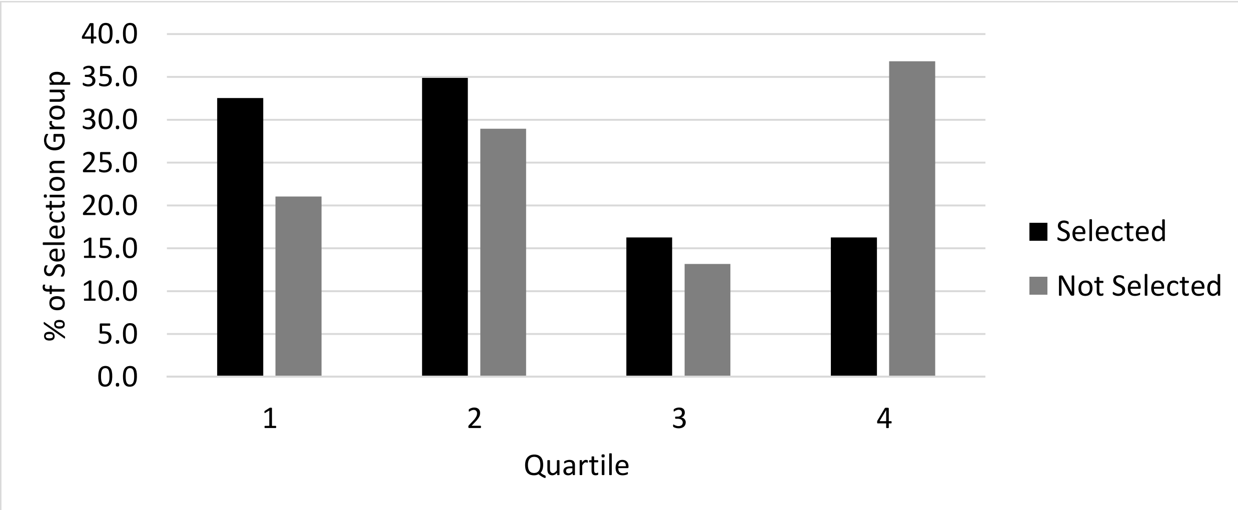


Figure 5.10 shows the quartile distribution of male football players within the study. Within this sample, there was no difference from the general population for birth quartile distribution ($p > 0.05$).

5.2 – Age, Height, Weight, and Maturity by sport, sex and Team Selection

The second and third hypotheses were that athletes who were selected for teams will tend to be taller, heavier, and have greater predicted heights than the athletes who were not selected, and that athletes who were selected for teams will tend to be more advanced in BA (earlier maturing) than the athletes who were not selected. Means for age, APHV, height, weight, father's height, and mother's height are shown in Tables 5.1-5.6.

Table 5.1 – Mean differences between selection groups in soccer players

Soccer	**Males**			**Females**		
	Selected (n=36)	**Not-Selected (n=38)**	**P**	**Selected (n=42)**	**Not-Selected (n=21)**	**P**
Age	13.5 (0.7)	13.9 (1.2)	*	13.4 (0.7)	12.4 (0.7)	NS
APHV	14.0 (0.6)	13.8 (0.5)	NS	12.1 (0.4)	11.9 (0.4)	NS
Height	160.8 (8.1)	164.7 (11.7)	*	160.4 (5.1)	157.2 (6.7)	NS
Height z-score	0.1 (1.1)	0.3 (1.0)	NS	0.4 (0.7)	0.5 (0.9)	NS
Predicted Height	180.5 (5.7)	179.8 (4.0)	NS	166.6 (4.0)	168.0 (3.7)	NS
Father's Height	177.0 (7.5)	177.1 (6.1)	NS	179.1 (5.4)	180.0 (5.4)	NS
Mother's Height	164.0 (6.3)	164.4 (6.5)	NS	166.4 (6.0)	166.4 (6.3)	NS
Weight	48.6 (8.1)	55.7 (14.3)	*	52.2 (7.8)	48.7 (8.4)	NS

Weight z-score	0.0 (0.9)	0.5 (1.3)	*	0.4 (0.8)	0.5 (0.9)	NS

*** p < 0.05**

For soccer players, statistical significance was only found for male athletes (Table 5.2.1). The athletes who were selected for soccer were younger (age 13.5 (0.7) vs 13.9 (1.2)), shorter (160.8 (8.1) cm vs 164.7 (11.7) cm), and weighed less (48.6 (8.1) kg vs 55.7 (14.3) kg) than those not selected ($p < 0.05$).

Table 5.2 – Mean differences between selection groups in volleyball players

Volleyball	**Males**			**Females**		
	Selected (n=27)	**Not-Selected (n=8)**	**P**	**Selected (n=29)**	**Not-Selected (n=37)**	**P**
Age	16.3 (0.8)	16.3 (0.6)	NS	15.9 (1.1)	15.8 (0.8)	*
APHV	13.5 (0.4)	13.8 (0.5)	NS	12.3 (0.6)	12.4 (0.5)	NS
Height	185.6 (5.7)	177.5 (4.8)	NS	174.1 (7.4)	172.4 (4.5)	*
Height z-score	1.6 (0.7)	0.5 (0.6)	NS	1.8 (1.1)	1.5 (0.7)	*
Predicted Height	187.2 (5.3)	179.5 (4.1)	NS	174.8 (6.9)	173.0 (4.4)	*
Father's Height	184.5 (7.3)	178.1 (3.9)	NS	186.0 (8.9)	184.1 (6.3)	NS
Mother's Height	169.3 (7.7)	168.7 (5.6)	NS	169.5 (7.0)	168.7 (5.7)	NS
Weight	72.4 (7.1)	72.6 (9.3)	NS	66.3 (8.8)	62.9 (8.7)	NS
Weight z-score	1.0 (0.7)	0.9 (1.0)	NS	1.3 (1.0)	0.9 (1.0)	NS

*** p < 0.05**

In volleyball players (Table 5.2.2), the significance was found in the female sample. On average, the athletes of the selected group were older (Age 15.9 (1.1) vs 15.8 (0.8)), taller (174.1 (7.4) cm vs 172.4 (4.5) cm), and had a higher predicted final adult height (174.8 (6.9) cm vs 173.0 (4.4) cm) ($p < 0.05$).

Table 5.3 – Mean differences between selection groups in hockey players

Hockey	**Males**			**Females**		
	Selected (n=115)	**Not-Selected (n=164)**	**P**	**Selected (n=76)**	**Not-Selected (n=58)**	**P**
Age	14.7 (0.3)	14.7 (0.3)	NS	14.2 (0.6)	14.1 (0.6)	NS
APHV	13.5 (0.5)	13.6 (0.6)	*	12.1 (0.4)	12.2 (0.5)	NS

Height	173.4 (5.9)	172.0 (7.2)	*	165.3 (6.7)	163.5 (6.3)	NS
Height z-score	0.8 (0.9)	0.6 (0.9)	NS	0.7 (0.9)	0.5 (0.9)	NS
Predicted Height	180.9 (4.8)	180.3 (4.7)	NS	168.2 (5.4)	166.9 (5.3)	NS
Father's Height	179.6 (5.9)	180.4 (6.8)	NS	180.8 (7.3)	180.4 (6.0)	NS
Mother's Height	166.7 (6.4)	166.1 (6.2)	NS	168.0 (6.5)	165.8 (7.9)	NS
Weight	66.7 (8.5)	66.0 (12.7)	*	61.4 (8.9)	56.2 (8.6)	NS
Weight z-score	1.1 (0.9)	1.0 (1.2)	*	1.1 (0.9)	0.5 (0.9)	NS

*** p < 0.05**

In the sample of hockey players, significant differences between group means were found only for males (Table 5.2.3). Male athletes selected for provincial teams were earlier maturing (APHV 13.5 (0.5) vs 13.6 (0.6)), taller (173.4 (5.9) cm vs 172.0 (7.2) cm), and heavier (66.7 (8.5) kg vs 66.0 (12.7) kg) ($p < 0.05$).

Table 5.4 – Mean differences between selection groups in basketball players

Basketball	**Males**			**Females**		
	Selected (n=14)	**Not-Selected (n=37)**	**P**	**Selected (n=12)**	**Not-Selected (n=24)**	**P**
Age	14.7 (0.6)	14.2 (0.7)	NS	14.4 (0.5)	14.4 (0.7)	NS
APHV	13.1 (0.8)	13.6 (0.6)	NS	12.1 (0.5)	12.1 (0.4)	NS
Height	180.5 (10.5)	170.9 (9.9)	NS	166.8 (9.5)	166.2 (6.6)	NS
Height z-score	1.8 (1.2)	0.8 (1.0)	NS	0.9 (1.4)	0.9 (0.9)	NS
Predicted Height	187.2 (7.0)	183.2 (4.9)	NS	169.4 (8.2)	168.9 (5.7)	NS
Father's Height	180.3 (10.1)	180.7 (7.6)	NS	180.6 (7.2)	183.5 (5.9)	NS
Mother's Height	166.5 (8.3)	165.6 (5.8)	*	172.6 (5.5)	166.4 (7.6)	NS
Weight	70.8 (12.4)	61.7 (11.3)	NS	60.8 (11.4)	59.9 (8.3)	NS
Weight z-score	1.5 (1.2)	0.9 (1.0)	NS	0.9 (1.2)	0.9 (0.9)	NS

*** p < 0.05**

In basketball players (Table 5.2.4), age, maturity, height, and weight were not significant indicators ($p > 0.05$). Male basketball players who were selected had taller mothers on average ($p < 0.05$).

Table 5.5 – Mean differences between selection groups in baseball players

Baseball	Males			Females		
	Selected (n=12)	Not-Selected (n=64)	P	Selected	Not-Selected	P
Age	14.9 (0.4)	14.9 (0.6)	NS	-	-	-
APHV	13.2 (0.6)	13.6 (0.5)	NS	-	-	-
Height	176.6 (6.9)	173.8 (6.7)	NS	-	-	-
Height z-score	1.1 (1.0)	0.7 (0.8)	NS	-	-	-
Predicted Height	182.0 (4.9)	180.8 (5.3)	NS	-	-	-
Father's Height	179.2 (10.1)	179.2 (6.3)	NS	-	-	-
Mother's Height	169.7 (6.8)	166.7 (6.4)	NS	-	-	-
Weight	69.3 (8.6)	65.6 (9.8)	NS	-	-	-
Weight z-score	1.3 (0.9)	0.9 (0.9)	NS	-	-	-

*** p < 0.05**

In baseball (Table 5.2.5) there was no significant differences between age, maturity (APHV), height, or weight between selected and not-selected groups ($p > 0.05$).

Table 5.6 – Mean differences between selection groups in football players

Football	Males			Females		
	Selected (n=43)	Not-Selected (n=38)	P	Selected	Not-Selected	P
Age	14.9 (0.4)	14.5 (0.6)	*	-	-	-
APHV	13.1 (0.5)	13.5 (0.5)	NS	-	-	-
Height	176.8 (7.3)	170.7 (8.4)	NS	-	-	-
Height z-score	1.2 (0.9)	0.6 (1.1)	NS	-	-	-
Predicted Height	181.9 (5.8)	179.8 (5.7)	NS	-	-	-
Father's Height	178.4 (6.3)	178.3 (5.7)	NS	-	-	-
Mother's Height	167.3 (5.3)	166.3 (6.7)	NS	-	-	-
Weight	76.6 (17.8)	67.3 (9.5)	*	-	-	-

Weight z-score	2.0 (1.7)	1.2 (0.9)	*	-	-	-

*** p < 0.05**

Football players (Table 5.2.6) had a significant difference between the age of the selected and not-selected athletes (Age 14.9 (0.4) vs 14.5 (0.6)) ($p < 0.05$). On average, football players who were selected also had significantly higher bodyweights (76.6 (17.8) kg vs 67.3 (9.5 kg) ($p < 0.05$).

5.3 – Effects of Team Selection on Long Term Sports Participation

The final hypothesis was that being non-selected for a team would lead to greater decreases in long-term sports participation of the tryout sport. Athletes were asked in the SPA questionnaire at study initiation, six month, and thirty-six month follow-up intervals to indicate their main sport in which they participated and this was compared to the sport that they tried out for. At study initiation for the entire sample, 81% of participants indicated the sport at selection camp was their main sport, at six month this was 82% and at 36 months this had dropped to 75%.

When comparing athletes who were selected versus not selected, at study initiation 82% of those successfully selected listed the sport at selection camp as the main sport they participated in compared to 79% of those not selected. At 6 months 91% of those selected indicated it was their main sport compared to 74% of not selected. By 36 months these values were 84% for selected and 68% of not selected (see Table 5.3.1).

Cutting athletes in this sample also did not lead to major sport dropout. At 36 months only 4% of athletes not-selected were no longer taking part in any forms of sports activities, compared to 1% in selected athletes.

Table 5.7 – Percentage of Athletes Who Indicated Tryout Sport Was Their “Main” Sport

	Study Initiation	**6 Month Follow-Up**	**36 Month Follow-Up**
Selected Athletes	82%	91%	84%
Non-Selected Athletes	79%	74%	68%

When looking at the sample split only by selection groups, Table 5.3.1 shows the pattern that was expected by the hypothesis. Athletes who were selected at provincial team tryouts showed higher rates of reporting tryout sport as their main sport at six-month follow-up. Athletes who were not selected during provincial tryouts showed decreasing rates of reporting tryout sport as their main sport at six-month follow-up. Interestingly, both selection groups saw a decrease in tryout sport participation between six and thirty-six month follow-up.

Table 5.8 – Percentage of Selected Athletes Who Indicated Tryout Sport Was Their "Main" Sport

	Study Initiation	36 Month Follow-Up
Soccer	84%	96%
Volleyball	75%	90%
Hockey	89%	86%
Basketball	83%	100%
Baseball	89%	33%
Football	51%	57%

Within the sample of selected athletes, the between sport data shows more variation in long-term reporting. Soccer, volleyball, basketball and football all showed higher rates of being an athlete's main sport after being selected. In contrast, hockey and baseball had decreased rates of athlete's claiming it as their main sport.

Table 5.9 – Percentage of Non-Selected Athletes Who Indicated Tryout Sport Was Their "Main" Sport

	Study Initiation	36 Month Follow-Up
Soccer	88%	79%
Volleyball	84%	71%
Hockey	85%	79%
Basketball	76%	75%
Baseball	78%	13%
Football	31%	56%

In the sample of non-selected athletes, all sport groups supported the hypothesis that being not-selected would lead to a decrease in reporting the tryout sport as their main sport, with one exception. Football actually saw a notable (25%) increase in athletes reporting it as their main sport even when athletes were not successful at provincial tryouts.

6.0 Discussion

In 2007, a study was performed which examined the heights, weights, birth dates, and maturity of male hockey players aged 14-15 in Saskatchewan (Sherar et al., 2007). In that study, they found that hockey players who were selected for the team were taller, heavier, and more mature than the players who were not selected, as well as compared to an age-matched control group. The results of our study show that over the last decade, things seem to be improving for sports in Saskatchewan. The effects of growth and maturation on team selection are less pronounced or not significant at all in the six sports observed. The RAE, however, is proving to be more pervasive than previously thought. The RAE did not affect selection because by the time adolescents were trying out for provincial sport teams, the sample of athlete birthdates was already skewed to the first two quartiles of the year.

It is good to remember when viewing these results that although the results may seem causal, the study of this design was never to be causal but rather to observe the relationships between certain variables. An individual's growth and maturation do not cause them to be selected or not selected for a team, but there are relationships between the types of athlete selected for each sport.

In the analysis of birthdate quartiles within different sports, we demonstrated that in certain sports the RAE has already had an effect prior to provincial team tryouts. Female soccer, male hockey, and male basketball all showed unequal birthdate quartile representation in the athletes who were trying out for the team. This finding suggests that in these groups the RAE has already had a profound effect prior to adolescence on the athlete group. At some time during childhood, athletes from certain birth month quartiles have already been preferentially selected causing an overrepresentation of quartiles in the sample later during adolescence. For example, club soccer players in Saskatchewan are separated into "Premier", "Division II", and "Division III" teams as early as under eleven years of age (http://aurorasoccer.ca/page.php?page_id=96925).

Once athletes are separated into sport by sex by selection groups, only not selected male hockey players and not selected male basketball players showed a significant difference from the general population for birthdate quartile distribution. This may seem surprising when we look, for example, at selected male basketball players and see that there are no athletes who were selected from the quartile 4 birth months. The reason for the lack of significance is likely because the sample becomes too small once you factor selection into the grouping variables. Therefore, the first hypothesis is false. Athletes who were selected for teams were not more advanced in CA or birth month quartile than non-selected athletes; but recall that the entire sample was already skewed towards the first two quartiles of the year.

The comparison between athletes who were selected and not selected revealed that there are few discrepancies between the age, maturity, height, weight, parental height, or predicted final height. For example, while hockey showed a significant difference ($p < 0.05$) in Table 5.1 between APHV, height, and weight, the differences between the means of the groups are so small that they likely have no real-world implications. The same can be said for the significant difference ($p < 0.05$) found between the maternal height of male basketball players who were selected versus not-selected (Table 5.3). Consequently, the second and third hypotheses are also false. Selected athletes were not older, taller, heavier, or more mature, and if they were, the effect size shows the differences were negligible. In fact, an interesting finding in the case of male soccer players (Table 5.4) proved the opposite to be true: athletes selected were on average younger, shorter, and weighed less. Anecdotally there could be logical explanations for this. One would be the emphasis in soccer on faster and more agile players. The second cause could be that soccer has not achieved the same level of popularity in Canada as ice hockey (Statistics Canada, 2011). In Europe, where soccer is more popular, the results of team tryouts showed similar results to Canadian hockey tryouts (Helsen, Van Winckel, & Williams, 2005). This and other anecdotal reasons could potentially explain Canadian soccer's inverse result, but none are backed in the scientific literature.

In football players (Table 5.4) a significant difference ($p < 0.05$) was found between the age and weight differences of the athletes who were selected and not-selected. While the difference in age is negligible, the difference in weight is not. There is a direct correlation between bodyweight and strength (Hasan, Kamal, & Hussein, 2016), and many coaches of contact sports identify strength as an indicator of sports performance. It is no surprise that football coaches select heavier athletes.

Finally, Table 5.5 showed that female volleyball players who were successful at tryouts were older, taller, and had a higher final predicted adult height, but the actual differences between the groups were again too small to be considered as preferential selection of taller athletes.

To summarize, while this study showed statistical significance between groups, there was no biological significance. For example, when comparing selected and not selected hockey players, a difference in height of 1.4 centimeters was considered statistically significant. This difference in height would not be taken into consideration by coaches in charge of team selection, especially because the difference would be hard to see even with exact measurements. The low number of meaningful biological differences between athletes who were selected and not-selected should be very encouraging, especially to the many researchers and coaches who have worked to combat the effects of the RAE. In fact, the only sport grouping where the differences may have had real biological significance were in male soccer, which actually showed the complete opposite of what would be expected from the RAE (i.e. soccer selects smaller, lighter, less mature athletes). In the last decade it seems coaches have become much better at selecting athletes based on potential talent as opposed to just selecting the athlete who is currently bigger and more mature.

The analysis on the effect of team selection on long term (36 month) sport participation showed a particular trend in soccer, basketball, and volleyball. In these three sports specifically, athletes who were selected during adolescence were more likely to report that same sport as their main sport 36 months later. Athletes who were not selected for these sports were also more likely to report that after 36 months a new sport had become their main, supporting the fourth hypothesis. In these three sports, adolescence is clearly a time of specialization and recognizing longevity in the sport. In this study, athletes who did not make a provincial team by adolescence reported lower rates of participating in their tryout sport.

Hockey players who were both selected and not selected showed decreasing rates of indicating hockey as their main sport after 36 month follow up; however, the drop for both groups was small (3% and 6% decrease respectively). With such a large cultural following and number of hockey players in Canada, it is likely that athletes find continued opportunities to play competitively or at a recreational level. An interesting follow up study for this cohort would be to examine the rates of drop-out from sport due to injuries and concussions.

Football saw an increase in athletes reporting as a main sport for both selected and not selected groups. This could indicate that football programs are currently doing a good job of preventing drop out of sport and ensuring that both selected and not selected athletes can remain involved. Saskatchewan also boasts one of the strongest fan bases for Canadian professional football which has boosted the popularity of the sport (https://www.tsn.ca/the-rouge-ranking-the-health-of-cfl-franchises-1.598564). For this sample group, the fourth hypothesis was false. Another likely explanation to the increase in football participation could be the time of year in which the follow-up data was collected. The 36 month surveys were sent to the athletes at the start of the 2017 school year in the month of September. During this time the high school football season is underway which may have led to a higher reporting in football participation.

Lastly, baseball saw large drops in the number of athletes who reported baseball as their main sport for both selected and not selected groups (56% and 65% decreases respectively). Baseball likely lacks the strong cultural following and professional scene in Saskatchewan to motivate youth to compete to play baseball for a long-term professional career. Baseball is also the only sport in this study that does not have high school baseball teams in Saskatoon, which means that after provincial team tryouts are done, there is no high school team to fall back on for selected and not selected athletes. With regards to the fourth hypothesis, it was true that baseball players who were cut decreased rates of participation in baseball, but this was true also for players who were successful at tryouts, and the dropout rates for this particular sport are large.

A positive finding showed that only 1% of selected athletes and 4% of not selected athletes discontinued sport participation in all forms.

The current structure of how athletes transition into and out of high school sports also contribute to the high levels of cutting and changes in sport participation that occurs during team tryouts. In Saskatoon, there are many elementary schools which have competitive sports teams, and often they will have more than one team per sport. These elementary school teams become feeder teams for the smaller number of high schools in Saskatoon. Having numerous different elementary schools feed into one high school creates a massive athlete pool which coaches must select athletes from, and the pressure for teams to be competitive at the high school level is higher. This process happens once again when the athletes leave high school and see that for all of the high school teams, there are much fewer University or College level programs to tryout for.

To summarize, the two main objectives of the SPRI study were to examine whether an athlete's growth and maturation could be identified as potential barriers to sports participation, and to also examine the relationships between growth, maturation, and team selection. The answer to these questions is that growth and maturation do not seem to be a barrier to participation in sport, nor do they have a significant relationship to team selection and long-term sport participation. However, these results are exclusive to this sample in Saskatchewan, and more research needs to be done in this area. This study supports the past literature of the prevalence of the RAE, and also expands upon it by showing that the effects can be mitigated over time.

6.1 – Limitations

For this study, the effects of age and maturation were to be examined on team selection results. As mentioned in section 4.1, the first limitation is that I was not present at the inception of the study or the decision as to which measures and which surveys to use. I relied on the expertise of those involved in the original drafting of the SPRI to choose the most valid measures and surveys to answer these research questions. Similarly, I was not present at the baseline collection of data at tryouts, so I am unable to say how accurate or reliable the data collection was, although the data collectors were familiarized and trained in proper data collection of anthropometric measures.

A large study limitation when looking at the relationship between growth, maturation, and team tryouts is that all of the female participants were past the age of menarche and APHV, meaning that there could be no comparison between somatic maturity groups. With the average APHV for females being ten to twelve years of age, studies wishing to examine these variables further should be done before adolescence is reached.

The goal of this study was to compare the athletes who were selected versus not selected when they were split by sex and sport groups. The sample size for all the study participants was large, but once the sample was split into sport, sex, and selection groups, each sample became much smaller, making it harder to find statistical significance between group means.

Another limitation is that this sample represents athletes who are trying out for provincial sport teams and represent a higher skill level of athlete than what you would see on the average high school team. Growth and maturation may not be key players when all the athletes are skilled, but in high schools where the skill levels could vary drastically it is likely that advanced age, growth, and maturation could override potential talent when teams are selected. This is likely also true when examining the effects of team tryouts on long-term sports participation. Athletes trying out for provincial teams are trying to be elite, and would probably be much more likely to find a new medium for competition if they were not selected at tryouts, as opposed to a high school athlete trying out who may not have the skills or athletic background to fall back onto another sport after being cut.

Similarly, less significance may have been found in this sample because much of the research regarding growth and maturation as barriers to sport participation began in this province. Things have improved over the last decade in Saskatchewan, but most of the education towards coaches and talent scouts was piloted there. This same study done in any other province in Canada could yield drastically different results.

Lastly, the entire sample showed DOB skewness to the first two quartiles of the year, indicating that preferential selection of older and more mature athletes has already happened before adolescence and prior to the initiation of this study.

6.2 – Future Directions

While the RAE is an old concept, it seems to be as prevalent as ever. In this study, growth and maturation were shown to have no significant relationships to team selection, but the RAE was so rampant that the entire sample was skewed towards having birthdates earlier in the year. Studies that wish to examine the effects of the RAE on sport selection and participation should start at a younger age. Adolescence is too late, and the RAE has already caused a skewness in the sample of participants. Studies wishing to examine the RAE should be done as early as teams begin splitting athletes into skill tiers (typically around nine to eleven years of age in Canada). For example, a longitudinal study following Canadian ice hockey players could measure age and anthropometrics and maturity of all the atom level teams (under eleven years of age) and track each athlete's team tryout success rates all the way to midget level teams (under 18 years of age). This would give great insight as to when the sample of athletes starts to see a shift towards the older athletes being preferentially selected. Since maturity has been recognized as a potential issue in CA banded teams, more data showing the efficacy of equations like the Mirwald equation (2002) in real world application would be helpful in the attempt to move teams towards "bio-banding" - grouping and/or evaluating athletes on the basis of size and/or maturity status, rather than chronological age (Cumming, Lloyd, Oliver, Eisenmann, & Malina, 2017).

A preliminary look into the benefits of bio-banding sports teams, the Elite Player Performance Plan (EPPP) in UK soccer recently trialled a bio-banded soccer tournament where players were grouped by biological maturity status rather than age (Cumming et al., 2017). Players described the experience as "positive and agreed that the bio-banded games presented them with unique challenges and a more diverse learning experience". The players also recommended that that the Premier League should continue to support this initiative (Cummings et al., 2017).

With regards to sport participation and dropout, the psychosocial factors should also be examined, such as parental factors, sport enjoyment factors, socioeconomic factors, as well as sociological and cultural factors. These can all be very fluid in the lifespan of an individual, so the information gathered in this study's longitudinal surveys will be beneficial to experts in this area.

While the design of this study was to observe quantitative variables and their relationship to team selection and long-term sports participation, more studies in this area should be done with a qualitative focus. Discussions and interviews with coaches would be highly beneficial to get an understanding of why they selected certain athletes and tryouts, and to recognise what rubrics each coach uses to quantify "talent". This could then be compared with exit interviews with athletes who may want to offer up why they think they were cut and to see if athletes offer more intrinsic or extrinsic factors for leaving sport. A qualitative study such as this could be pivotal in helping coaches provide better feedback to athletes after tryouts with the goal of making sure that all athletes continue in sport for life.

A metric worth exploring in future studies would be the concept of "Athletic Identity", and what role it had in an athlete's initial and continued participation in sport before and after team tryouts. The identity of a person is multidimensional, and one facet of an individual's personal identity is athletic identity. Athletic identity is "active" in an individual when they perceive that their role as an athlete is one of the most important aspects of life (Callero, 1985). The strength of a person's athletic identity is directly influenced by a number of factors such as sports participation, its outcomes, and feedback from an athlete's coaches or peers (Tasiemski, Kennedy, Gardner, & Blaikley, 2004). While some athletes have other strong areas of identity, others classify themselves only as an athlete (Brewer, Van Raalte, & Linder, 1993). When an athlete believes that their role as an athlete is the most or only important aspect of life, they are said to have exclusivity of the athletic identity (Brewer, Van Raalte, & Linder, 1993). The exclusivity of the athletic identity is an important factor to monitor when studying changes in sport participation because it can magnify the level of trauma experienced when sport participation ends. A future study which replicates this design but used athletic identity and other qualitative methods would be an excellent means to supplement the quantitative data of this study.

As was mentioned in the study limitations, the sample for this study was athletes trying out for a provincial team. Participants in this study would already be considered more elite than the average athlete on a high school sports team and are likely more resilient to the obstacles of age, growth, maturation, and team selection in sport. This study should be recreated, but preferably done on high school students in Saskatchewan. It would be safe to hypothesize that athletes in a high school setting may be more susceptible to the challenges of the RAE, delayed growth and maturation, and higher sport dropout following being cut during team selection. The comparison between the two studies would introduce new questions: does athletic skill have a potentially protective effect against the challenges of being younger, less mature, lighter, or being cut during tryouts? How can we start to quantify skill and better identify it?

Lastly, a key variable that would have been useful for more information on sport dropout would have been incidences of concussions and injuries, and how they influenced long-term sport participation rates. Concussions are a popular area of research in sport right now, and their influence on sport dropout has been noted. One study found that concussions are linked to dropout for a number of factors such as concerns about persistent symptoms, re-injury anxiety, a diminished perceived ability, lack of social support, and emotional turmoil and mental health problems (Hancock, 2018).

If given an opportunity to do this study again, I would have added to the collected measures rather than try to change them. The quantitative data collected shows that there are relationships between birth date quartile, growth, and maturation on team selection, but more questions would have helped to answer why this happens. There is no indication as to why the athletes tried out for the sport in the first place, whether their parents made them try out, whether they were recruited by the coaches of the teams, or if the athletes self-selected themselves. We saw that our sample's birth dates were skewed to the first two quartiles, but this is a sample that continues to self-select within itself and is not representative of a normal population. Questions to the athlete about their intrinsic or extrinsic motivators for being involved in sport would give further insight into how the sample of athletes becomes skewed in the first place. Factors of motivation could also then be compared from pre- and post-tryout to begin looking at actual causal reasons for sport dropout. As the research literature continues to identify variables that have a relationship with decreased sport participation, the interplay of these variables should be examined to identify strong causal factors for sport dropout.

Moving forward, the results of this study should also be used to further educate coaches on how the RAE can influence the athlete pool available for sports. The LTAD model discussed earlier is already being used by different coaching certifications to raise awareness on this issue. This study can be evidence for how the effects of the RAE can be mitigated over time. Coaches using this information should also consider that there are factors that may determine long-term athletic success in a sport, such as final predicted height. Sport governing bodies will hopefully understand that it is worth investing time and energy into late maturers if parental heights and predicted heights show that an athlete could have potential in the future. It should also be cautioned that coaches should be discouraged from using anthropometrics such as parental height and predicted final height as the only means of selecting future talent in a sport as this creates the same problems of segregating athletes.

7.0 Conclusion

When Drs Sherar, Baxter-Jones, Faulkner, and Russell did their initial study on male hockey players in 2007, they saw that there was a systematic issue with the way that hockey players were selected and not selected for sports teams. Athletes were statistically more likely to be chosen simply for having a birth date earlier in the calendar year. Having extra time to grow was deemed more important to coaches than evaluating true skill and future skill potential over the long term. Talent identification was short-sighted.

Thanks to the efforts of researchers bringing issues like this to the attention of coaches and educators, the results of this study can say that over the last decade much improvement has been made. In this study, it was shown that in sports like hockey and basketball the RAE is still skewing the athlete pool towards those selected earlier in the year, and more research needs to be done in examining team selection and talent identification at even younger levels of sport.

The differences between athletes who are selected and not selected in this new study were small and should encourage athletes in sport that coaches are doing their best to select the most talented players rather than those with the most advanced age, height, and weight.

The long-term sports participation follow-up should likewise be encouraging for governing sport bodies. Only 4% of athletes who were not selected for teams during adolescence ceased total sport participation, meaning that 96% of the other participants remained in either their original sport or migrated over to a new sport.

This study can also be offered as a small warning to the risks of early specialization of youth in sports. Rates of sport participation and physical activity have gone up, while rates of adolescence sport dropout have also continued to increase (Malina et al., 2004). In their Long-Term Athlete Development (LTAD) resource paper, Canada Sport for Life lists the consequences of early specialization in sport to be: one-sided sport-specific preparation, lack of fundamental sports skills, poor basic movements, overuse injuries, early burnout, and early retirement from training and competition (Balyi, Way, Norris, Cardinal, & Higgs, 2005). In order to ensure the long-term success of young athletes, the emphasis should be placed on participation in as many sports as possible. For example, the American Medical Society for Sports Medicine (2013) found that 9 out of 10 NCAA college athletes participated in more than one sport as a child (Harmon et al., 2013). Another study titled "The Path to Excellence" (2002) showed that of the American Olympians in the 1980s and 1990s, 88% of them participated in multiple sports growing up (Gibbons, 2002).

Dr Robert Chapman was also quoted as saying "Elite performers in senior sports tend to be the ones who mature later." A study done in 2013 supported this claim by comparing the performance of track and field athletes younger than the age of twenty versus those over the age of twenty. This study concluded that only 23.6% of the "successful" junior athletes enjoyed similar success as a senior, while also showing that only 29.9% of Olympian track and field athletes were also winners of junior championship medals (Indiana University, 2013).

Anyone who wishes to compare early and late maturers would do well to remember that the athletes who mature earlier are often not the ones who achieve senior-level or elite sporting success, despite the many competitive advantages that they enjoyed in their youth.

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Appendix A - Examples of Normal Adolescent Growth

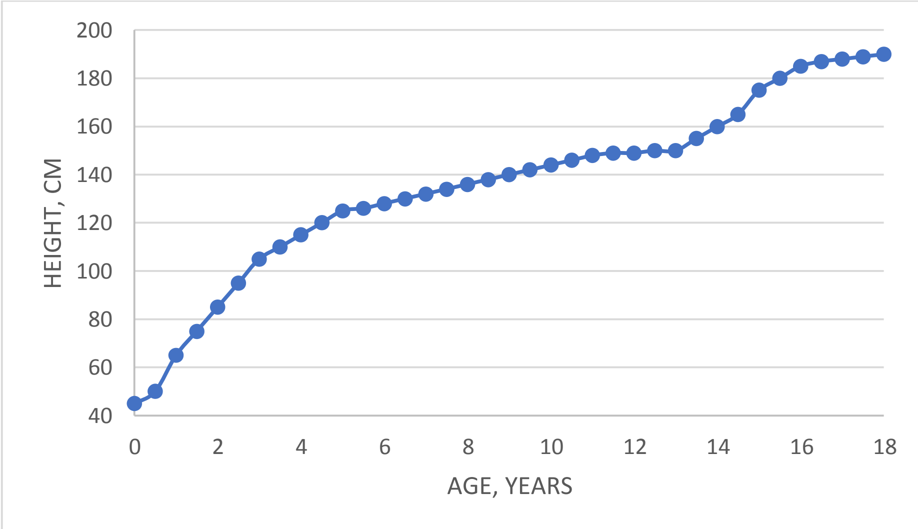

Figure A.1. Example of a distance curve, height attained at each age

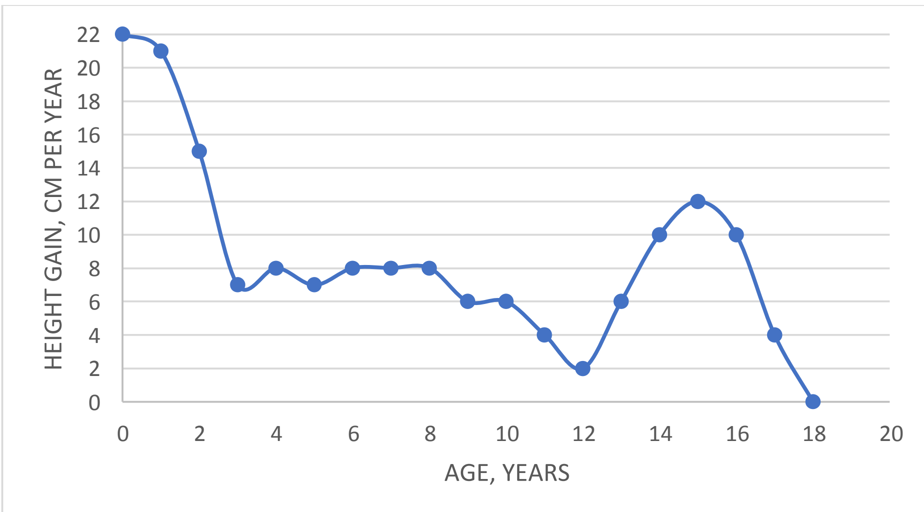

Figure A.2. Example of a velocity curve, increments in height from year to year

Appendix B - Example of Standard Height Velocity Graph

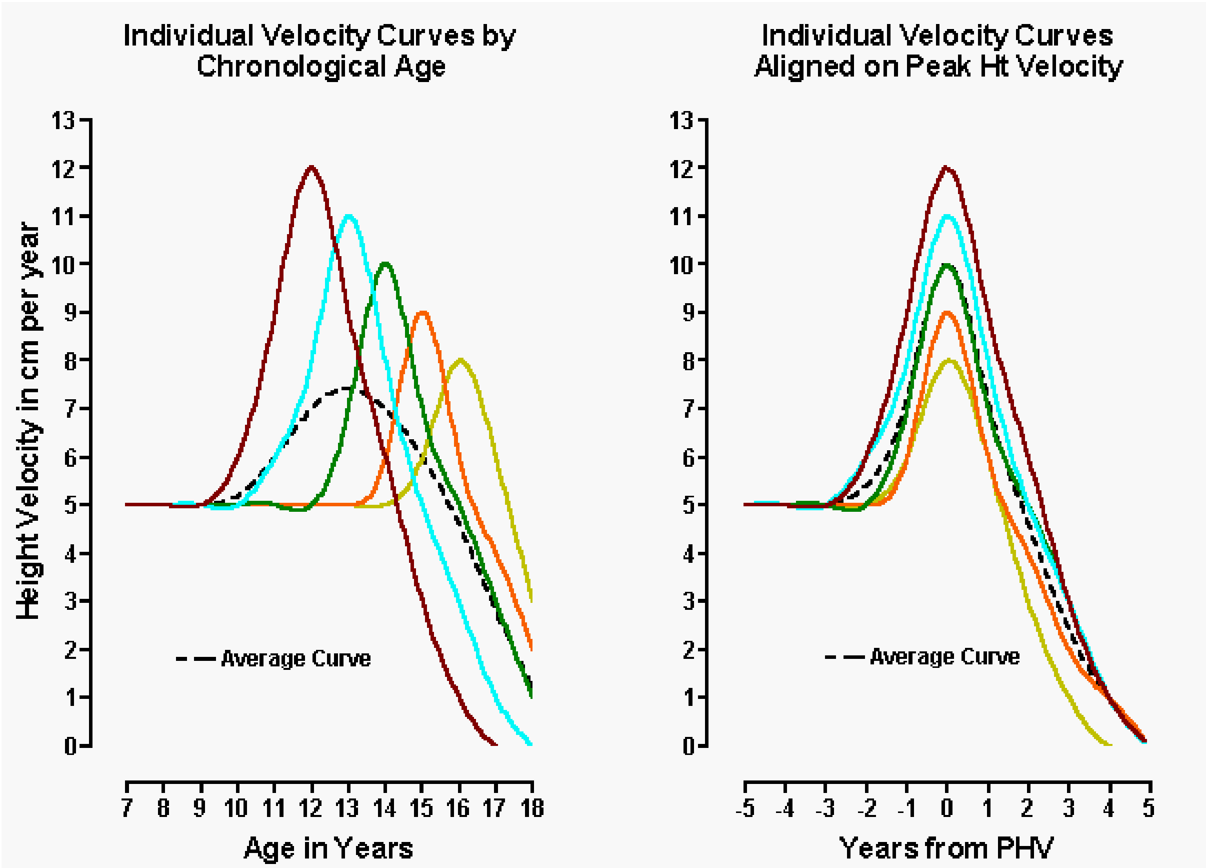

Figure B.1. Example of Standard Height Velocity Graph

Five different individuals experience different timings and tempos of growth (left)
Aligning the five individuals based on Age of Peak Height Velocity (right)

Appendix C – Sports Participation Activities (SPA) Survey

Question 1: Did you regularly participate in any sports during the past 6 months?

Participate *means as an athlete/participant – not as a coach, official or administrator.*

Regularly *means at least once a week during the season or for a certain period of the year.*

Exclude:
Non-competitive aerobics, aquafit, bicycling for recreation/transportation only, body building/body sculpting, car racing, dancing, fishing, fitness classes, hiking, jogging, lifting weights (non-competitive) motorcycling, snowmobiling, and non-competitive walking.

(circle one)
1) Yes
2) No *proceed to Question 28*
3) Don't know *proceed to Question 28*

Question 2: Which sport did you participate in? (*Choose one sport for this question. You will have an opportunity to report other sports later in the questionnaire*)

Sport Participation description: ___________________________ □ Don't know

Question 3: How often, in season, did you participate in the above sport?

(circle one)
1) 2 to 3 times per month
2) Once or twice per week
3) 3 or more times per week
4) Don't know

Question 4: Do you participate in this sport primarily for competition *or* recreation?

(circle one)
1) Competition
2) Recreation

3) Don’t know

Question 5: Do you participate in *another* sport?

(circle one)
1) Yes
2) No *proceed to Question 13*
3) Don’t know *proceed to Question 13*

Question 6: Which sport did you participate in?

Sport Participation description: ___________________________ □ Don’t know

Question 7: How often, in season, did you participate in the above sport?

(circle one)
1) 2 to 3 times per month
2) Once or twice per week
3) 3 or more times per week
4) Don’t know

Question 8: Do you participate in this sport primarily for competition *or* recreation?

(circle one)
1) Competition
2) Recreation
3) Don’t know

Question 9: Do you participate in yet *another* sport?

(circle one)
1) Yes
2) No *proceed to Question 13*
3) Don’t know *proceed to Question 13*

Question 10: Which sport did you participate in?

Sport Participation description: **___________________________** □ Don't know

Question 11: How often, in season, did you participate in the above sport?

(circle one)
1) 2 to 3 times per month
2) Once or twice per week
3) 3 or more times per week
4) Don't know

Question 12: Do you participate in this sport primarily for competition *or* recreation?

(circle one)
1) Competition
2) Recreation
3) Don't know

Question 13: Did you participate in any competitions or tournaments in the past 6 months?

> ***Include*** *competitions between schools or between teams within a school or at work.*
>
> ***Exclude:***
> *Non-competitive aerobics, aquafit, bicycling for recreation/transportation only, body building/body sculpting, car racing, dancing, fishing, fitness classes, hiking, jogging, lifting weights (non-competitive) motorcycling, snowmobiling, and non-competitive walking.*

(circle one)
1) Yes
2) No *proceed to Question 22*
3) Don't know *proceed to Question 22*

Question 14: For which sport? *(Choose one sport for this question. You will have an opportunity to report other sports later in the questionnaire)*

Sport Participation description: **___________________________** □ Don't know

Question 15: Was it at the local, regional, provincial, or national level?

Competitions between schools or between teams within a school or at work should be recorded as "Other". Refer to the sport from question 14.

(mark all that apply)
1) Local
2) Regional
3) Provincial
4) National
5) Other – Specify: ______________________
6) Don't know

Question 16: Did you participate in *any other* competitions or tournaments in the past 6 months?

(circle one)
1) Yes
2) No *proceed to Question 22*
3) Don't know *proceed to Question 22*

Question 17: For which sport?

Sport Participation description: ___________________________ □ Don't know

Question 18: Was it at the local, regional, provincial, or national level?

Competitions between schools or between teams within a school or at work should be record as "Other". Refer to the sport from Question 17.

(mark all that apply)
1) Local
2) Regional
3) Provincial

4) National
5) Other – Specify: ______________________
6) Don't know

Question 19: Did you participate in *any other* competitions or tournaments in the past 6 months?

(circle one)
1) Yes
2) No *proceed to Question 22*
3) Don't know *proceed to Question 22*

Question 20: For which sport?

Sport Participation description: __________________________ □ Don't know

Question 21: Was it at the local, regional, provincial, or national level?

Competitions between schools or between teams within a school or at work should be record as "Other". Refer to the sport from Question 20.

(mark all that apply)
1) Local
2) Regional
3) Provincial
4) National
5) Other – Specify: ______________________
6) Don't know

Question 22: Do you have a coach?

A coach specializes in improving sport-specific performance in training and competition
Exclude: *Personal trainers and fitness instructors*

(circle one)
1) Yes

2) No
3) Don’t know

Question 23: Is sport very important, somewhat important, or not important in providing you with: physical health and fitness?

(circle one)
1) Very important
2) Somewhat important
3) Not important
4) Don’t know

Question 24: Is sport very important, somewhat important, or not important in providing you with: family activity?

(circle one)
1) Very important
2) Somewhat important
3) Not important
4) Don’t know

Question 25: Is sport very important, somewhat important, or not important in providing you with: new friends and acquaintances?

(circle one)
1) Very important
2) Somewhat important
3) Not important
4) Don’t know

Question 26: Is sport very important, somewhat important, or not important in providing you with: fun, recreation, and relaxation?

(circle one)
1) Very important
2) Somewhat important
3) Not important
4) Don’t know

Question 27: Is sport very important, somewhat important, or not important in providing you with: a sense of achievement and skill development?

(circle one)

1) Very important *proceed to Question 29*
2) Somewhat important *proceed to Question 29*
3) Not important *proceed to Question 29*
4) Don't know *proceed to Question 29*

Question 28: Are there any particular reasons why you did not regularly participate in any sports?

ONLY COMPLETE THIS QUESTION IF YOU* **DID NOT** *REGULARLY PARTICIPATE IN ANY SPORTS DURING THE PAST 6 MONTHS.

(mark all that apply)

1) No particular reason
2) Not interested
3) Programs not available in the community
4) Do not have the time
5) Do not want to be committed to regular schedule
6) Facilities not available
7) Too expensive
8) Health/Injury
9) Age
10) Disability
11) Participated casually only for leisure
12) Other – Specify: ____
13) Don't know

Question 29: During the past 6 months, have you been involved in amateur sport as a: coach?

(circle one)

1) Yes
2) No

3) Don’t know

Question 30: During the past 6 months, have you been involved in amateur sport as a: referee/official/umpire?

(circle one)
1) Yes
2) No
3) Don’t know

Question 31: During the past 6 months, have you been involved in amateur sport as a: helper or administrator?

(circle one)
1) Yes
2) No
3) Don’t know

Question 32: During the past 6 months, have you been involved in amateur sport as a: spectator at an amateur sports competition?

(circle one)
1) Yes
2) No
3) Don’t know

END OF QUESTIONNAIRE

Appendix D - Sport Enjoyment Questionnaire (SEQ)

We want to find out how much you enjoyed playing this sport during the most recent season. It is very important that you be completely honest in answering the questions. For each item, please circle the number that indicates your answer to the question. **PLEASE ANSWER THE QUESTIONS BASED ON THE ORIGINAL SPORT THAT YOU ATTENDED TRYOUTS FOR AT THE BEGINNING OF THE STUDY**

IF YOU WOULD PREFER TO ANSWER THESE QUESTIONS BASED ON A SPORT OTHER THAN THE ORIGINAL SPORT FOR WHICH YOU WERE TRYING OUT, PLEASE INDICATE SPORT HERE:

____

1. How much do you like playing this sport, in general?

9 – I love playing this sport
8 –
7 – I like playing this sport a lot
6 –
5 – I neither like nor dislike playing this sport
4 –
3 – I dislike playing this sport
2 –
1 – I really dislike playing this sport

2. How much fun did you have playing on this team this past season?

9 – A great deal
8 –
7 – A lot
6 –
5 – Some
4 –
3 – A little
2 –
1 – None at all

3. How much did you like playing for your coach?

9 – I loved playing for my coach
8 –
7 – I liked playing for my coach a lot
6 –
5 – I neither liked nor disliked playing for my coach
4 –
3 – I disliked playing for my coach
2 –
1 – I really disliked playing for my coach

4. How much do you like the other players on your team?

9 – I loved playing with this team
8 –
7 – I liked playing with this team a lot
6 –
5 – I neither liked nor disliked playing with this team
4 –
3 – I disliked playing with this team
2 –
1 – I really disliked playing with this team

5. How much did your parents like your coach?

9 – Really liked
8 –
7 – Liked a lot
6 –
5 – Neither liked nor disliked
4 –
3 – Disliked
2 –
1 – Really disliked

6. How much did your coach like you?

9 – Really liked me
8 –
7 – Liked me a lot
6 –
5 – Neither liked nor disliked me
4 –
3 – Disliked me
2 –
1 – Really disliked me

7. How much does your coach know about this sport?

9 – Everything
8 –
7 – Very much
6 –
5 – A fair amount
4 –
3 – Not much
2 –
1 – Almost nothing

8. How good is your coach at teaching kids how to play this sport?

9 – Excellent
8 –
7 – Good
6 –
5 – Average
4 –
3 – Not very good
2 –
1 – Poor

9. How important was winning for you this past season?

9 – Very important
8 –
7 – Important

6 –
5 – Somewhat important
4 –
3 – A little important
2 –
1 – Not at all important

10. How important was winning for your coach?

9 – Very important
8 –
7 – Important
6 –
5 – Somewhat important
4 –
3 – A little important
2 –
1 – Not at all important

11. How much would you like to play for this coach in the future?

9 – I would love to play for the coach
8 –
7 – I would like to play for this coach
6 –
5 – This coach would be OK to play for
4 –
3 – I would not like to play for this coach
2 –
1 – I would hate playing for this coach

12. Are you going to play this sport again next year?

9 – Definitely will play
8 –
7 – Probably will play
6 –
5 – Not sure
4 –
3 – Probably won't play
2 –
1 – Definitely won't play

END OF QUESTIONNAIRE

Appendix E – Physical Literacy Assessment for Youth (PLAY) Inventory

* Regularly means at least once a week during the season or for a certain period of the year

PLAY*inventory*

Physical Literacy Assessment for Youth

Participant's Name ______________________ Gender: M F Age: _____

Place a check in the box if you have participated regularly in the activity during your leisure time (not in school or at work)
If you are a female, please recall any activities before the age of 12. If you are a male, please recall any activities before the age of 14.

	House chores		Triathlon		Zoomba
	Farm chores		Cycling		Spin classes
	Homework		BMX		Exercise classes
	Watching tv or movies		Mountain biking		Yoga
	Playing a musical instrument		Dirt biking or motocross		CrossFit
	Reading		Duathlon		Bowling
	Crafts		Inline skating		DVD/CD or home exercise
	Facebook or internet		Dog walking		Rock or wall climbing
	Playing "active" video games		Hiking		Fencing
	Playing video games		Skipping		Martial arts
	Swimming		Cross-country running		Boxing
	Swimming lessons		Trail running		Table tennis
	Waterskiing		Running		Track and field
	Wakeboarding		Jogging		Dance
	Surfing		Walking		Gymnastics
	Kiteboarding		Geocaching or orienteering		Weight training
	Synchronized swimming		Playing tag		Body building
	Canoeing		Cheerleading		Baton twirling
	Rowing		Scooter		Badminton
	Curling		Playground		Tennis
	Diving		Equestrian		Hunting
	Skating		Mountain climbing		Racquetball
	Snowshoeing		Jumping rope		Squash
	Snowboarding		Golf		Target shooting
	Tobogganing		Fishing		Archery
	Downhill skiing		Gardening		Playing catch
	Cross-country skiing		Skateboarding		Sailing
	Kayaking		Soccer		Football
	Basketball		Volleyball		Trampoline
	Shoveling Snow		Hockey		Ringette
	Figure Skating		Speed Skating		Ultimate
	Baseball		Softball		Other:
	Other:		Other:		Other:
	Other:		Other:		Other:

For more information go to: physicalliteracy.ca/PLAY
or Canadian Sport for Life: canadiansportforlife.ca

CS4L PHYSICAL LITERACY
physicalliteracy.ca

Appendix F – Parenting Scale (PSI-II)

Parenting Scale (PSI-II): FATHER

INSTRUCTIONS The purpose of this questionnaire is to identify the overall environment that your father (or male guardian) creates for you. Please help us to more fully understand the role that your father plays in sport by indicating the extent to which you **agree or disagree** with the following statements. (Circle one response option to the right of each statement). **There are no right or wrong answers** so please don't spend too much time on any one statement; simply choose the answer that best describes how you view each statement. If you have no interactions with your father (or male guardian) in your daily life, please do NOT complete this questionnaire.

	Answer the following questions based on your experiences with your *FATHER*	Strongly Disagree	Disagree	Slightly Disagree	Neither Agree nor Disagree	Slightly Agree	Agree	Strongly Agree
1.	My father doesn't really like me to tell her my troubles.	1	2	3	4	5	6	7
2.	My father hardly ever praises me for doing well.	1	2	3	4	5	6	7
3.	My father really expects me to follow family rules.	1	2	3	4	5	6	7
4.	My father tells me that her ideas are correct and that I shouldn't question them.	1	2	3	4	5	6	7
5.	I can count on my father to help me out if I have a problem.	1	2	3	4	5	6	7
6.	My father really lets me get away with things.	1	2	3	4	5	6	7
7.	My father respects my privacy.	1	2	3	4	5	6	7
8.	If I don't behave myself, my father will punish me.	1	2	3	4	5	6	7
9.	My father spends time just talking to me.	1	2	3	4	5	6	7
10.	My father gives me a lot of freedom.	1	2	3	4	5	6	7
11.	My father makes most of the decisions about what I can do.	1	2	3	4	5	6	7
12.	My father points out ways I could do better.	1	2	3	4	5	6	7
13.	When I do something wrong, my father does not punish me.	1	2	3	4	5	6	7
14.	My father and I do things that are fun together.	1	2	3	4	5	6	7
15.	My father believes I have a right to my own point of view.	1	2	3	4	5	6	7

Appendix G – Children and Youth Physical Self Perception Profile (CY-PSPP)

Children and Youth Physical Self Perception Profile (CY-PSPP)

What I Am Like

Sample Sentence

	Really True for me	Sort of True for me				Sort of True for me	Really True for me
(a)	☐	☐	Some kids would rather play outdoors in their spare time	**BUT**	Other kids would rather watch T.V.	✓	☐
1.	☐	☐	Some kids do very well at all kinds of sports	**BUT**	Other kids *don't* feel they are very good when it comes to sports.	☐	☐
2.	☐	☐	Some kids feel *uneasy* when it comes to doing vigorous physical exercise	**BUT**	Other kids feel *confident* when it comes to doing vigorous physical exercise.	☐	☐
3.	☐	☐	Some kids feel that they have a good-looking (fit-looking) body compared to other kids	**BUT**	Other kids feel that compared to most, their body *doesn't* look so good.	☐	☐
4.	☐	☐	Some kids feel that they *lack* strength compared to other kids their age.	**BUT**	Other kids feel that they are stronger than other kids their age.	☐	☐
5.	☐	☐	Some kids are *proud* of themselves physically	**BUT**	Other kids *don't* have much to be proud of physically.	☐	☐
6.	☐	☐	Some kids are often *unhappy* with themselves	**BUT**	Other kids are pretty *pleased* with themselves.	☐	☐
7.	☐	☐	Some kids wish they could be a lot better at sports	**BUT**	Other kids feel that they good enough at sports.	☐	☐
8.	☐	☐	Some kids have a lot of stamina for vigorous physical exercise	**BUT**	Other kids soon get out of breath and have to slow down or quit.	☐	☐
9.	☐	☐	Some kids find it *difficult* to keep their bodies looking good physically	**BUT**	Other kids find it *easy* to keep their bodies looking good physically.	☐	☐
10.	☐	☐	Some kids think that they have stronger muscles than other kids their age	**BUT**	Other kids feel that they have weaker muscles than other kids their age.	☐	☐

	Really True for me	Sort of True for me				Sort of True for me	Really True for me
11.	☐	☐	Some kids *don't* feel very confident about themselves physically	**BUT**	Other kids really feel good about themselves physically.	☐	☐
12.	☐	☐	Some kids are *happy* with themselves as a person	**BUT**	Other kids are often *not* happy with themselves.	☐	☐
13.	☐	☐	Some kids think they could do well at just about any new sports activity they haven't tried before	**BUT**	Other kids are afraid they might *not* do well at sports they haven't ever tried.	☐	☐
14.	☐	☐	Some kids *don't* have much stamina and fitness	**BUT**	Other kids have *lots* of stamina and fitness.	☐	☐
15.	☐	☐	Some kids are *pleased* with the appearance of their bodies	**BUT**	Other kids wish that their bodies looked in better shape physically.	☐	☐
16.	☐	☐	Some kids *lack* confidence when it comes to strength activities	**BUT**	Other kids are very confident when it comes to strength activities.	☐	☐
17.	☐	☐	Some kids are very *satisfied* with themselves physically	**BUT**	Other kids are often *dissatisfied* with them-selvers physically.	☐	☐
18.	☐	☐	Some kids *don't* like the way they are leading their life	**BUT**	Other kids *do* like the way they are leading their life.	☐	☐
19.	☐	☐	In games and sports some kids usually *watch* instead of play	**BUT**	Other kids usually *play* rather than watch.	☐	☐
20.	☐	☐	Some kids try to take part in energetic physical exercise whenever they can	**BUT**	Other kids try to *avoid* doing energetic exercise if they can.	☐	☐
21.	☐	☐	Some kids feel that they are *often* admired for their good-looking bodies	**BUT**	Other kids feel that they are *seldom* admired for the way their bodies look.	☐	☐
22.	☐	☐	When strong muscles are needed, some kids are the *first* to step forward	**BUT**	Other kids are the *last* to step forward when strong muscles are needed.	☐	☐
23.	☐	☐	Some kids are *unhappy* with how they are and what they can do physically	**BUT**	Other kids are *happy* with how they are and what they can do physically.	☐	☐
24.	☐	☐	Some kids *like* the kind of person they are	**BUT**	Other kids often wish they were someone else.	☐	☐

	Really True for me	Sort of True for me				Sort of True for me	Really True for me
25.	☐	☐	Some kids feel that they are *better* than others their age at sports	**BUT**	Other kids *don't* feel they can play as well.	☐	☐
26.	☐	☐	Some kids soon have to quit running and exercising because they get tired	**BUT**	Other kids can run and do exercises for a long time without getting tired.	☐	☐
27.	☐	☐	Some kids are *confident* about how their bodies look physically	**BUT**	Other kids feel *uneasy* about how their bodies look physically.	☐	☐
28.	☐	☐	Some kids feel that they are *not* as good as others when physical strength is needed	**BUT**	Other kids feel that they are among the *best* when physical strength is needed.	☐	☐
29.	☐	☐	Some kids have a positive feeling about themselves physically	**BUT**	Other kids feel somewhat negative about themselves physically.	☐	☐
30.	☐	☐	Some kids are very *happy* being the way they are	**BUT**	Other kids wish they were *different*.	☐	☐
31.	☐	☐	Some kids *don't* do well at new outdoor games	**BUT**	Other kids are *good* at new games right away.	☐	☐
32.	☐	☐	When it comes to activities like running, some kids are able to keep on going	**BUT**	Other kids soon have to quit to take a rest.	☐	☐
33.	☐	☐	Some kids *don't* like how their bodies look physically	**BUT**	Other kids are *pleased* with how their bodies look physically.	☐	☐
34.	☐	☐	Some kids think that they are strong, and have good muscles compared to other kids their age	**BUT**	Other kids think that they are weaker, and *don't* have such good muscles as other kids their age.	☐	☐
35.	☐	☐	Some kids wish that they could feel better about themselves physically	**BUT**	Other kids *always* seem to feel good about themselves physically.	☐	☐
36.	☐	☐	Some kids are *not* very happy with the way they do a lot of things	**BUT**	Other kids think the way they do things is *fine*.	☐	☐

END OF "WHAT I AM LIKE" QUESTIONNAIRE

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