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ONTARIO ICE-HOCKEY PARTICIPATION FOR MALE YOUTH BETWEEN THE AGES OF 10 AND 15 YEARS: AN EXAMINATION OF THE RELATIONSHIP BETWEEN RELATIVE AGE AND DROPOUT RATES

Srdjan Lemez
University of Windsor

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by

Srdjan Lemez

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Ontario Ice-Hockey Participation for Male Youth between the Ages of 10 and 15 Years:

An Examination of the Relationship between Relative Age and Dropout Rates

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Srdjan Lemez

APPROVED BY:

_____

Dr. J. Baker, External Examiner
York University

_____

Dr. V. Stenlund
Faculty of Education

_____

Dr. S. Horton
Department of Human Kinetics

_____

Dr. P. Weir, Advisor
Department of Human Kinetics

_____

Dr. N. Azar, Chair of Defense
Department of Human Kinetics

17 May 2012

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ABSTRACT

Sport is one avenue through which positive youth development (PYD) can occur (Jones et al., 2011). While some aspects about sport participation are positive, structural issues and registration cut-off dates may detract from positive development. The relative age effect (RAE) suggests that athletes born in the first two quartiles of a given selection year experience a selection advantage and therefore a greater opportunity for success. The purpose of the present study was to examine the relationship between relative age and dropout rates of Ontario Minor Hockey Association male ice-hockey players from ages 10 to 15 years (n=14,325). From chi-square analyses, it appears that dropout was highest amongst players born in quartiles three and four [$\chi^2(3) = 12.85$, $p < .05$; $w = .03$]. The over-representation of dropouts in the relatively younger players represents an important finding in youth ice-hockey research that has not previously been systemically examined by researchers.

DEDICATION

I dedicate my thesis to my family, friends, and Ginny.

ACKNOWLEDGMENTS

Thank you to Dr. Patti Weir for her continued support, guidance, instruction, and enthusiasm over the past two years. Your dedication to the research project and knowledge created an enjoyable and memorable learning experience. I could not have asked for a better advisor to have mentored and prepared me for the pursuit of a Ph.D degree and a future career in academia.

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GLOSSARY OF TERMS

Positive Youth Development (PYD) - the engagement in *pro-social behaviours* and avoidance of *health compromising behaviours* and future *jeopardizing behaviours* (Roth et al., 1998)

- *Pro-Social Behaviour* - voluntary behaviour intended to benefit another (Eisenberg, Fabes & Spinrad, 2007)
- *Health Compromising Behaviour* - behaviours with potentially negative effects on health, such as substance use, early onset of sexual activity or unsafe sexual practices, risky driving, violent or suicidal behaviours, anti-social behaviours, and disordered eating, among others (Igra & Irwin, 1996)
- *Jeopardizing Behaviour* - behaviours that put you at risk or pose a threat*

Dropout - One who has withdrawn from a given social group or environment*

Dropout Rates - A measure of dropout with respect to a whole; a proportion*

Relative - Considered in comparison with something else*

Relative Age – The age of a person or player given relative to other persons or players*

Relative Age Effect (RAE) – immediate participation and long-term attainment constraints in sport, occurring as a result of chronological age, physical differences, and selection practices in annual age-grouped cohorts (Cobley et al., 2009)

Statistical Significance - not likely due to sampling error; a measure of the confidence that can be placed in a result as not being merely a matter of chance*

Practical Significance - asks the larger question about differences e.g., "Are the differences between samples big enough to have an applied meaning in the real world?"*

* Indicates definitions obtained from http://www.thefreedictionary.com

INTRODUCTION

Sport researchers have illuminated value in sport as a context for developing physical, psychological, and social benefits (Hedstrom & Gould, 2004). Growth and attainment of functionally valued behaviours such as personal skills, including social and emotional qualities, creates an intention for the child to become a healthy member of society ("Promoting positive youth," 2009). The acquisition of these learned life skills, competencies, assets, and values help shape what is known as *Positive Youth Development* (PYD), illustrating the potential for PYD through sport (Jones, Dunn, Holt, Sullivan, & Bloom, 2011). These concepts suggest that every child has the potential for successful and healthy development, and that all youth exhibit the capacity for positive development (Lerner et al., 2005).

Roth, Brooks-Gunn, Murray, and Foster (1998, p. 426) defined PYD as "the engagement in pro-social behaviours and avoidance of health compromising behaviours and future jeopardizing behaviours." Youth sport has the potential to accomplish important objectives in children's development, such as providing improvement in physical health, psychosocial development, and the learning of motor skills (Côté & Fraser-Thomas, 2007). Participation in sport is assumed by most to automatically lead to positive character building experiences (Bredemeier & Shields, 2006; Camire & Trudel, 2010; Coakley, 2006; Fraser-Thomas, Côté, & Deakin, 2005), yet youth sport has also been found to lead to dropout and negative development (Fraser-Thomas & Côté, 2006; Fraser-Thomas, Côté, & Deakin, 2008a; Fraser-Thomas, Côté, & Deakin, 2008b; Fraser-Thomas & Côté, 2009).

To prepare for a healthy and active future, youth sport programs should be developed in a way for youth to acquire personal competency that will ultimately assist them in living a healthier life (Damon, 2004; Park, 2004; Witt, 2002). From a positive perspective, perceived parental influences with healthier interactions, support, and encouragement have consequently supplied children with greater sport enjoyment, higher intrinsic motivation, and a larger preference for challenge (Scanlan & Lewthwaite, 1986). Peers (Fraser-Thomas et al., 2008a), coaches (Conroy & Coatsworth, 2006), and siblings (Côté, 1999) have also been found to be positive influential factors in children's development. Conversely, while a great deal about sport participation is positive, there are some structural issues in sport that may detract from positive development. Players who acknowledged exposure to poor relationships through parental pressure, peers and siblings, reported experiencing a difficult and challenging time during the course of their participation, potentially affecting their motivation for future participation (Augste & Lames, 2011).

Ultimately, the goal of youth sport programs should be to nurture children's intrinsic motivation for sport participation (Fraser-Thomas & Côté, 2006). Quality learning experiences in early life help these players develop perceptions of competence, leading to motivation and continued participation (Kirk, 2005). In turn, continued involvement may factor into the development of expertise in sport, which is influenced by a range of primary and secondary factors (Baker & Horton, 2004; Ericsson, Krampe & Tesch-Roemer, 1993). One secondary factor which affects a players' chance of gaining accessibility to high quality coaching and training is relative age (Schorer, Baker, Busch, Wilhelm, & Pabst, 2009).

Grouping players by age is a universal practice in sport, which serves as an organizational tool. Much like in school, the participants are grouped by chronological age to equalize competition, facilitate instruction, provide for program continuity, promote safety for the participants (Barrow & McGee, 1971), and provide developmentally appropriate training (Helsen, Starkes, & Winckel, 1998). Determined by sport organizations, its intention to balance the competition between players has been criticized with respect to generating important differences in relative age: children born in the same year can have nearly 12 months difference in age, and those who are competing in a category involving two consecutive years of birth can cause a 24 month less-a-day gap between players who are not born in the same year (Delorme, Boiche, & Raspaud, 2010a; Dixon, Horton & Weir, 2011). Consequently, annual age groupings appear to promote relative age effects (RAEs), which refer both to the immediate participation and long-term attainment constraints in sport, occurring as a result of chronological age, physical differences, and selection practices in annual age-grouped cohorts (Cobley, Baker, Wattie, & McKenna, 2009). Registration cut-off dates, initially intended to promote equity and fair play, have had the unintended consequence of creating these selection and participation inequalities. A child who turns five years old in January will be nearly 20% older than a child who has their fifth birthday in December (Addona, & Yates, 2010). This age gap could reflect a major developmental difference in physical maturity between the two players at the middle childhood and preadolescence stage. As a result, differences in developmental outcomes stemming from relative age have been shown to persist throughout the lifespan producing long-term social, emotional, and economic benefits, or detriments (Dixon et al., 2011).

According to the International Hockey Federation (IHF) and Hockey Canada's annual report, there are currently 572,411 registered ice-hockey players in Canada as of 2011 (IHF, 2011; Hockey Canada, 2011b). With a population of 34,030,589, 1.68% of the Canadian population are registered ice-hockey players, making it the highest percentage of ice-hockey participation for a country in the world (IHF, 2011; Hockey Canada, 2011b). This participation and popularity establishes Canada as hotbed for ice-hockey, however with such a high number of players the sport will also yield a high number of dropouts.

With sport playing a central role in health promotion of our youth, injury is one example that may influence dropout rates (Edouard, Pruvost, Edouard & Morin, 2010). Canadian youth ice-hockey injuries account for 10% of all youth sport injuries (Emery et al., 2010). Specifically, ice-hockey injury literature has denoted cerebral concussions to be the most common type of injury occurring from collisions, accounting for more than 15% of all boys' injuries in a study that pooled 60 injured players (Emery & Meeuwisse, 2006; Roberts, Brust & Leonard, 1999). Particular concern has been raised when examining the impact of traumatic brain injury and how body-checking can be attributed to increased injuries in ice-hockey (Warsh, Constantin, Howard & Macpherson, 2009). Relative size is a primary reason why injuries occur, where considerable size differences between relatively younger and older plays can result in upwards of a 53 kilogram (kg) difference in weight and 55 centimetre (cm) difference in height among puberty-aged players (Brust, Leonard, Pheley, & Roberts, 1992). Emery and colleagues (2010) also found smaller player size to be a risk factor for all injuries when examining Peewee players who were in a body-checking permitted league.

In addition to injuries, youth have stated that their dropout tendency primarily results from a lack of time to complete daily tasks (Figueiredo, Goncalves, Silva, & Malina, 2009). The need for more time to complete school work and the longevity of training and practices, along with lack of opportunity to play in games, lack of enjoyment in training, lack of recognition for effort, low perception of ability, conflict of interest**,** loss of motivation, and tiredness served as reasons why discontinued participation occurred (Cervello, Escarti, & Guzman, 2007; Edouard et al., 2010; Figueiredo et al., 2009). Dropout as a consequence of relative age may also be perpetuated by the organizational structure of minor league ice-hockey programs, as indicated by Barnsley and Thompson (1988), where dropout was found from as early as 11 years of age.

Dropout has shown its prevalence across an array of youth sports, ranging from gymnasts (Klint & Weiss, 1986) to soccer players (Delorme et al., 2010a; Figueiredo et al., 2009; Helsen et al., 1998; Helsen, Starkes, & Winckel, 2000) to basketball players (Delorme, Chalabaev, & Raspaud, 2011). It may be precipitated by several factors, including: physical growth, biological maturity, and sport-specific skills, which were found to influence attrition, sustainment, or playing at higher levels in youth soccer (Figueiredo et al., 2009). Despite this knowledge, researchers have not systematically examined the issue of ice-hockey dropout as a function of relative age sufficiently. To that end, the purpose of the present study was to examine the relationship between relative age and dropout rates of Ontario Minor Hockey Association (OMHA) male youth ice-hockey players. Specifically, the study tracked a male cohort of players (n=14,325) born in 1995, over a five-year period from ages 10 to 15 years. It was hypothesized that relatively younger participants, born in quartiles three and four, would have a higher

likelihood to dropout from ice-hockey in Ontario as opposed to the relatively older participants.

METHODS

Subjects

A secondary dataset provided by the OMHA was utilized in the present study. The dataset was provided in Excel format and contained player membership identification (ID) number, birthdate, gender, season(s) of enrolment extending from 2005 to 2010, level of play, and region. Player names were removed and coded into membership ID numbers by the OMHA. All male players registered with births in 1995 (n=14,325) were selected as an initial cohort and tracked by their membership ID numbers throughout the five subsequent years of participation in order to determine dropout. Players who joined in subsequent years were not included. The study was descriptive and longitudinal in nature, and was approved by the University of Windsor Research Ethics Board (REB)

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Participation & Dropout

Participation trends were tracked through the development of a custom-made software program that extracted data from the Excel spread sheet and inserted them into a relational database. After the data were in the database, another program was written that analyzed the data using a query language called My Structure Query Language (MySQL). From there, multiple queries were written for the different data that needed to be extracted for the purposes of the study. After the program calculated the results from its analysis, Hypertext Markup Language (HTML) was used to output the results to a readable webpage that was presented in a tabular format. Player participation data was presented from 2005 to 2010 and coded into a YES or NO based on whether their membership ID number was located in the respective year. For example, our initial cohort that began being tracked in 2005 all contained YES's, serving as inclusion criteria**,**

followed by a YES if they retained their participation in a subsequent year or NO if they ceased participation. Players were coded into a 0 or 1 if they were currently playing or had dropped out respectively. The validity of the program was checked through manually tracking 100 random participants throughout the dataset and verified against the program. The results from the manual calculation matched those produced by the software program.

Specific to the study, dropout was defined as those who did not participate in ice-hockey in two or more consecutive years, similar to Figueiredo and colleagues' (2009) dropout study involving soccer player participation. Players who returned to the OMHA after a two-year hiatus remained statistically labeled as dropped out. The potential impact of players competing in two-year age groups, which creates possibilities of players being relatively younger on a team although having birthdates in the earlier months of a selection year, was not accounted for. Based on Canadian ice-hockey age categories and the multiple tiers they produce, it would have been difficult to determine from the secondary dataset which players competed in two-year age groups and which did not.

Classification of Relative Age

In literature, annual age groupings are commonly broken down into quartiles when dealing with RAEs (Cobley et al., 2009). Based on an annual participation cut-off date of December 31st (Hockey Canada, 2011c), Canadian ice-hockey players' respective birthdates were coded and placed into quartiles consisting of three months each: Q1 = January, February, March; Q2 = April, May, June; Q3 = July, August, September; Q4 = October, November, and December.

Classification of Competition Level

Since all age divisions contain several competitive levels in which a player can compete, ranging from AAA to House League (HL), a ranked order exists based on community size and success. Generally, larger communities containing teams with a history of winning ice-hockey games will be placed in a higher competitive level such as the AAA division, and vice versa. The present study did not differentiate between the 15 levels of play, keeping the sample whole. Competition level was not reflected in the dropout rate results and is discussed further as a future direction.

Research Questions/Aims & Statistical Analyses

A hierarchy of analyses, which started from a broad to a more specific examination, was designed to answer three main research questions pertaining to the relationship between relative age and dropout rates among Ontario male youth ice-hockey players. All statistical analyses were performed using the Statistical Packages for the Social Sciences (SPSS) 20 computer program, and all data were evaluated at the $p \leq .05$ level of significance.

1. To address the overall pattern of dropout rates and examine the percentages of players who had two or more consecutive years of "NO", a descriptive table illustrating overall dropout rates and dropout within each quartile over the five years was designed through the custom-made software program. The pattern of dropped out and retained players within each birth quartile was of particular importance. Additionally, percentages of dropped out and retained players with respect to each quartile were calculated.

The present study used a within-groups design that assessed attrition and retention for players. A goodness-of-fit chi-square analysis to measure expected birthdate distributions of 25% per quartile, based on a general population distribution, versus actual birthdate distributions with respect to each quartile was performed for the initial 2005 player cohort. A second goodness-of-fit chi-square analysis was performed to examine dropout across the five years (2005-2010). This allowed assessment of the RAE pattern within the initial cohort as players left the sport.

2. The question of what the pattern of dropout rates looked like within each year of play with respect to birth quartile was examined. Specifically, likelihood estimates (odds ratios at 95% confidence intervals) were calculated using binary logistic regressions. Binary logistic regressions provided a probability of attrition and retention based on players' birthdates. Unadjusted (univariate) regression analysis was performed to facilitate a better understanding of the complex relationships among the independent variable of birth quarter and the formation of predictive equations through odds ratios (King, 2008). Additionally, this analysis revealed how statistics, odds, and dropout rates changed when being manipulated by birth quartile through changes in the values produced by the SPSS program.

3. Finally, the quartile containing the highest number of dropouts warranted further analysis. Using the custom-made computer software program, four comparisons were made: 2006/2007, 2007/2008, 2008/2009, and 2009/2010, and coded into a 1, 2, 3 or 4 with respect to the year in which the player dropped out. A nonparametric, one-sample chi-square test was then performed, which measured whether there was significance

against a uniform standard. Specific to the present study, dropout rates were assumed to occur at equal 25% frequencies among the four comparison groups. This analysis allowed the study to determine at what age the players who were born in the quartile most susceptible to attrition had a tendency to dropout.

The practical significance of the chi-square was determined using the *w* effect size statistic calculated by taking the square root of the chi-square divided by the number of subjects [$w = \sqrt{(\chi/n)}$]. Cohen (1992) proposed that results of 0.1, 0.3, and 0.5 represented small, medium, and large effect sizes, respectively. A *w* effect size statistic of ≥ 0.1 warranted further analyses. Post-hoc tests for statistically and practically significant chi-square analyses were conducted in the form of standardized residuals (SR). A value of ≥ 1.96 indicated an over-representation, while a value of ≤ -1.96 indicated an under-representation in relation to relative age distribution in the sample ($p = .05$).

RESULTS

To determine the birthdate distribution of the present sample, the birthdates of 14,325 registered ice-hockey players in Ontario in 2005 who were born in 1995 were compared. Chi-square analysis identified evidence of a RAE in the initial analysis of birthdate distribution [$\chi^2(3) = 170.35$, $p < .05$; $w = 0.10$]. An uneven distribution of birthdates across the overall sample was apparent: quartile one (Q1) = 3645 (25.4%); quartile two (Q2) = 4082 (28.5%); quartile three (Q3) = 3612 (25.2%); and quartile four (Q4) = 2986 (20.8%) (see Figure 1). Q2 showed an over-representation of players (SR = 8.36) while Q4 showed an under-representation of players (SR = -9.94). Comparing the birthdate distribution for players in the first and last six months of the selection year, 7727 (53.94%) players were born in the first six months after the registration cut-off date, and 6598 (46.05%) players were born in the last six months, July 1-December 31. The 7.89% difference in half-year birthdate distribution among the 14,325 participants depicts the majority of the sample having been born between the months of January 1-June 30. The initial birthdate distribution analysis is perhaps reflective of the general population since all competitions levels, ranging from AAA to HL, were included in the examination.

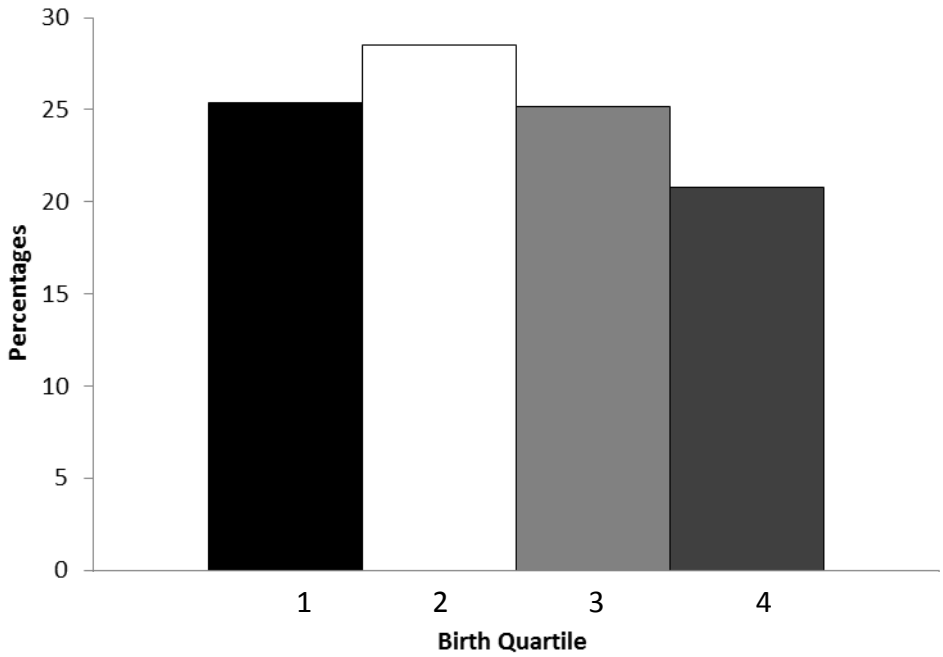

Figure 1. Birth quartile distributions across the overall sample (n= 14,325)

In terms of player attrition and retention over the five years (2005-2010), a total of 3,859 (26.9%) players dropped out, while 10,466 (73.1%) remained in the overall sample. An analysis performed on those players who dropped out revealed evidence of a RAE [$\chi^2(3) = 12.85$, $p < .05$; $w = .03$]. Given the magnitude of the *w* effect size, SR's were not calculated. Although the chi-square was statistically significant, practical significance was not attained due to the small effect size produced, likely having been driven by the large sample size (SS). In terms of the pattern of dropout rates, the highest percentage of dropout occurred in Q4, followed by Q3, both of which are in the last six months of the selection year.

Anchored to Q1, the results of the regression analysis revealed that players born in Q4 were 1.175 times more likely to dropout ($p = .003$). Players born in Q2 and Q3 did not portray a significantly higher or lower likelihood of dropout. See Table 1 for full results. Retained and dropout percentages are illustrated in Figures 2 and 3.

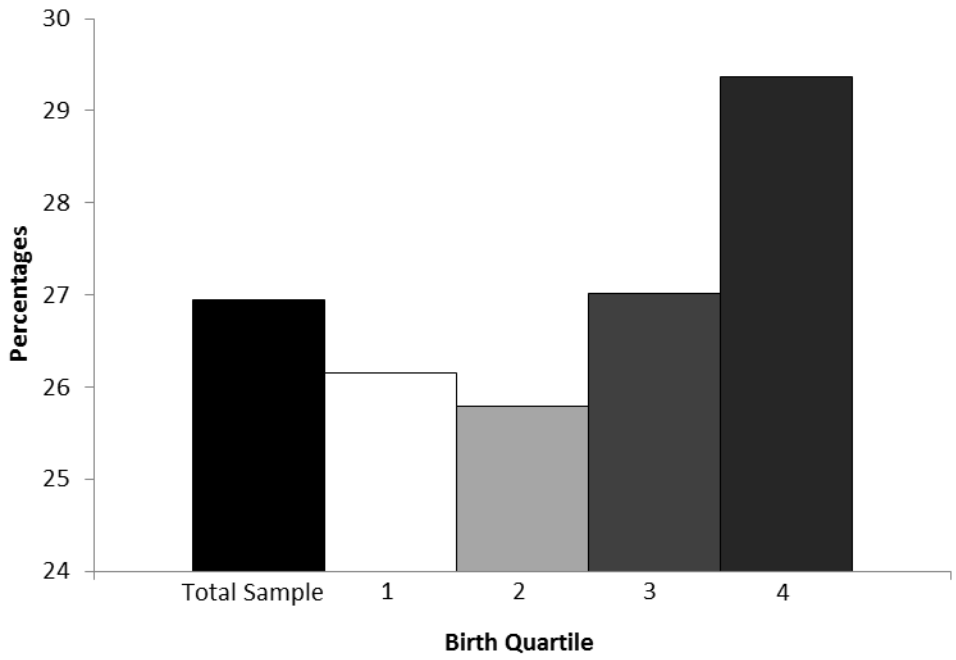

Figure 2. Dropped out player percentages across birthdate quartiles

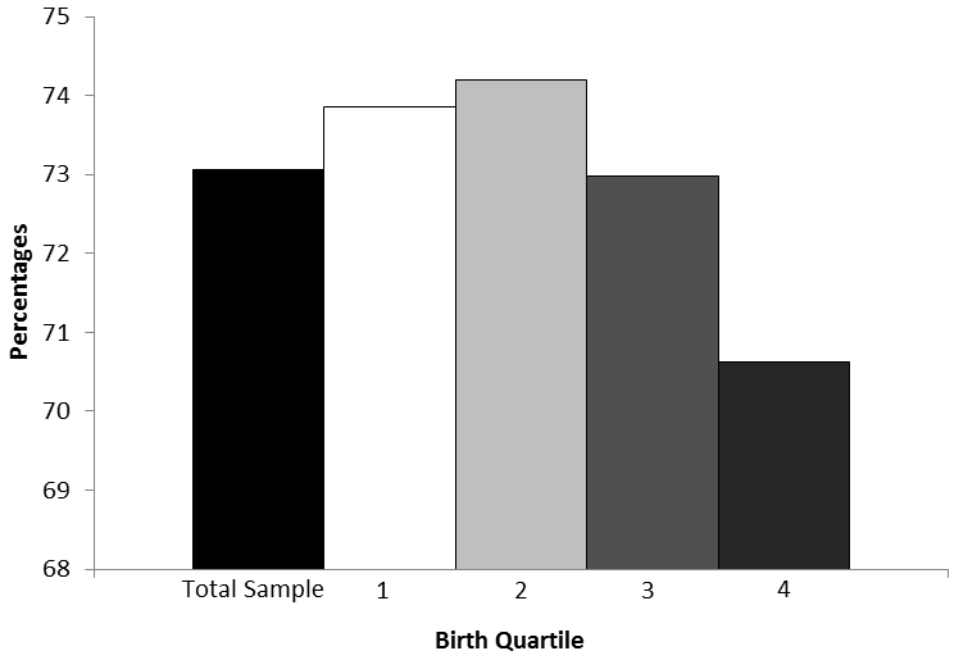

Figure 3. Retained player percentages across birthdate quartiles

Table 1. Goodness-of-Fit/Odds Ratios (Overall sample, years 2005-2010)

Measure	Q1	Q2	Q3	Q4
Chi-square $\chi^2(3) = 12.85$, $p < .05$; $w = .03$				
Dropped Out	953 (26.14%)	1053 (25.79%)	976 (27.02%)	877 (29.37%)
Retained	2692 (73.85%)	3092 (74.20%)	2636 (72.97%)	2109 (70.62%)
Odds Ratios	--	.982 (95% CI)	1.046 (95% CI)	1.175*(95% CI)

Note: $p < .05$; CI = Confidence Interval
*Statistical significance

With Q4 identified as the birth quartile containing players with the highest likelihood of dropout, further analyses of when the dropout occurred within the five-year ban was warranted. Frequency analyses showed the largest dropout rates in Q4 occurred between 2006 and 2007, where 271 (30.9%) players were found to have ceased participation, followed by 234 (26.68%) between 2008 and 2009, 195 (22.23%) between 2009 and 2010, and 177 (20.18%) between 2007 and 2008.

The one-sample chi-square supported the unequal dropout rates across years [$\chi^2(3) = 24.03$, $p < .05$; $w = 0.16$]. The patterns of Q4 dropout indicated an over-representation of dropouts in 2007 (SR = 3.49), and an under-representation in 2008 (SR = -2.85). Dropout results in Q4 are illustrated in Figure 4 and depicted in Table 2.

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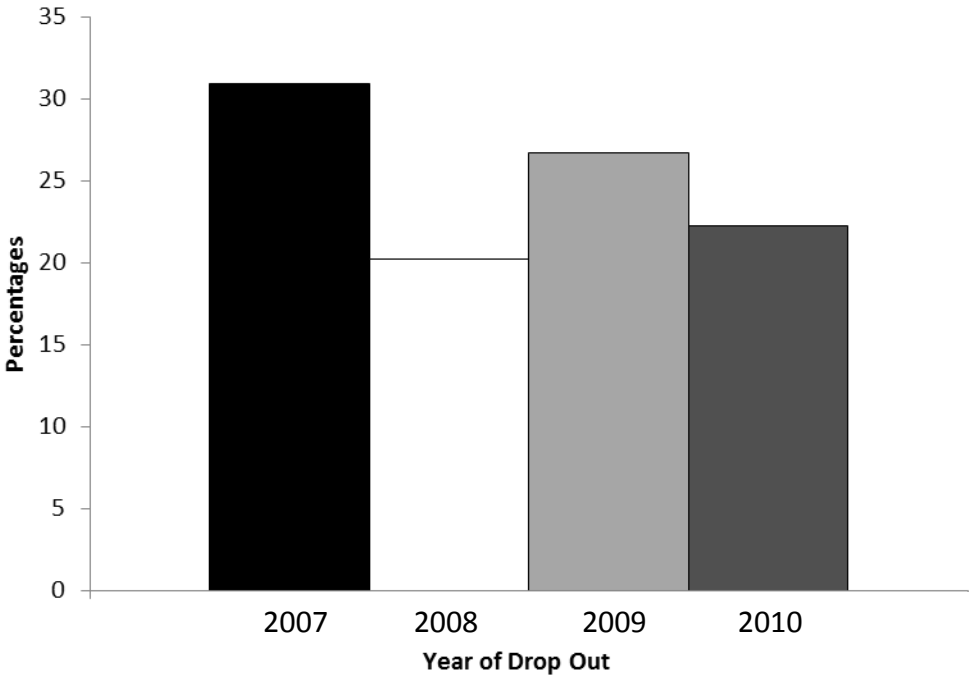

Figure 4. Percentage of Q4 players who dropped out in each year

Table 2. Q4 Dropout

Year of play (Coded number)	Frequency	Percent	Cumulative Percent	Age	Standardized Residuals
2007 (1)	271	30.9	30.9	12	3.49*
2008 (2)	177	20.2	51.1	13	-2.85*
2009 (3)	234	26.7	77.8	14	0.99
2010 (4)	195	22.2	100.0	15	-1.63
Total	877	100.0			

Note: $p < .05$; SR = ±1.96
* Statistical significance

DISCUSSION

The purpose of this research project was to examine the relationship between relative age and dropout rates in male youth ice-hockey in Ontario. It was hypothesized that relatively younger participants, born in quartiles three and four, would have a higher likelihood to dropout from ice-hockey in Ontario as opposed to the relatively older participants over the five-year span. This hypothesis was supported; the younger the player was on a team, the higher likelihood he would drop out of ice-hockey. This represents an important finding in youth ice-hockey literature that has not previously been systemically examined by researchers.

The birthdate distributions across the 2005 sample did not demonstrate a typical patterning of the RAE as the largest spike occurred in Q2 and not in Q1. While this may be a consequence of the birth rates trending towards a higher prevalence in Q2 among the general population, it was not possible to confirm this through available population statistic data. Coaches may also be becoming increasingly aware of the RAE and consciously avoiding selection of players born between January and March. Lastly, the sample itself creates further speculation as to why Q2 had the highest prevalence of birth rate, as the sample of 14,325 registered ice-hockey players covered a range of competition levels. Across a number of studies, competition level has emerged consistently as a precursor to the emergence of the traditional linear RAE pattern. The inclusion of non-elite players in the current sample may have skewed the birthdate distribution data.

Nevertheless, the uneven distribution of birthdates in the initial cohort of players supports a common trend regarding relative age in sport literature; team selection practices generally have a tendency to select players from the first and second birth quartiles, those that are relatively older, compared to those who were born in the third and fourth birth quartiles (Augste & Lames, 2011). Furthermore, the initial analysis based on 1995 birthdates set the stage of relative age playing a role in youth ice-hockey participation rates from the beginning of a player's career.

Musch and Grondin (2001) completed an extensive review of the RAE in sport, revealing that the effect is not only firmly established in ice-hockey, but present in most other sports. Concerning youth sport, the RAE is seen as a discriminatory effect through disadvantaging players who are born in quartiles three and four by compromising their chances to attain a competitive level in their respective sport (Delorme et al., 2011). Past literature involving youth sport dropout has highlighted the critical influence of significant others, such as parents, during sport participation (e.g., Fraser-Thomas et al., 2008b). As mentioned previously, parents (e.g., Scanlan & Lewthwaite, 1986), peers (e.g., Fraser-Thomas et al., 2008b), coaches (e.g., Conroy & Coatsworth, 2006), and siblings (e.g., Côté, 1999) have both positive and negative influences on sport participation. These past findings indicate potential reasons why youth drop out from sport, something outside the scope of this study. However, comparisons can be made with past literature concerning the RAE influencing sport dropout.

The pattern of relative age affecting youth sport dropout has been limited in its examination. Helsen and colleagues' (1998) and Delorme and colleagues' (2010a)

studies involving male soccer participation, and Delorme and colleagues' (2011) study on relative age and dropout in basketball are the only studies that have looked at the RAE as a factor in dropout from sport. Furthermore, Delorme, Boiche, and Raspaud (2010a) are the lone researchers to have reported empirical data on dropout distribution as a function of birth quarters (Delorme et al., 2010a; Delorme et al., 2011). This would make the present study one of the first longitudinal analyses that examined the distribution of birthdates of players that ceased participation from a particular sport.

Helsen and colleagues (1998) sampled 1,337 male youth soccer players ranging from ages six-16 years, finding that players born late in the selection year tended to dropout as early as 12 years of age, and from that age onwards, a higher number of dropouts occurred from those players born towards the end of the selection year. Additionally, Delorme and colleagues (2010a) sampled soccer players from the U-7 to the adult age categories, with their results portraying a linear increase in dropout percentage across the whole sample every two years from the U-7 (8.11% dropout rate) age category to the U-15 (21.76% dropout rate) age category, followed by another three percent increase in dropout rate in the U-18 (25.52% dropout rate) age category. With the SS exceeding 1.8 million, an over-representation of dropped out players born towards the end of the selection year was observed, whereas an under-representation of dropouts occurred in those born earlier in the selection year (Delorme et al., 2010a). These findings provide a snapshot of dropout rates as they were analyzed based on a single season.

Similarities between the aforementioned studies and the present study exist. Participation among all youth categories was the largest in the U-7, U-9, and U-11 age categories and lowest in the U-15 age category for Delorme and colleagues' (2010a) soccer study, comparable to the present study's youth ice-hockey participation rates where participation was largest at 10 years of age (n=14,325) and lowest at 15 years of age (n=10,466). The longitudinal design of the study produced declining participation rates for the present sample as expected; the unbiased controlled cohort did not account for new players being added. Both aforementioned studies demonstrated results indicative of the present study: those born late in the selection year were shown to have higher dropout numbers. This can be explained through Feltz and Petlichkoff's (1983) idea of perceived competence; through early selection into more "talented" streams a player will demonstrate a sense of increased self-competence, which in turn will aid in positive development, as opposed to perceived lower self-competence which was shown to be more prevalent in those who dropped out from sport. Additionally, Musch and Grondin (2011) suggested that the relatively youngest players are more susceptible to dropping out due to increased frustration from an inability to compete with the older and bigger players.

A limitation of Helsen's and colleagues' (1998) dropout study was that the pool of players was not based on a single cohort, but represented a cross-sectional analysis whereby it was difficult to determine if the same players were being consistently tracked across the different ages. In addition, Barnsley and Thompson (1988), who did not directly look at the RAE and dropout rates but determined that the relatively older players continued to play minor ice-hockey until a later age than did the relatively younger

players, added new participants to their SS as their study progressed, which raises the question of whether the changes that occurred could have simply been a function of players coming in and out of the sample. The present study controlled for these methodological shortfalls by tracking the same initial cohort of players for the five-year period thereby ensuring a more accurate analysis of player dropout rates.

While Delorme and colleagues' (2011) examination of dropout in youth basketball and Delorme and colleagues' (2010a) examination of dropout in soccer showed a similar patterns of under-representation of dropouts among male players born in the first two quartiles and an over-representation of dropouts among those born in the last two quartiles, they only tracked players for a single season, or one year of registration, providing only a snapshot of dropout patterns. The present study examining dropout rates over a five-year period permitted a more detailed analysis of the age at which dropout is most prevalent. Although both studies used a goodness-of-fit chi-square approach, the more stringent approach coupled with the *w* effect size analyses used in the present study reduced the bias introduced into the analyses by the large SS. Moreover, SR analyses allowed conclusions to be drawn about the patters of over- and under-representation within each quartile.

Results of all of the aforementioned studies involving an examination of the RAE and its influence on sport participation rates confirm that the effect may indeed influence sport dropout. Taking into account the large SS's however, it is possible that these inflated samples helped to drive the RAE findings in previous studies. As mentioned by Delorme and colleagues (2011), Delorme and Raspaud (2009) were the first researchers

to examine an entire population of registered players of a particular sport, suggesting that the absence of the RAE in previous studies may have been a consequence of small SS's. Although no previous studies have examined dropout in youth ice-hockey as a consequence of birth quartile, the results of the birthdate distributions and participation rates are consistent with previous soccer and basketball literature. It appears that the RAE is prevalent in male youth ice-hockey in Ontario based on the present study's results, potentially affecting participation rates among the players.

To address the first question of the statistical analyses concerning the pattern of dropout rates, 26.9% of the players (n=3,859) dropped out over the five-year period, while 73.1% continued playing (n=10,466). However, a negative relationship emerged between birth quartile and player retention; as the birth quartile increased, player retention decreased. Players born in the second quartile had the highest retention rates over the five-year span, as well as the lowest percentage of dropout rates. Predictably, the second highest percentage of retained players was found in Q1, along with the second lowest percentage of dropout rates. Players born in Q3 had the third highest percentage of retained players, alongside with the third lowest percentage of dropout rates. Finally, players born in Q4 had the lowest percentage of retained players and the highest percentage of dropout rates. The over-representation of players retained born in quartiles one and two portrays a trend which suggests and supports the idea in which the later a player is born in a selection year, the higher their chance is of attrition from ice-hockey.

To address the second question regarding probability of attrition and retention, it was found that the likelihood of dropping out increased the later in the selection year the

player was born. Players who were born in Q4 had a 1.175 times higher likelihood of dropout, compared to Q2 and Q3, where the likelihood of dropout was not related to birth quartile. The odds ratio findings support the existence of a RAE; as a player progresses from one quartile to the next, the likelihood of dropout from ice-hockey will increase in a similar fashion. These results are consistent with Cobley and colleagues' (2009) meta-analysis findings, where across a variety of sports and samples, odds ratios indicated inequalities among participation rates; for every two players born in Q4, greater than three were found to be participating from Q1 of the same age-group.

Addressing the final question of the trends in Q4 dropout rates, the quartile identified with the highest dropout, this study was able to distinguish at what age players were dropping out from ice-hockey. Results indicated that 12 year-old boys born in Q4 had the highest dropout rates with almost one-third (30.9%) having dropped out by the end of the 2007 season. With the "growth spurt" starting in boys at 12-13 years of age and reaching its peak around ages 15-16 years of age (Wolman, 1998), this finding suggests that those most prone to dropout from ice-hockey were only at the onset of their adolescence. From a developmental perspective, the RAE has been found traditionally to be the strongest immediately post-puberty (Delorme & Raspaud, 2009), where physical variability in height and weight prior to the onset of puberty is less evident. With biology indicating that the majority of those born earlier in the year will reach puberty sooner than those born in the later months, it provides a vast disadvantage to the players who were born the second of half of the year where their relatively older teammates had already hit puberty and they had yet to do so.

Interestingly, the dropout rates at age 13 years were lower than expected, portraying an inequality in dropout rates within the Q4 sample. Although findings indicated that 271 out of the 877 dropped out players who were born in the last quarter of the year were for the most part pre-adolescent, the remaining sample did not expose a linear relationship pertaining to age and dropout rates based on year of dropout. Beyond the age of 13 years, dropout rates did not exhibit a relationship with year of play, suggesting that maturation differences may have been minimal between the Q4 players. It appears that the most robust Q4 players were left while the smallest and weakest dropped out of the sample, despite the players having been developed similarly.

As alluded to previously, the potential impact of players competing in two-year age groups is important to consider when examining the Q4 dropout rates. The challenge of determining which players competed in two-year age groups and which did not stemmed from the study's inability to link each player's registration to their respective tier age grouping. A relatively older player who is competing in a two-year age group may have a higher likelihood to continue playing when compared to a relatively younger player, who may face up to a 24 month less-a-day gap disadvantage in physical maturation. Theoretically, the two-year age groups create eight quartiles, thus providing a more pronounced difficulty for ice-hockey success for those players competing in the younger half of the two-year age grouping who are born in the later months of a given selection year.

Dating back nearly three decades to Barnsley and colleagues' (1985) groundbreaking RAE study that established a linear relationship between birth month and the proportion of players in the NHL, birthdate quartile and success in ice-hockey go hand in hand. Addona and Yates (2010) categorized birth month and frequency of playing in the NHL for all of the league's players, as well as birth month distribution for all Canadian players, and showed an apparent negative linear trend by month, thus providing further recent evidence of an RAE. The present study's findings of unequal birthdate distribution and unequal dropout rates across the birth quartiles sheds light on what researchers may have already suspected: birthdates in sport affect player participation rates.

Relative age was shown to play an integral role in the retention and attrition rates among Ontario ice-hockey players between the ages of 10 and 15 years. Moreover, the relative age inequalities may stem from selection practices that perpetuate the mindset of picking players for potential, where size is often highly regarded, over skill. As highlighted by Dixon and colleagues (2011), once players were selected into the advantaged stream, they received increased contact time and improved competitive conditions that helped to further distance the privileged minority from the performance norms, and dropout rates may surge in those who were not selected. With a variety of levels of play and differing coaching styles, it is beyond the capacity of this study to speculate exactly why the players dropped out at a particular age. Therefore, the existence of RAEs undermines the effectiveness of talent identification and development programs (Baker et al., 2010). Sport is intended to provide a gateway to PYD, which Roth and colleagues (1998) described as engaging in pro-social behaviours that will lead in the

acquisition of important life skills. With goodness-of-fit and odds ratio analyses revealing a significant relationship between birth quartile and dropout rates, PYD may be harder to attain for those born later in a given selection year; a consequence of sport participation.

Results of this study suggest that PYD does not occur simply by participating in a sport. A competitive sport environment may contribute to adolescents' stress, where mental challenges that often arise from sport contribute to sport-related stress (Camire et al., 2011). Furthermore, relating back to the importance of coaches in creating a PYD atmosphere, it is important for them to understand that it is not automatic, but rather a strategy created to use the power of sport as a positive influence for youth, while viewing themselves as responsible for the creation of PYD (Camire et al., 2011; Vella, Oades & Crowe, 2011). The maximum potential of a sport program can be reached if the focus of development is not only on the athletes, but healthy individuals as well (Strachan, Côté & Deakin, 2011).

Strengths & Limitations

Several contributions to the existing body of research regarding youth sport involvement will be made. The controlled cohort design coupled with the large SS will make a unique contribution to youth ice-hockey literature in terms of providing more concrete information of when dropout occurs. No other published study has used this approach to examine the relationship between the RAE and dropout rates in youth sport. The biggest strength in the study lied with the consistency of the SS. By distinguishing an initial cohort of players to follow throughout the five years of ice-hockey participation,

the study accounted for miscellaneous discrepancies that may have emerged with any addition of new players in each subsequent year of the sample, dissimilar to Helsen and colleagues' (1998) approach.

An additional strength of the study was specificity. Having the ability to calculate exact percentages and ages in relation to dropout rates and probability of dropout based on what birth quarter a player was born in can aid in development of future dropout prevention strategies.

A limitation of the present study is a question that many researchers strive to answer; why did the player drop out? The present study looked at dropout rates but can only speculate as to why the player discontinued participation. However, it is a step in the direction of ultimately being able to answer why. Results indicated at what age youth were found to be most susceptible to dropping out, establishing a target group for future studies. An open-ended demographic questionnaire, as used by Armentrout and Kamphoff (2011), is a potential tool that can be utilized during focus groups to alleviate pressures that a child may feel during a more stringent interview-based approach in answering why they dropped out from ice-hockey.

An additional limitation to the study was its inability to account for competition level in its analyses. Through not differentiating between the 15 levels of play that were presented in the dataset, the study was unable to make conclusions regarding whether a player dropped out or dropped down from a particular division due to being relatively younger. This is will an important dimension to account for in the future.

Future Directions

With development of young players being a cornerstone of the game (King & LeBlanc, 2006), future studies involving youth ice-hockey dropout should seek potential reasons why attrition occurs, and how competition level may influence player dropout rates and drop-down from higher to lower divisions of play. Distinguishing between whether a player dropped out, dropped down, or was cut altogether from a team would be a valuable addition to the present study's OMHA sample. Additionally, identifying the dropout rates across the different levels of competition, AAA through to HL, may display a different patterning of the RAE due to the competition levels being collapsed.

Utilizing the same goodness-of-fit approach from the present study but with actual birthdate distributions from the dropped out cohort, aside from the general 25% per quartile, is also worth pursuing. This analysis will potentially display a stronger statistical chi-square effect in relation to dropout rates and percentages.

Although RAE literature in sport has been prevalent for a number of decades now, few studies have attempted to reduce and/or eliminate the biased effects it produces (Dixon et al., 2011). Many approaches have been suggested to minimize the RAE in ice-hockey, however little action has taken place. With respect to minimizing the risk of injury, examples include: changes in equipment, education about sportsmanship, and enforcement of rules (King & LeBlanc, 2006). Other suggestions that have been made to reduce injury in ice-hockey include examination of risk factors such as body size, previous injury, and helmet age and type (Emery & Meeuwisee, 2006). Aside from injury, examples of recommendations to reduce the RAE include: review of the 24-month

age band (Helsen et al., 1998), reduction in the age range of the age groups (Barnsley & Thompson, 1988), requirement that the average age of any team should be one-half the age group range, and a rotating eligibility date (Helsen et al., 2000), despite evidence that such a modification will only lead to corresponding shifts in RAEs (Baker, Schorer & Cobley, 2010).

The coach mentorship program established by Hockey Canada (2011a) allows coaches to learn how to teach specific skills such as skating and puck control, which in turn may reduce selection bias through educating them to identify and select skill instead of their current trend of selecting size. Brewer, Balsom and Davis (1995) even went as far as to suggest that teams should split their rosters into "current" and "potential" squads to separate the best players and those who are lacking in terms of their physical development, which may ultimately reduce dropout rates due to relative age differences. It is unlikely that governing bodies would adopt this solution as players who are chosen to be on the "potential" squad may become discouraged and begin to feel unappreciated by their coach, thus constructing other reasons for dropping out besides being relatively younger.

Although methods to eradicate the RAE in sport have been examined by researchers for decades, competition in youth sport programs is only one of many developmental periods in a person's life. That is why the vital question of whether participation in physical activity persists after these former athletes outgrow their youth sport days has been raised (Butcher et al., 2002). A professional career in sport is a goal that many young athletes strive for, but chances of reaching that plateau are slim.

According to the Bureau of Labor Statistics, players have a 24,550 to 1 shot, or .00565% chance, of becoming a professional athlete (Freeland, 2009). Therefore, Butcher and colleagues (2002) drew attention to post-organized competition activity to avoid dwelling on just a small time period of competition during a lifespan. With that being said, speculation can be made that looking back on a positive youth sport experience may be the catalyst for a physically active lifestyle after organized sport, just as much as a negative youth sport experience may deter an individual from physical activity forever.

Skill development interventions aimed at the younger players with the goal of increasing player retention is another potential solution to the issue. Aside from a competitive setting, holding focus groups with players who dropped out can help in understanding if structural factors related to ice-hockey are influencing participation or factors related to changes in patterns of social interaction or school involvement. Personal factors, such as how much the player enjoys the sport, along with system factors may contribute to the RAE and need to be further examined. These sessions can be held in an attempt to answer the "who," "when," and "why" of youth ice-hockey dropout in Canada.

Further research is required to fully understand the patterns of activities that lead to youth sport dropout (Wall & Côté, 2007). It is also important for future studies to attempt to reduce the biased effects the RAE produces, as the effect may likely decrease the overall quality of the highest competitive teams while squandering talent for subsequent generations through advancing careers of less-qualified candidates in both sport and education contexts (Dixon et al., 2011).

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Appendix A

Review of Literature

The influence sport participation has on a child has great importance in shaping development in physical, psychological, and social assets (Hedstrom & Gould, 2004). Growth and attainment of functionally valued behaviours such as personal skills, including social and emotional qualities, creates an intention for the child to become a healthy member of society ("Promoting positive youth," 2009). The acquisition of these learned life skills, competencies, assets, and values help shape what is known as *Positive Youth Development* (PYD), illustrating the potential for PYD through sport (Jones, Dunn, Holt, Sullivan, & Bloom, 2011). These concepts suggest that every child has the potential for successful and healthy development, and that all youth exhibit the capacity for positive development (Lerner et al., 2005). Participation in sport is assumed by most to automatically lead to positive character building experiences (Bredemeier & Shields, 2006; Camire & Trudel, 2010; Coakley, 2006; Fraser-Thomas, Côté, & Deakin, 2005), yet youth sport has also been found to lead to dropout and negative development (Fraser-Thomas & Côté, 2006; Fraser-Thomas, Côté, & Deakin, 2008a; Fraser-Thomas, Côté, & Deakin, 2008b; Fraser-Thomas & Côté, 2009).

Positive Youth Development

Youth sport has the potential to impact important objectives in children's development, such as providing improvement in physical health, psychosocial development, and the learning of motor skills (Côté & Fraser-Thomas, 2007). Roth and colleagues (1998, p. 426) defined PYD as "the engagement in pro-social behaviours and avoidance of health compromising behaviours and future jeopardizing behaviours."

Therefore, a child who exhibits an absence of negative or undesirable behaviours is explicitly regarded as developing positively (Benson, 2003), whereas if they were participating in risky behaviours negative development could ensue.

Researchers have studied the concept of PYD vigorously over the past 20 years. The concept of 'Cs' was initially proposed by Little (1993) which served as a theoretical construct through working definitions designed to establish clarity and understanding of the goals and outcomes of a community-based program whose aim is to enhance youth development. Since Little's (1993) four 'Cs' of PYD was published, literature has continued to examine the model that represented the constructs of *competence*, *confidence*, *connection* and *character* in relation to PYD. Developmental psychologists have added a fifth 'C' following Little's (1993) original work, which stood for *caring* or *compassion* (Eccles & Gootman, 2002; Jones et al., 2011; Lerner, 2004; Roth & Brooks-Gunn, 2003). Lerner and colleagues' (2005) '5Cs' model has been regarded as one of the most prominent theories of PYD in recent literature and has served as a framework for assessing PYD in sport (Jones et al., 2011). The culmination of *competence*, *confidence*, *connection*, *character*, and *caring/compassion* suggest overall positive development in youth and a clear guideline in which evaluations can be made.

Having children participating in sports does not necessarily translate to PYD. To prepare for a healthy and active future, youth sport programs should be developed in a way for youth to acquire personal competency that will ultimately assist them in living a healthier life (Damon, 2004; Park, 2004; Witt, 2002). For example, a child who is part of a team will learn discipline through common commitment and purpose, performance

goals, complementary skills, and mutual accountability (Katzenbach & Smith, 1993). These elements that make a team function exemplifies inclusion into a group setting as critical, where individual athlete development is affected by supportive influences and the positive environment in which the sport setting takes place in. Therefore, the majority of performance athletes' self identity, defined as the extent to which the individual identifies with the athlete role (Brewer, Van Raalte, & Linder, 1993), is to a significant extent developed and confirmed through their participation in sportive activities (Miron, 2010).

Influences

Literature has examined multiple factors that can have both positive and negative influences on youth sport experiences. From a positive perspective, perceived parental influences with healthier interactions, support, and encouragement have consequently supplied children with greater sport enjoyment, higher intrinsic motivation, and a larger preference for challenge (Scanlan & Lewthwaite, 1986). Guidelines for supportive parents that are followed, such as showing empathy for their child, decreasing the pressure to win, understanding the risks, and avoiding using guilt, fear, and criticizing facilitate positive development for the child (Feigley, n.d.). Peers (Fraser-Thomas et al., 2008), coaches (Conroy & Coatsworth, 2006), and siblings (Côté, 1999) have also been found to be positive influential factors in children's development. Youth who experience positive peer relations during participation are reported to have higher enjoyment and commitment to the sport (Patrick et al., 1999), as well as better attitudes and sense of physical competence (Smith, 2003). Fraser-Thomas and Côté's (2009) work involving competitive swimmers linked those who demonstrated meaningful adult and peer relationships to having a positive experience, in addition to having a sense of community

belief. Sibling relationships, which are assumed to be inherently conflicted and the reason as to why limited studies regarding their influence on sport participation exist, have been suggested to create an environment within the household favourable to the development of sport skills (Côté, 1999). Conversely, while a great deal about sport participation is positive, there are some structural issues in sport that may detract from positive development. Those who acknowledged exposure to poor relationships through parental pressure, or with peers and siblings, reported experiencing a difficult and challenging time during the course of their participation, potentially affecting their motivation for future participation (Augste & Lames, 2011).

Negative Youth Development

Dropout rates in sport can be influenced at the youth level by a number of reasons. One of the most important actors in the youth sport context are coaches, who play an influential role in facilitating or hindering development (Camire, Forneris, Trudel & Bernard, 2011). Coaches who utilize a training program that encompasses appropriate reinforcement and praise, encouragement after mistakes and instruction will positively affect youths' psychosocial development (Conroy & Coatsworth, 2006). Although coaches can have a great impact on PYD (Conroy & Coatsworth, 2006), a large number have limited training and knowledge on how to properly structure an environment that facilitates positive development (Camire et al., 2011). Price and Weiss (2000) found coaches who feel emotionally depleted and worn out as being seen by their players as showing less care and concern about them, while providing less teaching and interaction resulting in a reduced amount of structure within the team. Burnout, along with other factors such as favouritism and one-on-one attention (Fraser-Thomas & Côté, 2009;

Fraser-Thomas et al., 2008), autocratic style approach (Fraser-Thomas et al., 2008b), and a primary emphasis on winning through exploitation rather than development (Gilbert, Gilbert, & Trudel, 2001a; Gilbert, Gilbert, & Trudel 2001b), where the focus of feedback should be task rather than outcome oriented (Fraser-Thomas & Côté, 2006), have been associated with negative experiences with the sport.

Conversely, those who identify with their role and are facilitated by their coach will develop a comfort level which enables them to excel in their respective sport, and opportunities to further develop their distinctiveness arise. Stevenson (2001) states that as these athletes receive more rewards and acknowledgement for their play, the challenge will then become greater for them to live up to the role and the incentive to keep their identity that has been established will become more present. Extended periods of pressure placed on youth can lead to burnout and a loss of interest, resulting in them seeking other hobbies or interests to occupy their time with. A child who is unsure of their role on their team will experience a decrease in the '5Cs' that is so vital in positive development, and in turn may decide to drop out altogether from sport.

Another manner in which negative development in sport may arise is through parental pressure. For example, early specialization is often pushed upon children through parents funding their involvement in camps, clinics, and lessons (Hill & Hansen, 1988). In turn, this provides encouragement from parents in the hopes of the children being offered an athletic scholarship and ultimately a professional contract (Malina, 2010). Baker and Robertson-Wilson (2003) suggested that through these excessive behaviours of over-involvement, pressure, and using the child to achieve their personal

ambitions, the parents are abusing their authoritative responsibility and undermining their child's participation. The lack of positive feedback can lead to decreased motivation and self-confidence, consequently causing effort and performance to suffer (Augste & Lames, 2011). A parental figure is often turned to for guidance amidst competition; however, those who exhibit a lack of empathy accompanied with unrealistic expectations may discourage the child from continuation in sport. By limiting their expectations to solely achievement in school and sport, parents reduce the importance of other social demands put on children during their maturation period (Côté, 1999). Sport literature has also denoted a positive relationship between parental pressure and presence on players' pre-competitive anxiety (Bois, Lalanne & Delforge, 2009). Further, the early specialization the child was a product of can ultimately influence long-term physical activity participation negatively, resulting in future health risks due to inactivity (Baker & Robertson-Wilson, 2003). There is limited literature that supports the idea of early success leading to later success, where focusing in too early on one sport may prove more detrimental than beneficial.

Development

Youth sport participants may find it hard to differentiate themselves from the rest of the players as talent seems to be more alike at a younger age rather than in the latter years of competition. The wide range of "normal variation" in children makes it difficult to determine whether physical size or maturation can directly be attributed to skill (Helsen, Starkes, & Winckel, 1998). Musch and Grondin (2001) stated that skill is as much the product of maturity as it is ability, therefore basing selection decisions on observed skill can often lead to systematic selection errors as a result of the influence of

maturity (Dixon, Horton & Weir, 2011). Hence, coaches and trainers will look at the potential the player has rather than solely at the skills they possess at the current time. The physical attribute has heightened itself as a primary indicator of potential success in sport. Although mental and emotional traits play a significant role, developing earlier physically results in being taller and heavier than individuals in the same age group. Despite physical and biological attributes alone being poor predictors of skill (Burgess & Naughton, 2010), they grasp an observer's attention immediately and serve as inclusion criteria into sports. Onlookers will define an athlete on the basis of their size, but also on their performance and skill. Thus, the individuals' athlete role reflects how they identify themselves when being examined from a social point of view from the external side, such as their family, friends, and community (Coakley, 1998).

For an athlete to experience success and recognition, it is widely accepted that multiple factors have to occur in succession to provide the best opportunity to do so. Participating in higher calibre competition at a young age is an approach that many athletes take who are striving for elite status in their respective sport. However, the current talent identification system is in large part influenced by a player's physical attributes rather than skill (Helsen et al., 1998). Thus, the athlete's skills have to be either vastly superior or the athlete has to be physically bigger than the majority of players in the same age group, or both. Being bigger is associated with two factors; genetics and reaching puberty at an earlier age. The "growth spurt" is a sign of the onset of adolescence, starting in girls around 10-11 years of age, reaching its peak around ages 12-13 years, and 12-13 years of age in boys, reaching its peak around ages 15-16 years (Wolman, 1998). Biology suggests that the majority of those born earlier in the year will

reach puberty, or hit the "growth spurt", sooner than those born in the later months. As the youth enter adolescence (ages 13-17 years), they then become more abstract thinkers and better able to self-reference their performances (Fraser-Thomas & Côté, 2006).

Progressive development in overall size is beneficial when competing in a physically demanding sport. Furthermore, it creates a means in which PYD can occur through the function of age. Ultimately, the goal of youth sport programs should be to nurture children's intrinsic motivation for sport participation (Fraser-Thomas & Côté, 2006). Quality learning experiences in early life help these players develop perceptions of competence, leading to motivation and continued participation (Kirk, 2005). Once intrinsic motivation has been established, the child will then be able to progress through sport growing at their own pace. The development of expertise in sport is influenced by a range of primary and secondary factors (Baker & Horton, 2004). One secondary factor that has yet to be discussed which affects a players' chance of gaining accessibility to high quality coaching and training is relative age (Schorer, Baker, Busch, Wilhelm, & Pabst, 2009). It is one means by which both positive and negative youth development can occur. The present study looked at the effect relative age has on negative athlete development through dropout rates in male youth ice-hockey players in Ontario.

Relative Age Effect: Defined

Grouping players by age is a universal practice in sport, which serves as an organizational tool. Much like in school, the participants are placed into age groupings to equalize competition, facilitate instruction, provide for program continuity, promote safety for the participants (Barrow & McGee, 1971), and provide developmentally appropriate training (Helsen et al., 1998). Determined by sport organizations, its intention to balance the competition between players has been criticized with respect to generating important differences in relative age: children born in the same year can have up to nearly 12 months difference in age, and those who are competing in a category involving two consecutive years of birth can cause a 24 month less-a-day gap between players who are not born in the same year (Delorme, Boiche, & Raspaud, 2010a; Dixon et al., 2011). Malina (1994) found that just an 11 month difference can provide a substantial advantage to an individual in terms of height, weight and co-ordination during adolescence. Therefore, annual age groupings appear to promote relative age effects (RAEs), which refer both to the immediate participation and long-term attainment constraints in sport, occurring as a result of chronological age, physical differences, and selection practices in annual age-grouped cohorts (Cobley, Baker, Wattie, & McKenna, 2009). Immediate participation and attainment constraints refer to a presumed preference for immediate success instead of long-term goal attainment, creating a tendency to select athletes for youth teams born earlier in the selection period (Augste & Lames, 2011).

RAEs were first identified by Barnsley, Thompson, and Barnsley (1985) when they found a strong correlation between birth month and the likelihood of playing in the National Hockey League (NHL) and two major developmental leagues (Barnsley, &

Thompson, 1988). The Western Hockey League (WHL) and the Ontario Hockey League (OHL) were found to contain four times the players who were born within the first quarter of the year (January, February, and March) than were born in the last quarter (October, November, and December). Barnsley and colleagues (1985) found this trend to continue through to the NHL as well, hypothesizing that those who are born in the first months of the year tend to have a developmental advantage over the younger children in the same age grouping. Players who were born in the later months of the year were found to have a higher likelihood of dropping out (Barnsley et al., 1985), mostly due to the majority of them being smaller, weaker, and less co-ordinated than the older children. On the other hand, the bigger and stronger players who receive greater incentives to play through rewards and recognition were found more likely to exhibit continuity in sport participation.

Registration cut-off dates, initially intended to promote equity and fair play, have had the unintended consequence of creating these selection and participation inequalities. In literature, annual age groupings are commonly broken down into quartiles when dealing with RAEs. For example, women's rugby at the provincial level in Canada has a registration cut-off date of December 31st. This will result in the players' respective birthdates to be placed into quartiles consisting of three months each: Q1 = January, February, March; Q2 = April, May, June; Q3 = July, August, September; Q4 = October, November, and December. Alternatively, England's registration cut-off date for male rugby is August 31st, meaning that September to November will represent Q1 and so forth. Whereas most observers may not think that a child born earlier in the year has a significant effect, a child who turns five years old in January will be nearly 20% older

than a child who has their fifth birthday in December (Addona, & Yates, 2010). This age gap could reflect a major developmental difference in physical maturity between the two players at the middle childhood and preadolescence stage, thus producing an advantage in the favour of the older child and a vast disadvantage for the younger one. As a result, differences in developmental outcomes stemming from relative age have been shown to persist throughout the lifespan producing long-term social, emotional, and economic benefits, or detriments (Dixon et al., 2011).

History of RAE: Education

The RAE phenomenon may not have reached "mainstream" attention until Malcolm Gladwell's book *Outliers* reached the bestseller's list in 2008. However, researchers have investigated relative age for four decades, where Thompson's (1971) groundbreaking study titled "Season of birth and success in the secondary school" found a correlation between success in academia with being born within the first few months of the year. Thompson's (1971) study was built upon the work of Dickinson and Larson (1963) who were the first to have reported a link between chronological age at school entry and the profound effect it had on later school achievement. Shearer (1967) also demonstrated that birthdates correlated with educational achievement in both children and adults. Relative age may affect a child's performance in the classroom for several reasons. One example is relative immaturity; the younger students within their age cohort will be at a larger disadvantage since early childhood maturity can influence long-term cognitive performance through ability grouping (Sprietsma, 2006). Ability grouping in the educational practice implies a means of grouping students for instruction by ability, achievement, or academic potential in hopes of reducing their heterogeneity (Slavin,

1987). Consequently, students who are less able to perform the same tasks as their peers who were born earlier in the year may be placed in a lower ability group which limits their growth all the while discouraging them from academic prowess.

The following is a quote from *Ouliers*: "It's just like sports, we do ability grouping early on in childhood. We have advanced reading groups and advanced math groups. So, early on, if we look at young kids, in kindergarten and first grade, the teachers are confusing maturity with ability. And they put the older kids in the advanced stream, where they learn better skills; and the next year, because they are in the higher groups, they do even better; and the next year, the same thing happens, and they do even better again (Dhuey, 2008. p. 28-29)."

Fenzel (1992) measured self-esteem in fifth and sixth grade students, finding the older pupils benefiting from a higher self-esteem and feeling less strained at school. Maturational and psychological mechanisms have been also been found to influence attainment in the 11-14 year-old age group, where older students tended to have significantly higher attainment in subjects, consistency in high scores, higher enrolment in enriched programs (Cobley, McKenna, Baker & Wattie, 2009), and being referred more often for gifted evaluation (DeMeis & Stearns, 1992). Younger classmates will suffer from a lower attainment rate, an over-representation in learning support programs, and infrequent class attendance of up to an average of six days of school missed more than their older counterparts (Cobley et al., 2009). In contrast, relative age was also found to have a positive effect on long-term test scores in some countries despite displaying ability grouping (Sprietsma, 2006) and influencing attainment in physical

education (Cobley, Abraham, & Baker, 2008), disagreeing with literature that suggests relative age is detrimental to school performance.

Gladwell (2008) used sociologist Robert Merton's "self-fulfililng prophecy" theory (1948) in accordance with the way Canadians select ice-hockey players. A situation where a false belief in the beginning evokes a new behaviour consequently making the false belief to come true serves as an example of Canadian ice-hockey selection practices; through picking the "best" minor ice-hockey players the oldest players are generally chosen, but the way they are developed onwards ends up making the original false judgement look correct (Gladwell, 2008). This "accidental" selection practice in turn influences the children's motivation and performance, resulting in increased contact time and improved competitive conditions for the relatively older players (Dixon et al, 2011). The relatively older children benefit from greater opportunites for training from more highly qualified instructors, which enables them to further distance themselves from the performance norms of the relatively younger players within the same age cohort (Dixon et al., 2011).

History of RAE: Sport

Although it was not until the mid-1980's that Canadian psychologist Roger Barnsley first drew attention to the phenomenon of relative age (Gladwell, 2008, p. 21), research has found RAEs to predominantly exist within sport worldwide in many, but not all, competitive sports (Musch & Grondin, 2001). Nolan and Howell (2010) revisited Barnsley and colleagues' (1985) RAE study with a similar sample of NHL, WHL, and OHL players, in addition to Quebec Major Junior Hockey League (OMJHL) players,

reporting results indicative of a continued existence of a RAE among minor ice-hockey despite the globalization and changes that have occurred within the sport. These results mimic that of a RAE effect found among youth ice-hockey players in Quebec (Grondin, Deshaies, & Nault, 1984), and in the Edmonton Minor Hockey Association (Barnsley & Thompson, 1988).

A study on 1013 North American NHL draftees between 2000 and 2005 revealed a RAE along with a birth place effect, suggesting players from cities with a population of 250,000 to 999,999 were over two times more likely to be drafted by an NHL team (Baker & Logan, 2007). This is in contrast to World Junior ice-hockey players from Canada, America, Sweden, and Finland between 2000 and 2009 who were found less likely to be from major cities even with the presence of a RAE across the four countries (Bruner, Macdonald, Pickett & Côté, 2011). These results reinforce the conclusion that contextual factors specific to an athlete's developmental environment affect their chances of attaining elite status (Bruner et al., 2011), much like factors of relative age, size, and birthplace that play a role in the likelihood of an athlete being selected in the NHL draft (Baker & Logan, 2007).

The RAE was first identified in 1951 in Canada, while its existence has been reported dating back to 1879 (Addona & Yates, 2010). It was discovered that Canadian ice-hockey players born in 1951 and onwards who have played in the NHL exhibited a prevalence of relatively older players across rosters (Addona & Yates, 2010), although studies have disputed an unvarying RAE as selection can occur primarily by body type with their abilities being minimally affected by a function of relative age (Baker, Cobley,

Montelpare, Wattie & Faught, 2010). Sherar, Baxter-Jones, Faulkner and Russell (2007) looked at the selection of 14-15 year-old male players to a provincial ice-hockey team examining the relationships among biological maturity, physical size, and relative age, concluding that those selected for the final team were taller, heavier, and more mature than the unselected players across the 281 player sample. Thus, a lack of physical development may impede many potentially talented players from continuation in the sport, producing a selection bias in the favour of those who have birthdates earlier in a given selection year (Sherar et al., 2007).

In addition to ice-hockey, researchers have shown a prevalence of the RAE in a wide variety of sports across a broad range of ages. Although Horn and Okumura (2011) stated that the RAE is called "relative" because it becomes smaller with increasing age, literature containing RAEs in nearly every age group exists. Major League Baseball (MLB) players were found more likely to have been born in the first months of the selection year due to a developmental advantage dating back to Little League baseball (Thompson, Barnsley, & Stebelsky, 1991), whereas Masters swimmers and track and field athletes (Medic, Young, & Medic, 2011; Medic, Young, Starkes, Weir, & Grove, 2009), but not Masters weightlifting and rowing participants (Medic, Starkes, Weir, Young & Grove, 2009), have also shown a RAE that suggests its existence in the older sport populations irrespective of the psychological, social, and/or physiological mechanisms that underlie the effect (Medic et al., 2009). From childhood to adulthood, the RAE seems to be in existence throughout the lifespan. Researchers have predominantly looked at the RAE in youth and young adulthood age categories however. Some examples include the United Kingdom (UK) male rugby players aged Under (U)-7

to senior levels of competition who displayed uneven birthdate distributions throughout different age groups, clearly demonstrating the RAE as a function of early selection and performance level and retention processes (Till et al., 2010). German basketball players (Schorer, Neumann, Cobley, Tietjens, & Baker, 2011) along with French youth basketball players ranging from U-7 to over 18 years of age, who reported an under-representation of dropouts among those born early in the competition year as opposed to an over-representation among those born later in the competition year, also indicated that their chances to attain a high level in sport was compromised by physical development and maturation, or lack thereof (Delorme, Chalabaev, & Raspaud, 2011). RAEs have even been linked in conjunction with handedness as seen in relatively older right-handed tennis players (86.56%) who were born in the first half of the year being vastly over-represented (Loffing, Schorer, & Cobley, 2010).

A stronger RAE is expected for sports that are more popular, in which competition for a spot on the team is challenging (Delorme, Boiche, & Raspaud, & 2009; Musch & Grondin, 2001; Okazaki, Keller, Fontana & Gallagher, 2011), as well as in physically demanding sports where physical maturity plays a factor (Auguste & Lames, 2011). The more culturally valued the sport is the more likely participants will be identified and streamlined at an early age (Dixon et al., 2011). Thus, the RAE in soccer has been prominent in literature across the globe. Youth level Spanish soccer clubs aged U-11 to U-18 reported a RAE in both the elite and amateur levels (Del Campo, Vicedo, Villora, & Jordan, 2010). A study using a regression analyses conducted in Germany found their U-17 first leagues whose teams with a median of birthdates one month earlier were expected to finish 1.035 ranks better (Auguste & Lames, 2011). In France, the RAE in U-7 to 18

years of age and over male soccer players was linked to dropout in a study that was first to report empirical data on the biased distribution of birthdates of players that dropped out from their respective sport (Delorme et al., 2010a). Coming back to North America, the RAE was found to be prevalent in elite American youth players 17 years of age who were ranked as the most talented in the country by the Olympic Development Program, reporting to have a 70% chance of being born in the first half of the year and three times as likely to have been born in Q1 than Q4 (Glamser & Vincent, 2004).

The influence of relative age in soccer has been examined extensively by researchers, yet dropout has not been as prominent in youth sport literature. Helsen and colleagues (1998) found players who were born later in a given selection year tended to dropout as early as 12 years old when compared to those born in the early part of the selection year. Even at the ripe age group of six to eight, players begin to get labelled as talented and exposed to higher levels of coaching increasing their chances of elite level participation (Helsen et al., 1998). Developmental differences at such a young age have a potentially major significance in children, unlike the adult physique (Helsen et al., 1998). These developmental advantages impact perceived potential and predicted sport success, consequently providing a possible correlation between RAEs seen in senior level players which are now emerging throughout youth sport categories (Helsen, Starkes, & Van Winckel, 2000). Characteristics of elite youth soccer players have indicated them to be chronologically and skeletally older, larger in body size, and better at performing in functional capacities than players who dropped out, as found in a study of 159 male soccer players (Figueiredo, Goncalves, Silva, & Malina, 2009). Further, dropout was precipitated by several factors, including: physical growth, biological maturity, and sport-

specific skills, which were found to influence attrition, sustainment, or playing at higher levels in youth soccer (Figueiredo et al., 2009).

Physically less impressive players are particularly at a disadvantage in a sport like soccer which begins high levels of competition at an earlier age relative to other sports (Helsen et al., 1998). Specifically, the dropout tendency from this has been attributed to a lack of time to complete daily tasks. The need for more time to complete school work and the amount of time devoted to training and practices were listed as reasons as to why the players discontinued their participation in soccer (Figueiredo et al., 2009). A lack of opportunity to play in games, lack of enjoyment in training, lack of recognition for effort, low perception of ability, conflict of interest, loss of motivation, and tiredness also served as reasons why discontinued participation occurred (Cervello, Escarti, & Guzman, 2007; Edouard, Pruvost, Edouard & Morin, 2010; Figueiredo et al., 2009).

In order to level the playing field by reducing the developmental and social constraints the RAE causes, research has proposed to delay the start of competitive soccer, reduce the age bands from one year to six months, design tryouts differently with a lesser emphasis on competition, and equalize the practice experience of players that do and do not succeed at tryouts (Horn & Okumura, 2011). Literature has questioned the accuracy of past results regarding the RAE at the elite level however, citing bias in statistical testing as a possible explanation (Delorme, Boiche, & Raspaud, 2010b). A RAE favouring males and females born in the first half of the year that were aged 25-60 years was also found, suggesting a positive effect on the rate of engagement in the sport (LaRouche, Laurencelle, Grondin, & Trudeau, 2010).

The type of sport, age and gender influence the frequency of the RAE in youth sport (Musch & Grondin, 2001). Although extensive research on the RAE involves male-dominated sports, the effect is present in female-dominated sports as well. Despite findings of weaker RAEs for females in sports such as handball and soccer (Baker, Schorer, Cobley, Brautigam, & Busch, 2009), Weir, Smith, Paterson, and Horton (2010) examined the prevalence of the RAE in Canadian women's ice-hockey and found a sixty-forty ratio across a 660 player sample of those born in the first half of the year compared to the second half. The second quartile (32.88%) contained the highest proportion compared to Q4's 16.82%, suggesting a similar pattern to men's ice-hockey where elite level players are relatively older. Recent work by Lemez, Weir, and MacMahon (2011, in press) found a comparable pattern of the RAE to occur in Canadian developmental women's rugby at the U-15 and U-18 age levels where Q1 was found to be over-represented and Q4 being under-represented. Brazilian female youth volleyball players also displayed a RAE, with reports indicating an upwards of 74% who were born in the first six months of the year across the 148 player sample (Okazaki et al., 2011). In essence, many moderators of the RAE exist, namely sex, the intensity of competition, socio-economic status, and playing position (Baker et al., 2010). Examination of these specific factors is important in gaining further understanding of why the effect persists throughout the lifespan.

Canadian Developmental Model for Youth Hockey

For the purposes of the present study, it was important to understand the Canadian developmental model for youth ice-hockey and its structure. The RAE is likely to be present in any developmental system where selection of participants is made on the basis of ability and where different competitive streams influence opportunities for instruction, contact time, and competition (Dixon et al., 2011; see Figure 5). The Canadian Development Model (CDM) handbook has been developed by Hockey Canada (HC), the sole governing body for amateur ice-hockey in Canada, with the goal of providing young players and their parents with information regarding critical "decision points" ("Canadian developmental model," 2011). The objectives of the CDM are to create an improved uniform system assisting in the progression and development of Canadian players, to keep the top amateur players in the Canadian system, to ensure the club systems are complimenting one another, and to develop a system that allows players to advance at an appropriate pace based on their maturation and development ("Canadian developmental model," 2011). Building upon the CDM, Canada's Long-Term Athlete Development (LTAD) model is also a framework that strives to help athletes reach their full athletic potential through a multi-stage approach (Athletics Canada, 2011). The LTAD model emphasizes that the current Canadian athlete developmental trend rewards winning and competing over training and developing fundamental skills; a shortcoming in the Canadian sport system (Athletics Canada, 2011). Regardless, the current structure of the system developed by HC has propelled organizations such as the Canadian Hockey League (CHL) to produce more NHL players than any other developmental league worldwide.

The following seven levels of ice-hockey are available for Canadian players aged 13-20 years: Bantam "AAA" (ages 13-14 years), Midget "AA" (ages 15-17 years), and Midget "AAA" (ages 15-17 years) minor ice-hockey have a primary focus of development and advancement for players. Junior "C"/"D", Junior "B", Junior "A", and Major Junior contain more skilled and advanced players between the ages of 16-20 years. The Canadian Junior "A" Hockey League (CJAHL) is comprised of over 140 teams, while the Major Junior, or CHL, comprises 60 franchises in three regional member leagues (WHL, OHL, and QMJHL). The CHL are leaders in developing players that go on to play in the NHL and other professional leagues, although players still have an option of playing for their university/college teams or in the Senior Amateur Hockey League. The self-paced structure that HC has created puts youth in a position to be successful and play to their own strengths against similarly talented players. Horn and Harris (2002) found that not until approximately the age of 12 or 13 years does the ability to fully understand the differing effects that effort, practice, and ability have on performance sink in, further shedding a positive light on HC's developmental approach which begins at the age of 13 years. The age divisions also extend to a younger cohort where the players between the ages of five and six years are categorized into the "Initiation" group, ages seven to eight years as "Novice", ages nine to 10 years as "Atom", and ages 11 to 12 years as "Peewee" (King & LeBlanc, 2006).

While HC's player developmental framework is regarded by many as a gold standard in ice-hockey skill development, attrition in youth ice-hockey is not uncommon. Armentrout and Kamphoff (2011) surveyed 237 parents whose child discontinued participation in ice-hockey finding dissatisfaction with the youth sport organization as an

indicator of dropping out. The average attrition age was 10 years, with the sample ranging from four-17 years of age. Too much time and travel, cost, early or late practice times, politics, and competitiveness were the top five complaints parents had regarding the organization. Other notable reasons reported that ice-hockey took too much time up and the child wanted to do other activities. When asked for a recommendation for continued involvement of their child, the majority of parents believed that it was too late and nothing could be done, while others would have liked to see the organization more affordable. These findings of dropout rates indicate that multiple organizational barriers and personal reasons exist (Armentrout & Kamphoff, 2011), revealing a growing issue in youth ice-hockey.

Youth Ice-Hockey Dropout

Similar to soccer (Helsen et al., 1998), dropout as a consequence of relative age may also be perpetuated by the organizational structure of minor league ice-hockey programs, as indicated by Barnsley and Thompson (1988), where dropout was found from as early as 11 years of age. Wall and Côté (2007) conducted an interview of 12 parents regarding their child's ice-hockey participation, revealing that both active and dropout players enjoyed a positive and diverse beginning to sport. However, the players who dropped out were found to have begun off-ice training at a younger age, thus investing significantly more hours in training during the Bantam level years. This finding suggests that possible negative implications for long-term ice-hockey participation exist, which may be a consequence of expertise (Ericsson, Krampe & Tesch-Roemer, 1993). Ericsson and colleagues (1993) defined the acquisition of expert performance by long-term engagement in a highly specialized form of training termed deliberate practice, although

studies have shown frequent sport-specific practice at a young age may lead to dropout (Wall & Côté, 2007). If an overload of deliberate practice occurs early in a child's life, their intrinsic motivation for the sport may suffer, resulting in burnout and decreased participation motives.

Three distinct chronological categories emerged in a study done by Côté (1999) that labelled sport participation into sampling years (ages six-13), specializing years (ages 13-15), and investment years (ages 15 and over). The main objective during the sampling years is for the child to experience fun and excitement through sport, similar to the specializing years with the exception of the emergence of a sport specific skill development focus where the child decreases their involvement in various extra-curricular activities and hones in on a particular sport (Côté, 1999). Once the athlete approaches the age of 15 years, they are categorized into the investment years group where they are now committed to achieving elite status in their respective sport. Côté (1999) suggests that the strategic, competitive, and skill development characteristics of sport are of particular importance in this category.

These three stages of sport participation form a framework that attempts to explain influences that affect youth sport participation and how expertise in sport is developed. Specific to the three categories, parents changed from a leadership role in the sampling years, where they initially got their children interested in sport, to a more supportive role during the investment years where times of stress and anxiety begin to emerge (Côté, 1999). Whereas in the sampling years the child may be more intrinsically motivated to participate due to involvement being voluntary and pleasurable, teenagers who chose to

specialize in an activity that is associated with a negative involuntary experience may be at an increased risk to dropout. Many teenagers were reported to have dropped out of a sport because they never had a chance to enjoy using their talent (Csikszentmihalyi, Whalen, Wong & Rathunde, 1993). Furthermore, the relatively younger players were found to participate less and to be more susceptible to discontinue sports that require strong physical attributes (Delorme & Raspaud, 2009), all the while being prone to receiving less favourable feedback and lower levels of self-perception (Dixon et al., 2011). The amount of time spent within the three categories during early sport participation may also differentiate those who remain in sport and those who withdraw (Wall & Côté, 2007).

The Developmental Model of Sport Participation (DMSP), first introduced by Côté (1999), considers elite participation, recreational participation, and dropout as outcomes of sport participation (Wall & Côté, 2007). The DMSP emphasizes the importance of participating in a wide array of sports during the sampling years in order to develop intrinsic motivation and enjoyment for the sport. It suggests that children eventually come to the conclusion of participating at a recreational or elite level, or dropout of sports altogether (Côté, 1999; Fraser-Thomas & Côté, 2006). A 10-year study done by Butcher, Lindner, and Johns (2002) looking at 1,387 grade 10 students found that 94% had withdrawn from at least one sport since grade one, citing "lack of enjoyment", "other non-sport activities", and "other sports" as the primary reasons for withdrawal. Reasons for withdrawal from sport vary according to the age of the participants along with the level and intensity of previous participation (Butcher et al., 2002).

According to the International Hockey Federation (IHF) and Hockey Canada's annual report, there are currently 572,411 registered ice-hockey players in Canada as of 2011 (IHF, 2011; Hockey Canada, 2011b). With a population of 34,030,589, 1.68% of the Canadian population are registered ice-hockey players, making it the highest percentage of ice-hockey participation for a country in the world (IHF, 2011; Hockey Canada, 2011b). This participation and popularity establishes Canada as hotbed for ice-hockey, however it is a system with a high number of dropouts as a result of the high percentage of players registered on a team. HC launched the Hockey Canada Skills Development Camps in 1997 as a resolution to this growing issue, consisting of on-ice and off-ice skill building in hopes of increasing player retention (Hockey Canada, 2011b). Although HC's ample developmental programs are considered the gold standard in ice-hockey development, injuries have been found to play an influential factor in dropout rates and have got to be taken into consideration when assessing potential reasons for dropping out (Edouard, Pruvost, Edouard & Morin, 2010).

Canadian ice-hockey data suggest that ice-hockey injuries account for 10% of all youth sport injuries (Emery et al., 2010). Specifically, ice-hockey injury literature has denoted cerebral concussions to be the most common type of injury occurring from collisions, accounting for more than 15% of all boys' injuries out of a pool of 60 injured players (Emery & Meeuwisse, 2006; Roberts, Brust & Leonard, 1999). Particular concern has been raised when examining the impact of traumatic brain injury and how body-checking can be attributed to increased injuries in ice-hockey (Warsh, Constantin, Howard & Macpherson, 2009). King and LeBlanc (2006) define body-checking as an "individual defensive tactic designed to legally separate the puck carrier from the puck."

With literature suggesting body-checking a primary mechanism of injury (Emery & Meeuwisse, 2006), Warsh and colleagues (2009) examined body-checking as a mechanism of injury through comparison of injury rates between leagues that permitted body-checking and those that did not. Twenty studies consisting of players who were 20 years of age or younger attributed increased injuries associated with body-checking, which was the reported mechanism between 2.9% and 91% of all injuries (Warsh et al., 2009). Other literature has also indicated similar findings in which body-checking was associated with 45% to 86% of injuries among youth ice-hockey players (Brust, Leonard, Pheley & Roberts, 1992; Emery & Meeuwisse, 2006).

Relatively younger players who were born in Q3 and Q4 may be susceptible to a higher incidence of injury, in part due to inexperience of playing in an older age group as well as the higher intensity that is associated with training and games at the start of a new season (Helsen, Winckel, & Williams, 2005). The RAE plays a significant role concerning the consequence body-checking has on a child. Anthropometric differences such as relative size is a primary reason as to why injuries occur, where considerable size differences between relatively younger and older plays can result in upwards of a 53 kilogram (kg) difference in weight and 55 centimetre (cm) difference in height among puberty-aged players (Brust et al., 1992). Specifically, a 10 year-old in the 95th percentile is likely to be almost a foot taller and 27 kg heavier than one who falls in the fifth percentile (Helsen et al., 2005). Emery and colleagues (2010) further found smaller player size to be a risk factor for all injuries when examining Peewee players who were in a body-checking permitted league, which exemplified a three-fold increase in risk of all game-related injuries compared to a non-body-checking permitted league. Literature

regarding significant differences in injury rates found by age and category has also found injury risk to be higher in Peewee, Bantam, and Midget leagues when compared with the Atom league, with the risk of injury greatest in Peewee players (Emery & Meeuwisse, 2006). Although there has been controversy as to what age body-checking should be permitted in youth ice-hockey (Warsh et al., 2009), relatively older children have also been found to be at an increased risk of injury compared with their younger peers in ice-hockey as a result of experiencing a larger proportion of injuries at more competitive levels of play (Wattie, Cobley, Macpherson, Howard, Montelpare, & Baker, 2007b).

Warsh and colleagues (2009) recommended that children play in non-contact ice-hockey leagues until at least the Bantam level, suggesting the removal of body-checking earlier on will result in a decrease of the overall burden of injury. Furthermore, King and LeBlanc (2006) suggested that body-checking should be eliminated from minor ice-hockey programs with body contact being taught in a progressive manner from Atom to Bantam playing levels. The length of exposure to body-checking has also been taken into consideration, with findings proposing a typical Peewee level player is exposed to a two-fold increased risk of serious injury, totalling six hours of playing time, for a single season (King & Leblanc, 2006). Peewee boys had also been reported to have the highest game rate of concussions in a minor league tournament setting, in part to collisions being involved in 65% of all boys' injuries in the study (Roberts et al., 1999). The question of allowing continued high impact body-checking at the younger levels remains a major topic of discussion (Roberts et al., 1999). Even internationally where different regulations regarding when body-checking should be implemented exist, the reluctance to remove body-checking in the minor leagues is continually leading to more injuries in the

younger players (Emery et al., 2010). Alternatively, Canadian youth ice-hockey data has suggested that relatively older players have an increased risk of injury, citing selection biases that exclude on the basis of maturation as opposed to potential talent and skill as a reason why relative age may in actuality limit performance (Wattie, Cobley, Macpherson, Howard, Montelpare, & Baker, 2007a).

Youth sport researchers value sport as a context for developing physical, psychological, and social benefits (Hedstrom & Gould, 2004). Nevertheless, increasing concerns over the competitive nature of youth sports that results in injury or burnout from the excessive stress and pressure it causes are being voiced. However, given the rising epidemic of obesity in North American from inactivity, it is understood the positive contribution sport makes in improving health (Hedstrom & Gould, 2004). Despite its potential to promote physical, psychological, and social development, youth sport is often neglected in literature involving physical activity (Weiss, 2008). Many benefits are associated with competition, such as learning physical skills, acquiring sport skill for leisure, gaining an appreciation of fitness, and developing a sense of belonging (Seefeldt, Ewing & Walk, 1992). Thus, the importance of physical activity at a young age cannot be overstated.

Dropout has shown its prevalence across an array of youth sports, ranging from gymnasts (Klint & Weiss, 1986) to soccer players (Delorme et al., 2010a; Helsen et al., 1998; Helsen et al., 2000; Figueiredo et al., 2009) to basketball players (Delorme et al., 2011). For the purposes of the present study, however, Ontario male youth ice-hockey dropout rates as a consequence of relative age was the main focus. With sport playing

such a large role in health promotion of our youth, it is important to note that our objective was not intended to see a high rate of dropouts, but rather inform us of participation trends in relation to Canadian minor ice-hockey.

Appendix B

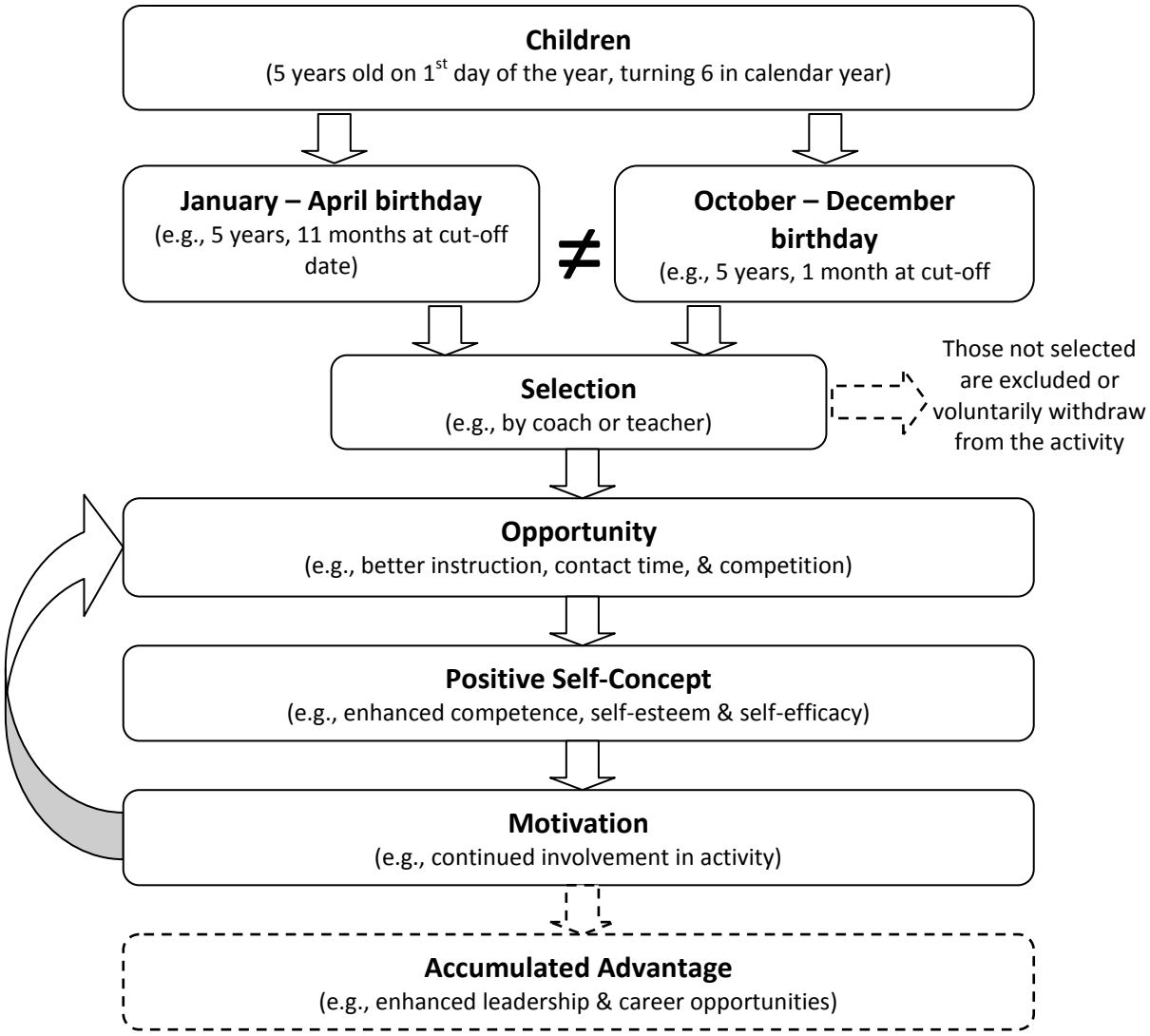

Figure 5. A model of the RAE (Dixon, Horton & Weir, 2011)

VITA AUCTORIS

NAME:	Srdjan Lemez
PLACE OF BIRTH:	Sarajevo, Bosnia and Herzegovina
YEAR OF BIRTH:	1988
EDUCATION:	Riverside High School, Windsor 2002-2006
	University of Windsor, Windsor, Ontario 2006-2010 B.H.K.
	University of Windsor, Windsor, Ontario 2010-2012 M.H.K.