

Relative age effects: Exploring possible solutions and the relationships between relative age, sport participation, education, and indicators of positive youth development

by

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# CERTIFICATE OF APPROVAL

## ABSTRACT AND KEY WORDS

Relative age occurs when youth are placed into age groups in sport and education. Relative Age Effects (RAE) indicate that being born closer to the cut-off date holds an advantage in sport and academic outcomes. **Study 1** explores what effects relative age has on educational achievement, participation in school and extracurricular sport and physical education, and positive youth development (PYD). *Methods.* A secondary analysis of Ontario secondary school students (N = 22,915) age 13 to 18 from the COMPASS study was carried out. The influence of relative age on academic achievement, sport and physical activity participation, and feelings of connectedness were considered. *Results.* Statistically significant relationships were found between relative age and academic achievement in math and English, relative age and sport participation, and relative age and feelings of connectedness. Feelings of connectedness were related to sport participation as well as higher academic achievement, for all quartiles. **Study 2**, a systematic review of the relative age literature between January 1980 and May 2016, aimed to assess the strengths and weaknesses of various proposed solutions to relative age effects (RAEs) in youth sport. *Results.* Forty-one peer-reviewed publications and three articles from online sources met the criteria for inclusion. Most solutions were theoretical and the majority of solutions proposed attempt to address environmental constraints (rather than task or individual) and seek to change sport systems or alter cut-off dates. Many of the solutions proposed would also be difficult to implement. **Conclusions:** Future research should seek to investigate the effects of relative age on youth sport and educational outcomes, especially as related to connectedness and PYD, and the consideration of other multi-dimensional aspects of youths' developmental ecology. Future research should also seek to test possible proposed solutions to RAEs in sport.

**Key Words:** Relative age effects, sport, youth, education, connectedness, physical activity

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*Relative age* describes the difference in age within an annual age group. Academic and sport systems impose cut-off dates to ensure fair competition between participants of roughly the same physical size and cognitive development. For example, one cohort may include youth born between January 1<sup>st</sup> and December 31<sup>st</sup> of a given year. However, within the same cohort those born on January 1<sup>st</sup> are in effect a full year older than those born on December 31<sup>st</sup>. Although the most common age groups are annual (12 month), there are others as well (see Schorer, Baker, Büsch, Wilhelm, & Pabst, 2009).

*Relative Age Effects (RAEs)* are the outcomes associated with relative age differences (Barnsley, Thompson, & Barnsley, 1985).

### *Positive Youth Development*

“*Positive youth development* is an intentional, pro-social approach that engages youth within their communities, schools, organizations, peer groups, and families in a manner that is productive and constructive; recognizes, utilizes, and enhances youths' strengths; and promotes positive outcomes for young people by providing opportunities, fostering positive relationships, and furnishing the support needed to build on their leadership strengths.” (Youth.gov, n.d.)

## LIST OF ABBREVIATIONS

**RAE** – Relative Age Effects

**PYD** – Positive Youth Development

**SES** – Socioeconomic Status

# PREFACE

This thesis is written in manuscript-style. Following introductory and literature review chapters, each study is presented as a stand-alone chapter in the style of a journal article manuscript (i.e., with introduction, methods, results and discussion sections), and thus there is some repetition of background information.

This thesis is composed of five sections:

1. Introduction
2. Literature Review
3. Manuscript 1 [Study 1: Compass Data Analysis]
4. Manuscript 2 [Study 2: Systematic Review of Proposed Solutions]
5. Overall Discussion



# Chapter 1 – Introduction

## OVERVIEW

Relative age effects (RAEs) predominantly describe the advantage experienced by older youth within a cohort compared to the relatively younger youths within the same cohort (Barnsley, R., Thompson, & Barnsley, P., 1985). RAEs are prevalent in environments where cut-off dates (based on birth date) are used to group youths into cohorts. The use of cut-off dates is common practice within education and sport settings globally in developed nations (Musch & Grondin, 2001). Cut-off dates are implemented in order to maintain developmentally appropriate learning opportunities, fair competition, and equal opportunity. These cut off dates are often based on the calendar year, school year, or sport season. For example, The Ontario Minor Hockey Association divides players into two-year bands based on their age as of December 31<sup>st</sup>. The Ontario school system also divides children into school grades based on their age as of December 31<sup>st</sup>. Typically, children with late birthdays attend school with their peers born in the same calendar year (Alphonso, 2017).

The current cut-off date system used in education and sport, which stems from public policies, may discriminate against the relatively young. Baker, Janning, Wong, Cobley, & Schorer (2014) hypothesized that relatively older youth born shortly after the “cut off” date in Ontario (i.e., January, February, and March) may exhibit greater cognitive and physical maturity than those born later in the year. Cognitive and physical advantages for relatively older youth in the same cohort (or grade) emerge because they could have up to a full year of additional cognitive and physical development over their younger peers. As a

result of an unfortunate combination of birthdate and cut-off date, relatively younger youth are less likely to be selected for teams, more likely to drop out or stop participating in sport, less likely to excel academically, and may be at greater risk for a range of negative health outcomes (Musch & Grondin, 2001; Cobley, Baker, Wattie, & Mckenna, 2009a; Wattie & Baker, 2013). This is a potentially significant problem as it has the capacity to influence all education and sport systems where cut-off date policies are common practice.

Though relative age has been shown to impact performance academically (Bell & Daniels, 1990; Massey, Elliot, & Ross, 1996; Sharp, Hutchison, & Whetton, 1994; Cobley, Baker, Wattie, & Mckenna, 2009b), and in sport (Barnsley & Thompson, 1988; Barnsley, Thompson, & Legault, 1992; Grondin, Deschaies, & Nault, 1984), no studies to date have considered RAEs as a complex social phenomenon and taken a multifaceted approach to studying the phenomenon. Though studies have explored the existence of RAEs in independent disciplines (education and sport participation), research has yet to explore whether these two domains interact. Previous research has taken an isolated and specific approach to looking at each aspect individually, rather than a more ecologically representative approach considering how multiple developmental influences may impact each other and the individual as a whole. For example, studies have looked at a specific sport, a specific team, or a cohort of athletes, for the existence of RAEs. Research has shown that relative age is associated with levels of sport participation in that relatively older youth are more likely to be selected for teams (Cobley et al., 2009a). Similarly, studies have

explored academic grade differences in cohorts of students related to relative age. Relatively older students are more likely to get better grades in school (Wattie & Baker, 2013). Furthermore, participating in sport has been shown to be positively related to educational achievement and attendance (Barber, Eccles, & Stone, 2001; Eccles, Barber, Stone, & Hunt, 2003). However, research has not addressed how these multiple influences may interact and affect the individual's development as a whole.

Factors influenced by relative age have thus far been considered independently; however, if considered together, the findings have implications for research and interventions. Examples of questions thus far unexplored include: Does being relatively younger negate or temper the positive influence of sport participation on education outcomes? Do relatively younger youth who participate in sport have better educational outcomes than relatively younger youth who *do not* participate in sport? The answers to these questions may have important implications for school policy, the role of physical education and sport in schools, and for addressing RAEs in education.

Contemporary theories of youth development suggest that human development is multifactorial and influenced by many interacting systems within a person's environment (Bronfenbrenner, 2001). For example, Bronfenbrenner's theory "*the bioecological perspective on human development*" identifies 5 systems: individual, microsystem, mesosystem, exosystem, and macrosystem (Bronfenbrenner, 2001). Microsystem refers to the institutions and groups that most immediately and directly impact the child's development including: family,

school, religious institutions, neighborhood, and peers. Mesosystem equates to the interconnections between the microsystems. For example, interactions between the family and teachers, or the relationship between the child's peers and the family. Exosystem involves links between a social setting in which the individual does not have an active role and the individual's immediate context. For example, a parent's or child's experience at home may be influenced by the other parent's experiences at work. Macrosystem describes the culture in which individuals live. Cultural contexts include developing and industrialized countries, socioeconomic status (SES), political climate, and ethnicity. A child, his or her parent, his or her school, and his or her parent's workplace are all part of a larger cultural context. Members of a cultural group share a common identity, heritage, and values. The macrosystem evolves over time, because each successive generation may change the macrosystem, leading to their development in a unique macrosystem (Bronfenbrenner, 1979).

Therefore, to isolate just one factor (i.e., relative age) and analyze how it influences one outcome (i.e., sport participation) may not provide a comprehensive, ecologically valid view of the individual and their development. Because previous research has largely been univariate and specific to isolated groups and activities/outcomes it is difficult to measure the scope of the impact on the real lived experiences of youth. This is rather alarming when we consider the impact that RAEs can have on various aspects of youth development, such as participation and sport drop-out rates (Wattie, Tietjens, & Schorer, 2012). These outcomes are important to understand because they result from policies

that disadvantage certain kids through no fault of their own. Some have described this as a form of discrimination (Cobley, Miller, Till, & Mckenna, 2013). The importance of this topic should not be underestimated; most mandatory education systems (in Canada and internationally) use date of birth cut-offs that create relative age differences, and as a result many youth can be affected by their relative age. This study provides further knowledge in an effort to better understand the multidimensional nature of positive youth development (PYD) and the influence of RAEs. Few of the interventions that have been proposed to date have been tested and each come with their own set of potential new negative implications, this is discussed in the Possible Solutions section of this thesis.

In summary, previous research has largely been univariate, while in reality youth grow up with multiple influences. There is a need for studies that will allow us to better understand how relative age influences youth development in a more ecologically representative way, are more representative of how kids actually grow up and develop, consider the impact of other activities, and investigate how relative age influences youth development in the bigger picture. Studies thus far have failed to analyze participation patterns and combinations of participation and academic outcomes. This research aims to address the gaps in the literature on RAEs in order to better understand how these phenomena affect youth development with the ultimate goal of informing changes in policy to better support youth.

Study 1 is a secondary data analysis of the COMPASS Study dataset and seeks to explore the relationships between educational, sport and physical

activity participation, and connectedness outcomes. Study 2 is a PRISMA systematic review of existing literature that identifies and strives to categorize possible solutions to RAEs.

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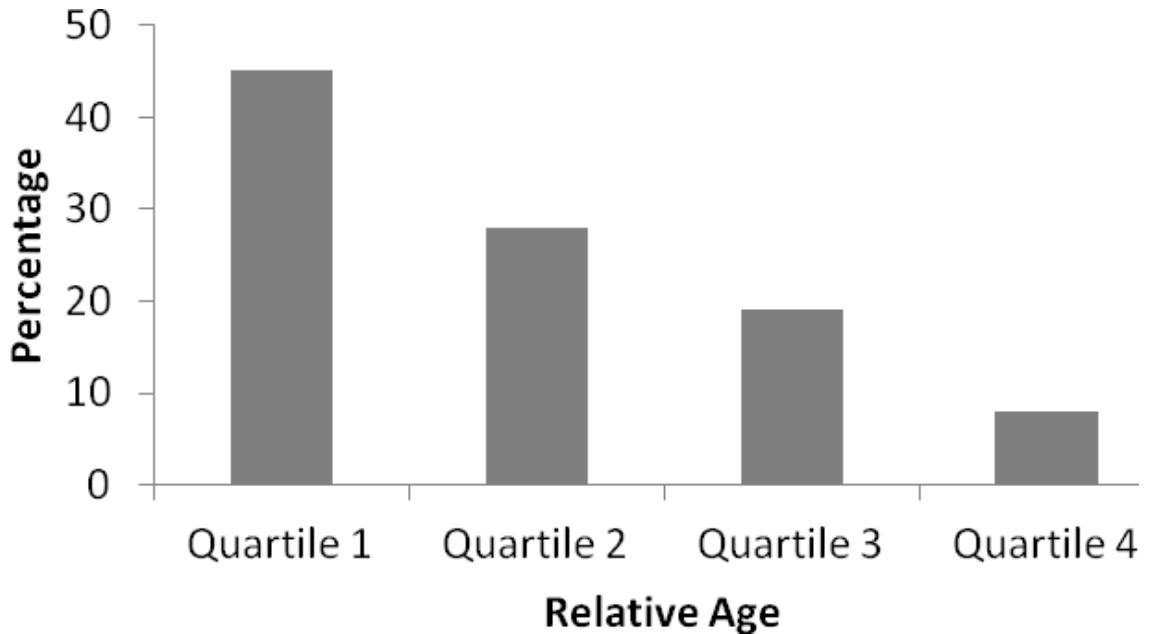
## Chapter 2 – Literature Review

# BACKGROUND

## Introduction

For studies on RAEs it is common to divide participants into quartiles. In the graph below (Figure 1) Quartile 1 (Q1) represents those born between January 1<sup>st</sup> and March 31<sup>st</sup>, Quartile 2 (Q2) includes those born between April 1<sup>st</sup> and June 30<sup>th</sup>, Quartile 3 (Q3) represents those born between July 1<sup>st</sup> and September 30<sup>th</sup>, and Quartile 4 (Q4) includes those born between October 1<sup>st</sup> and December 31<sup>st</sup>.

**Figure 1.** An example of a typical RAE using the quartile method.



Cut-off dates differ (i.e. September 1<sup>st</sup> or January 1<sup>st</sup>) for education and sport contexts and depend on where the study is conducted and what sport league or educational setting is being considered. However, Q1 always represents the oldest constituents within a cohort and those born immediate after

the cut-off date. Relative age effects (RAEs) generally refer to the advantages bestowed upon those born earlier within their cohort (and proportionately the disadvantages conferred onto the relatively younger individuals within the group).

The first study on RAEs in sport was published in 1984 and found that among 3,826 competitive hockey players, those born in the first quarter of the year were consistently overrepresented in comparison to the birth rate in the population for the same period, whereas individuals born in the fourth quarter were underrepresented (Grondin et al., 1984). The same results were not found for the 1,391 competitive volleyball players in the study, suggesting that the age category system used in hockey unduly favours those born early in the year and discriminates against those born late in the year (Grondin et al., 1984). Since 1984 multiple studies have been conducted to determine how relative age impacts sport performance/selection and academics (see below). The studies conducted thus far tend to be specific to one sport or one demographic grouping (Cobley et al., 2009a). There is a need for research that looks at the whole picture of PYD holistically. To date, the research conducted on RAEs has been largely limited to North America, Europe, and Australia.

### ***RAEs in Education***

RAEs were first noted in education and are apparent across subject areas as well as the primary and secondary years, suggesting that RAEs have early and persistent effects throughout the education process (Cobley et al., 2009b). Relatively older students are more likely to: attain higher grades than their relatively younger peers across a range of different subjects (Bell & Daniels,

1990; Massey et al., 1996; Sharp et al., 1994; Cobley et al., 2009b); be placed in top ability streams (Thompson, 1971); and to be identified as 'gifted and talented' (Cobley et al., 2009b). Maddux, Stacy, and Scott (1981) observed that in a group of children who were classified as gifted, 61% were advantaged by a late entry to Grade 1 and thus by a relative age advantage. Cobley, McKenna, Baker, and Wattie (2009b) conducted a study looking at attainment, program participation, and attendance data for 657 pupils (aged 11–14) at a secondary school in North England for the period of 2004–2005. They found that relatively older pupils (September–November born) attained significantly higher grades (in subjects except for English), were more likely to attain consistently high scores across subject areas, and were more likely to be enrolled in gifted and talented programs. Quartile 1 pupils were likely to attain between 0.3– 0.7 of an attainment level higher than a Quartile 4 pupil, depending upon the subject area. Relatively older pupils born in Quartile 1 and 2 were identified as being over four (odds ratio [OR]: 4.66, 95% confidence interval [CI]: 1.91–11.39) and five (OR: 5.69, 95% CI: 2.27–13.78) times more likely to be in the high attaining group (top 20%) compared to pupils born in the last quartile of the academic year. Girls were also identified as being 2.82 times more likely to be represented in the high attaining group after controlling for relative age (95% CI: 1.57–5.06). In contrast, relatively younger pupils (January–August born) were overrepresented in learning support programs, being identified as having special educational needs, and were more likely to be among the lowest 20% of attainment. The youngest girls also had lower attendance (attending school on average 6 days less). Low

attainment was 4.66 times more likely in Quartile 4, and boys were significantly more likely to be represented (OR: 2.82, 95% CI: 1.57–5.06). These findings indicate that RAEs are pervasive and systemic across the curriculum, implicating maturational and psychological mechanisms (Cobley et al., 2009b).

Relative age may also have an influence on developmental wellbeing. Previous research has found that relatively younger children are more likely to be identified as having 'special educational needs' (Wilson, 2000; Bookbinder, 1967; Martin, Foels, Clanton, & Moon, 2004; Wallingford & Prout, 2000) and are over-represented among those identified as learning disabled (Maddux, 1980). Relatively younger children are also over-represented among those referred for psychological counselling due to academic and/or behavioural problems (Drabman, Tarnowski, & Kelly, 1987; Tarnowski, Drabman, Anderson, & Kelly, 1990) and have been found to have lower attendance rates (Carroll, 1992; Cobley et al., 2009b). In addition to these negative outcomes, Thompson, Barnsley, and Battle (2004) and Fenzel (1992) found that relatively younger youth have lower levels of self-esteem. Younger relative age has also been linked to lower motivational and engagement outcomes (though results were mixed) (Martin, 2009). Relatively younger students have been found to be at greater risk of psychiatric disorders than relatively older pupils (Goodman, Gledhill, & Ford, 2003) and one study found that they are more likely to commit suicide (Thompson, Barnsley, & Dyck, 1999). These results suggest that the potential psychological, emotional, behavioural, and developmental consequences associated with relative age differences may be important for

schools and social policy to acknowledge and manage. Supporting attainment and reducing detrimental impacts of RAEs is critical to the success and well-being of all students.

### ***RAEs in Sport & Physical Education***

The majority of RAE studies have been on hockey and soccer participation and talent identification (Cobley et al., 2009a). Numerous studies have examined RAEs in soccer which have identified RAEs among youth and elite players in France, England, Germany, Sweden, Netherlands, Brazil, Japan, Australia, Spain, and United States (Carling, Le Gall, Reilly, & Williams, 2009; Edgar & O'Donoghue, 2004; Dudink, 1994; Brewer, Balsom, & Davis, 1995; Musch & Grondin, 2001; Simmons and Paull, 2001; Jimenez & Pain, 2008; Vincent & Glamser, 2006; Mujika et al., 2002; Helsen, Van Winckel, & Williams, 2005). Over-representation of relatively older players has also been documented for baseball in the United States (Thompson, Barnsley, & Stebelsky, 1991; Côté, MacDonald, Baker, & Abernethy, 2006) and Japan (Grondin & Koren, 2000) along with rugby in Australia (Abernethy & Farrow, 2005). In competitive youth rugby in England nearly 60% of all players are born in the first 3 months of the selection year (Till et al., 2010). RAEs are even evident in professional race car driving (NASCAR) (Abel & Kruger, 2007) and shooting sports (Delorme & Raspaud, 2009). Interestingly, reverse RAEs have been found for gymnastics, where smaller stature and delayed physical maturation are assets (Baker et al., 2014).

In Canada there is a higher representation of hockey players born in January, February, and March selected for provincial and national level teams (Grondin et al., 1984; Barnsley et al., 1985). A study of birthdates of National Hockey League (NHL) players during the 2008-2009 season found that 29.7% of players were born in Quartile 1, 27.4% were born in Quartile 2, 21.9% were born in Quartile 3, and 16.2% were born in quartile 4 (Nolan & Howell, 2010). This study compared their results to the results of the 1985 study by Barnsley, Thompson, & Barnsley (*Hockey success and birthdate: The relative age effect*) and found a similar linear trend between relative age and likelihood of making the NHL. Similar asymmetries have been identified in baseball (Thompson et al., 1991), cricket (Edwards, 1994), and soccer (Dudink, 1994; Verhulst, 1992). In the youth sport contexts similar trends have been observed in hockey (Barnsley & Thompson, 1988), soccer (Vincent & Glamser, 2006; Helsen, Starkess, & Van Winckel, 1998), swimming (Baxter-Jones, 1995) and tennis (Dudink, 1994).

Relatively older students receive higher grades in Physical Education (PE) classes (Cobley, Abraham, & Baker, 2008; Bell, Massey, & Dexter, 1997) and are more likely to be selected to school sports teams (Wilson, 1999; Cobley et al., 2008). Cobley, Abraham, and Baker (2008) collected and analyzed data including PE attainment data and sport participation records of 621 pupils (317 male, 304 female) aged 11–14 years old, at a large secondary school in the North of England for the year 2003–2004. “PE attainment” was based upon observational assessments by PE teachers, where mark allocations reflected the degree of pupil progress and attainment in the academic year. The school PE



department was also asked to provide sport participation information. Effects were found for birth-date (i.e. quartile) and year group on attainment in PE. It was also found that higher frequencies of students born in the first quartile were representing the school across sexes and sports. Cobley et al. (2008) concluded that current age-grouping, assessment and selection strategies in school may be compounding RAEs inside and outside of the classroom. School PE and sport environments may be facilitating attainment and representation for the relatively older individuals in each year group, while simultaneously disadvantaging a high proportion of relatively younger pupils.

Some of the largest magnitude RAEs have been observed in competitive youth sport. In competitive youth hockey 20% more youth than expected (compared to population statistics) were born within the first three months of the selection year & approximately 20% less youth than expected were born in the last three months of the selection year (Barnsley & Thompson, 1988; Barnsley et al., 1992; Grondin et al., 1984). Interestingly, these RAEs emerge among groups as young as 8-9 years of age.

RAEs also persist into elite adult (professional) levels of play in ice hockey (Grondin & Trudeau, 1991; Montelpare, Scott, & Pelino, 1998; Wattie, Baker, Cobley, & Montelpare, 2007). However, although once thought to be a linear relationship, RAE risk is not linear with skill level or age category (Cobley et al., 2009a). At the elite level (professional or senior national representative) risks decreased to below that of the youth representative. At senior ages (>18 years) RAE risk also decreased to below that of the adolescent ages. Nevertheless,

RAEs have been shown to persist into older cohorts (Cobley, 2009a). In a study done on RAEs in UK Rugby League, player data were collected for the male and female community games ranging from Under 7s to senior levels for junior representative selections (i.e. regional) and professional players. Significant uneven birth date distributions were found beginning at the earliest stages of the game and throughout into senior professionals. In junior representative selections, 47.0% of regional and 55.7% of national representative players were born in Quartile 1, with RAE risk increasing with performance level (Till et al., 2010).

## **Possible Explanations**

Various explanations have been proposed as to why RAEs exist. The benefit of early maturation in adolescent sport appears to provide one explanation for RAEs in sport (Grondin & Trudeau, 1991; Musch & Grondin, 2001). The increased likelihood that relatively older youth are of advanced cognitive and/or physical maturity because of older chronological age may afford them a probabilistic (not deterministic) advantage. Relatively older youth have the advantage of life experience and practice time, as well as increased brain development. For example, a child who has just turned 5 years old has been alive for 60 months, and a child who is 5 years old, but about to turn 6 years old (still in the same cohort), has been alive for 72 months. Despite being in the same age-based cohort the older child has had 20% more time to develop physically and cognitively. Similarly, relatively older children are more likely to

have greater physical development in terms of size and strength. Size in youth strongly correlates with physical performance (strength and speed). Interestingly, gymnastics shows an opposite RAE where late-born athletes benefit from delayed onset of physical maturity (Baxter-Jones, 1995; Malina, 1994), offering further support of this theory.

Musch and Grondin (2001) proposed that the cultural popularity and the degree of physicality of a sport are potential catalysts of RAEs. The notion that RAEs are most likely to occur in highly popular sports due to maturation and selection of athletes within the developmental tiers of a sport is also supported by other researchers (Barnsley et al., 1988; Helsen et al., 1998; Sherar, Baxter-Jones, & Faulkner, 2007). Amount of practice accumulated may also contribute to RAEs. Relatively older kids have simply been around longer, which means more lived experience and perhaps experience playing a sport and receiving formal/informal education (Musch & Grondin, 2001). Subsequently, when the older youth within a cohort are selected for higher levels of competition they are often awarded more practice time and access to better coaching. Like education, ability streaming from a young age appears to be conducive to fostering and propagating RAEs in youth sport (Grondin et al., 1984; Musch & Grondin, 2001).

Advanced cognitive maturation could also explain the RAEs seen in terms of academic outcomes. In a study by Helsen et al. (2016) it was found that relatively older youth chess players were more likely to participate in competitive chess and were significantly more often in the top 10 players for each age level of the Belgian Youth Championship 2013. It is likely that the cognitive skills

gained through additional development, life experience, and learning practice benefit relatively older students. Negative experiences at school resulting from being relatively younger may also influence motivation, academic achievement, attendance, and dropout rates. If relatively younger children feel that they are already disadvantaged from a young age, the feelings of discouragement may persist and be magnified as time goes on. This may explain in part the higher prevalence of mental health issues and suicide observed in relatively younger teenagers (Thompson et al., 2004).

It has been argued that to understand RAEs multiple constraints need to be considered (Wattie, Schorer, & Baker, 2015). Individual constraints including height, weight, the timing of maturation, and psychological qualities like resilience, motivation, and personality impact how relative age affects individual youth. Environmental constraints including geographical area, the physical environment, sociocultural environment, policies, and the influence of coaches, family, and friends also affect the youth's development and interact with the effects of relative age. Finally, task constraints including strength, speed, agility, flexibility, technical ability, as well as the goals, rules, and structure of an activity (e.g. individual vs. team sport) also interact with RAEs to impact an individual throughout their development. It is important to note that individual, environmental, and task constraints can both enhance and moderate RAEs and vary from person to person.

## Gaps

Currently available RAE studies do not take a holistic perspective related to RAEs and how they affect the whole person in all aspects of their life. Rather, previous research has taken an isolated and specific approach, often looking at just one variable. The field would benefit from research that considers RAEs as a complex social phenomenon. One advantage of RAE studies is that they have increased ecological validity by nature as they observe real-world outcomes, not outcomes in experimental lab settings/studies. However, the unidimensional nature of that research consequently limits the ecological validity of findings to some degree. In short, we do not know how multiple factors interact to influence RAEs (or lack of RAEs) or why some relatively younger youth *do* succeed/avoid risk associated with their relative age.

Although various solutions to RAEs have been proposed, there has been no attempt to consolidate and/or evaluate the proposed solutions as a collective group. There has been no systematic review of solutions. Anecdotally the solutions have been decontextualized / unidimensional. As there is a need to look at development in a holistic and multidimensional way, there is also a need to review the solutions with the same frame of mind.

Another issue brought to light by Musch and Grondin (2001) in their paper: *“Unequal Competition as an Impediment to Personal Development: A Review of the Relative Age Effect in Sport”*, is that beyond participation *trends*, researchers have not explored whether RAEs actually impede youth development and wellbeing. Rather, the focus of relative age research has largely been on topics

related to talent development/identification in sport. In fact, only approximately 11% of samples in sport-related relative age research have been recreational sport participants (Cobley et al., 2009a). What is more, given that only approximately 10% of samples have been comprised of females (Cobley et al., 2009a) our understanding of how relative age and sport participation may influence PYD is somewhat incomplete.

PYD is derived from developmental systems theory and takes a strength-based view of adolescent development. Rather than trying to correct or focus on negative behaviours or aspects of development, programs and program leaders seek to empathize with, educate, and engage youth in productive activities (Lerner, R., Almerigi, Theokas, & Lerner, J., 2005). PYD emerges when human development is aligned with developmental assets (such as competence, confidence, character, connections, and compassion/caring) (Lerner, Fisher, & Weinberg, 2000; Fraser-Thomas, Côté, & Deakin, 2005). PYD is fostered when other youth, adults, communities, government agencies, and schools make intentional efforts to provide opportunities for youth to enhance their interests, skills, and abilities. The theory of PYD suggests that "if young people have mutually beneficial relations with the people and institutions of their social world, they will be on the way to a hopeful future marked by positive contributions to self, family, community, and civil society." (Lerner et al., 2005).

PYD goes beyond sport participation and encompasses all aspects of youth's lived experiences that contribute to developmental outcomes. PYD may be important because if relatively younger players / students are provided with

fewer opportunities to become engaged within their communities they are less likely to experience the positive outcomes known to be associated with this engagement. Sport in particular is an important aspect of PYD as it has been linked to many positive developmental outcomes including the five 'C's of positive development (competence, confidence, character, connections, and compassion/caring) (Lerner et al., 2000; Fraser-Thomaset al., 2005). Sport participation has also been shown to have a positive influence on academic achievement. Thus, there is a need for research exploring the reality of youth's lived experiences and looking at sport and education as aspects of PYD.

Because PYD involves the active promotion of optimal human development, not just the avoidance of risk, it is important for us to understand how RAEs impact development and investigate what changes we can make to better support all youth. Previous research has focused on the advantages of being relative older and the negative outcomes associated with being relatively younger. To take a PYD approach would mean to look at how we can foster positive developmental assets in all youth regardless of birthdate.

## **Research Questions**

- ▶ How does relative age influence curricular and extracurricular sport and physical education participation?
- ▶ What is the impact of relative age on daily physical and sedentary activity, academic achievement, and feelings of connectedness to one's school?

- ▶ How do RAEs, education, sport / physical activity participation, and feelings of connectedness interact to affect youth?
- ▶ What solutions have been proposed thus far to resolve RAEs in sport?
- ▶ What types of constraints do these solutions address?
- ▶ What are the strengths and weaknesses of each proposed solution?

## **Purpose / Hypothesis**

The purpose of this study is to determine what impact relative age has on educational achievement, participation in school and extracurricular sport and physical education, and the subsequent influence of participation patterns on indicators of PYD. The aim of this research is to gain a better understanding of how relative age influences the complete pattern of youth's curricular and extracurricular activity engagement and to explore the impact of those patterns of participation on developmental outcomes. It is hypothesized that relatively younger students will be disadvantaged in all aspects. This is based on the findings of previous research centred on the effects of relative age on academic and sport outcomes that have found relatively older youth to be advantaged in both educational and sport settings.



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# Chapter 3

## STUDY 1: COMPASS DATA ANALYSIS

**Exploring the relationships between relative age, sport participation, education, and indicators of positive youth development**

## ABSTRACT

Relative age describes the age differences within age groups in sport and education. Relative Age Effects (RAE) indicate that being older within an age group cohort results in advantages in sport and academic outcomes (Musch & Grondin, 2001). However, previous research has predominantly isolated relative age's influence on development outcomes (i.e., sport participation or academic achievement). This study explored interactions between relative age, educational achievement, participation in school and extracurricular sport, and an indicator of positive youth development (i.e., feelings of connectedness to school). A secondary analyses of Ontario secondary school students (N = 22,915; average age = 15.7, SD = 1.25; 50.2% female) from the COMPASS study was conducted. Overall, the greatest percentage of students who participated in sports was found in Quartile 1, followed by Quartiles 2, 3 and 4 ( $\chi^2$  range = 20.12 - 60.91,  $p < .001$ ). There was also a statistically significant effect of relative age (favouring relatively older youth) on feelings of connectedness [ $F(3, 21978) = 5.50$ ,  $p = 0.001$ ]. Moreover, sport participation was positively related to academic achievement and feelings of connectedness (OR = 1.15). Finally, feelings of connectedness were positively related to sport participation as well as higher academic achievement, for all relative age quartiles. No statistically significant relationship was found between relative age and time spent on moderate or hard physical activity or between relative age and sedentary time. Future research should seek to investigate the effects of relative age on other youth sport and education outcomes, especially as they relate to positive youth development and other multi-dimensional aspects of youths' developmental ecology (e.g., socioeconomic status and participation in other non-sport extracurricular activities).

Key Words: Relative age effects, sport, youth, education, connectedness, physical activity

## INTRODUCTION

Youth development outcomes (i.e. grade achievement, engagement, sport attainment) are shaped by many aspects of an individual's lived experiences (Bronfenbrenner, 2001). For example, Bronfenbrenner's theory "*the bioecological perspective on human development*" identifies several systems that each interact and can influence human development. These systems include institutions and groups that most immediately and directly impact a child's development (e.g., family, school, religious institutions, neighborhood, and peers). There can also be interactions between the family and teachers, or the relationship between the child's peers and the family. Systems also include social policies and the culture in which individuals live. Cultural contexts include developing and industrialized countries, socioeconomic status (SES), political climate, and ethnicity. A child, his or her parent, his or her school, and his or her parents' workplaces are all part of a larger cultural context. Members of a cultural group share a common identity, heritage, and values. These systems evolve over time as each successive generation may change the developmental environment (Bronfenbrenner, 1979).

As a result of grouping individuals within developmental systems, youth experience relative age effects (RAEs). Relative age refers to an individual's age relative to their peers in the same cohort. Youth are commonly divided into groups using cut-off dates in order to group individuals with similar cognitive, emotional, and physical development for the purpose of learning or competition in academic and sport settings. Cut-off dates differ (i.e. September 1<sup>st</sup> or January 1<sup>st</sup>) for education and sport contexts and depend on where the study is



conducted and what sport league or educational setting is being considered. However, those born immediately after the cut-off date always represent the oldest constituents within a cohort. Many studies have been conducted to determine how RAEs impact sport performance/selection and academics (see below). However, the studies conducted thus far tend to be specific to one sport or one demographic grouping (Cobley, Baker, Wattie, & Mckenna, 2009a). There is a need for research that looks at the whole picture of positive youth development (PYD) holistically.

## **RAEs in Education**

RAEs are apparent across subject areas as well as the primary and secondary years, suggesting that RAEs have early and persistent effects throughout the education process (Cobley, Baker, Wattie, & Mckenna, 2009b). Relatively older students are more likely to: attain higher grades than their relatively younger peers across a range of different subjects (Bell & Daniels, 1990; Massey, Elliot, & Ross, 1996; Sharp, Hutchison, & Whetton, 1994; Cobley et al., 2009b); be placed in top ability streams (Thompson, 1971); and to be identified as 'gifted and talented' (Cobley et al., 2009b). Maddux, Stacy, and Scott (1981) observed that in a group of children who were classified as gifted, 61% were advantaged by a late entry to Grade 1 and thus by a relative age advantage. Cobley, McKenna, Baker, and Wattie (2009b) conducted a study looking at attainment, program participation, and attendance data for 657 pupils (aged 11–14) at a secondary school in North England for the period of 2004–

2005. They found that relatively older pupils (September–November born) attained significantly higher grades (in subjects except for English), were more likely to attain consistently high scores across subject areas, and were more likely to be enrolled in gifted and talented programs. Quartile 1 pupils were likely to attain between 0.3– 0.7 of an attainment level higher than a Quartile 4 pupil, depending upon the subject area. These findings indicate that RAEs are pervasive and systemic across the curriculum, implicating maturational and psychological mechanisms (Cobley et al., 2009b).

## **RAEs in Sport & Physical Education**

The majority of RAE studies have been on hockey and soccer participation and talent identification (Cobley et al., 2009a). Numerous studies have examined RAEs in soccer and RAEs have been identified among youth and elite players in France, England, Germany, Sweden, Netherlands, Brazil, Japan, Australia, Spain, and United States (Carling, Le Gall, Reilly, & Williams, 2009; Edgar & O'Donoghue, 2004; Dudink, 1994; Brewer, Balsom, & Davis, 1995; Musch & Grondin, 2001; Simmons & Paull, 2001; Jimenez & Pain, 2008; Vincent & Glamsler, 2006; Mujika et al., 2002; Helsen, Van Winckel, & Williams, 2005). Over representation of relatively older players has also been documented for baseball in the United States (Thompson, Barnsley, & Stebelsky, 1991; Côté, MacDonald, Baker, & Abernethy, 2006) and Japan (Grondin & Koren, 2000). RAEs have been identified in rugby union in Australia (Abernethy & Farrow, 2005). In competitive youth rugby in England nearly 60% of all players are born

in the first 3 months of the selection year (Till et al., 2010). RAEs are even evident in professional race car driving (NASCAR) (Abel & Kruger, 2007) and shooting sports (Delorme & Raspaud, 2009). Interestingly, reverse RAEs have been found for gymnastics, where smaller stature and later physical maturation are assets (Baker et al., 2014).

Relatively older students receive higher grades in Physical Education (PE) classes (Cobley, Abraham, & Baker, 2008; Bell, Massey, & Dexter, 1997) and are more likely to be selected to school sports teams (Wilson, 1999; Cobley et al., 2008). Cobley et al. (2008) concluded that current age-grouping, assessment and selection strategies in school may be compounding RAEs inside and outside of the classroom. School PE and sport environments may be facilitating attainment and representation for the relatively older individuals in each year group, while simultaneously disadvantaging a high proportion of relatively younger pupils.

Some of the largest magnitude RAEs have been observed in competitive youth sport. In competitive youth hockey 20% more youth than expected (compared to population statistics) were born within the first three months of the selection year & approximately 20% less youth than expected were born in the last three months of the selection year (Barnsley & Thompson, 1988; Barnsley, Thompson, & Legault, 1992; Grondin, Deschaies, & Nault, 1984). Interestingly, these RAEs emerge among groups as young as 8-9 years of age.

## **RAEs & Developmental Wellbeing**

Relative age may also have an influence on developmental well-being (the state of being comfortable, healthy, or happy). Previous research has found that relatively younger children are more likely to be identified as having 'special educational needs' (Wilson, 2000; Bookbinder, 1967; Martin, Foels, Clanton, & Moon, 2004; Wallingford & Prout, 2000) and are over-represented among those identified as having a learning disability (Maddux, 1980). Relatively younger children are also over-represented among those referred for psychological counselling due to academic and/or behavioural problems (Drabman, Tarnowski, & Kelly, 1987; Tarnowski, Drabman, Anderson, & Kelly, 1990) and have been found to have lower attendance rates (Carroll, 1992; Cobley et al., 2009b). In addition to these negative outcomes, Thompson et al. (2004) and Fenzel (1992) found that relatively younger youth have lower levels of self-esteem. Younger relative age has also been linked to lower motivational and engagement outcomes (Martin, 2009). Relatively younger students have been found to be at greater risk of psychiatric disorders than relatively older pupils (Goodman, Gledhill, & Ford, 2003) and one study found that they are more likely to commit suicide (Thompson, Barnsley, & Dyck, 1999). These results suggest that the potential psychological, emotional, and behavioural consequences associated with relative age differences may be important for schools and social policy to acknowledge and manage. Supporting attainment and reducing detrimental impacts of RAEs is critical to the success and well-being of all students.

## **Gaps**

For the most part currently available RAE studies do not take a holistic perspective related to RAEs and how they affect the whole person in all aspects of their life. Rather, previous research has taken an isolated and specific approach, often looking at just one variable. The field would benefit from research that considers RAEs as a complex social phenomenon.

Another issue brought to light by Musch & Grondin (2001), is that beyond participation *trends*, researchers have not explored whether RAEs actually impede youth development and wellbeing. Rather, the focus of relative age research has largely been on topics related to talent development/identification in sport. In fact, only approximately 11% of samples in sport-related relative age research have been recreational sport participants (Cobley et al., 2009a). What is more, given that only approximately 10% of samples have been comprised of females (Cobley et al., 2009a), our understanding of how relative age and sport participation may influence PYD is somewhat incomplete.

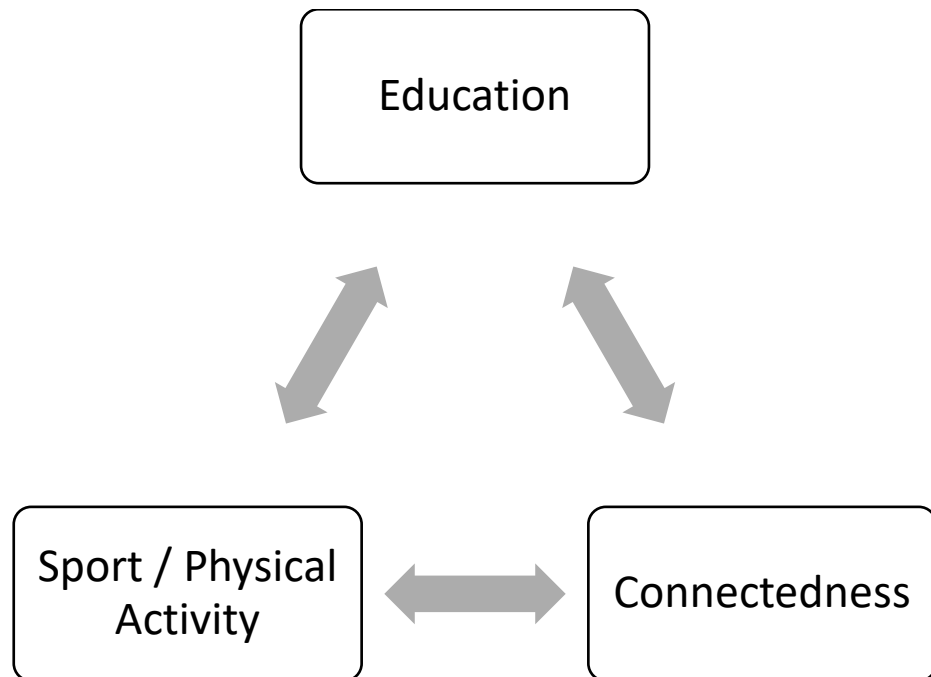
## **COMPASS Data Analysis**

This study examined how relative age influences curricular and extracurricular sport and physical education participation of secondary school students in Ontario. The impact of relative age on daily physical and sedentary activity, academic achievement, and feelings of connectedness to one's school were also examined. Our aim was to gain a better understanding of how relative age influences the multidimensional pattern of youth's curricular and

extracurricular activity engagement and to explore the impact of those patterns of participation on developmental outcomes.

Secondary analysis of data collected for the COMPASS study was conducted using SPSS software. Research to date on RAEs for females specifically is limited. The data collected from all students was analyzed and then males and females were considered as separate groups in order to gain a better understanding of how (or if) relative age affects female and male groups differently. Our hypothesis was that relatively younger students would be disadvantaged in all aspects. This hypothesis was based on the findings of previous research centred on the effects of relative age on academic and sport outcomes. Motivations for undertaking this research included addressing the gaps in the literature on RAEs in order to better understand how these phenomena affect youth development with the ultimate goal of informing changes in policy to better support youth. For the sake of clarity, we discuss the study's findings in four sections: education, sport, PYD, and interactions between these subtopics (see Figure 1).

**Figure 2.** Subtopics and interactions studied



## METHODS

### **Data Source: The COMPASS Study**

The COMPASS study was a four-year study about youth health behaviours. It was funded by the Canadian Institutes of Health Research (CIHR). The study was conducted by researchers at the University of Waterloo in collaboration with researchers at the University of Alberta and the University of Toronto. Participating students in grades 9-12 were surveyed annually for four years (2012-2016). COMPASS also tracked any changes made to the school's health policies and programs during this time.

Each year, participating schools received a detailed feedback report which included evidence-based recommendations for health policy and program improvement. COMPASS had support staff and resources available to schools to help them translate these recommendations into action.

“This was the first time in Canada and the world that a survey allowed us to: see changes in youth health behaviours over time, determine whether changes to school health policies and programs were effective, and work directly with schools to implement change.” (The COMPASS study, 2015)

The 30-minute self-report questionnaire (Appendix 2) asked participating students questions about: their height and weight, daily physical activity, daily sedentary activity, eating behaviours, experience with tobacco, alcohol and marijuana use, feelings of connectedness to their school, academic achievement, bullying, and absenteeism. The COMPASS study design was a longitudinal cohort study. The surveys were distributed by teachers in class. Research Assistants were also present to assist with administration of the study and to answer questions.

## **COMPASS data usage**

Data from the COMPASS study is stored at the University of Waterloo on a secure server. The principal investigator of COMPASS, Professor Scott Leatherdale, maintains ownership of all COMPASS data. In order to gain access



to the COMPASS data for use in this study, the COMPASS data usage application was completed and approved by the principal investigator of COMPASS. Upon full approval, data was made available through a secure server. The COMPASS study survey is available in Appendix 2.

## **Confidentiality**

The following steps were taken by the COMPASS administrators to ensure that the answers provided by individuals on the survey remained confidential:

- “no names were written on the surveys
- each survey was identified by a self-generated alpha-numeric code, only for the purpose of comparing data over four years
- students sealed their completed surveys in an envelope before submitting them to project staff
- all student information was kept separate from the survey responses
- individual student responses were not given to the school or other personnel
- surveys will be stored at the University of Waterloo for seven years and only research staff have access to the completed surveys; the surveys will be destroyed after seven years while the electronic data with no personal identifiers will be kept for an indefinite period of time”

(The COMPASS study, 2015)

## **Study Design**

This study is a secondary analysis of the COMPASS data set, and explores the effects of relative age on participation patterns and health behaviours in secondary school aged youth by analyzing survey responses grouped by relative age quartiles. This study examined survey responses of secondary school students in Ontario in grades 9-12 for the one-year period of 2012-2013.

Secondary data analysis involves taking a data set that already exists (which was collected for use in other research) and analyzing the data to answer a new question. The existing data set is comprehensive and suitable for this study as it includes a large sample size (n= 22,915) and the questionnaire addresses student participation and health behaviours. The COMPASS data set is multivariate as it questions students on demographic information, academic performance, participation in extracurricular activities, and feelings of connectedness. Analyzing this data will demonstrate how these factors interact to affect youth development by comparing relative age to patterns of participation. This data set will also allow comparison of differences between males and females.

## ***Ethics***

This study was conducted using secondary data analysis. The initial data collection and project was approved by REB at University of Waterloo. The Tri-Council Policy Statement (TCPS-2) on Ethical Conduct for Research Involving Humans (Article 2.4) states that REB review is not required for research that is

exclusively secondary use of anonymous data. Although all information in the COMPASS dataset is completely confidential and anonymous and there is no way that participants could be identified, ethical approval has been obtained from UOIT (REB #: 13606)

### ***The Database and Variables***

The COMPASS dataset includes information collected for the following categories: about you, physical activity, healthy eating, your experience with smoking, alcohol and marijuana use, your school and you. Data from the sections of the questionnaire: “about you”, “physical activity” and “your school and you” were analyzed.

#### *About You*

The “About You” section contains information on month of birth, grade, age, and sex. This section also includes information on time spent on sedentary activities throughout the week. Variables from this section were used to group respondents into relative age quartiles and to analyze trends related to relative age and sedentary time (see below).

#### *Physical Activity*

This portion of the data set includes information on time spent in the last seven days doing hard or moderate physical activity. The students were also asked to provide information on their participation in physical activities organized by their school, physical education class, competitive school sports teams, and

teams outside of school. Variables from this section were used to analyze trends related to relative age and physical activity time as well as participation in various types of sport and physical activities (see below).

### *Your School and You*

The “Your School and You” section contains information regarding academic achievement (grades for Math and English), perceptions of safety, and feelings of connectedness. These variables were used to analyze trends related to relative age and academic achievement as well as relative age and feelings of connectedness (see below).

### ***Power Calculation***

This study dataset contains information on 22,915 secondary school students. Typical sample sizes for RAE studies have been between 16 and 8857 (Cobley et al., 2009a), and effect sizes tend to be small to medium for relative age studies. Assuming we are looking for a small effect size with a statistical significance criterion of  $p < .05$ , with a power value of 95%, the sample size needed would be 1700 (calculated using G power software: Faul, Erdfelder, Lang, & Buchner, 2007). This demonstrates that the data set of 22,915 is more than sufficient to detect any existing effect sizes at the statistical significance threshold.

## ***Participants***

The number of participants was 22,915. Participants were from secondary schools in Ontario. In order to keep the information collected completely confidential, there was no way of matching participants to schools or regions of the province. Secondary data analysis was used to examine data collected over the 2012-13 school year. Participants were in grades 9-12 at the time of the study. The average age of the participants was 15.7, SD = 1.25. The participants were 50.2% female (The COMPASS study, 2015).

## ***Variables***

### *Demographic*

Demographic variables used in the current study include sex and relative age. For relative age, the participants of the survey were divided into quartiles based on birth date and the selection date criteria. Those born January 1<sup>st</sup> – March 31<sup>st</sup> (inclusive) were assigned to Quartile 1, those born April 1<sup>st</sup> – June 30<sup>th</sup> (inclusive) were assigned to Quartile 2, those born July 1<sup>st</sup> – September 30<sup>th</sup> (inclusive) were assigned to Quartile 3, and those born October 1<sup>st</sup> – December 31<sup>st</sup> (inclusive) were assigned to Quartile 4. The quartiles were arranged in this way to match the cut-off dates commonly used in Ontario in education and sport settings (January 1<sup>st</sup> is the most commonly used cut-off date). This is also the common convention in RAE research (Musch & Grondin, 2001; Wattie, Schorer, & Baker, 2015).

Other variables examined were divided into three general categories: 1. Education, 2. Sport and Physical Activity Participation, and 3. Connectedness.

### *Education*

Variables considered for the second category, education, include self-reported grades attained for math and English. The response options were as follows: 90 - 100%, 80 - 89%, 70 - 79%, 60 - 69%, 55 - 59%, 50 - 54%, and less than 50%. The categories of 55-59%, and less than 50% were combined for the purpose of analyses in order to simplify the results.

### *Sport and Physical Activity Participation*

Respondents filled in scantron bubbles for the hours (0, 1, 2, 3, 4, 5, 6, 7, 8, or 9) and minutes (0, 15, 30, or 45) they spent per day on each of the following activities: watching tv / streaming tv shows or movies, playing video / computer games, doing homework, talking on the phone, surfing the internet, and texting, messaging or emailing. For the purpose of analyses, the new variable “combined total sedentary time” was created by combining the total time spent per day (hours and minutes) on each of the aforementioned activities. In order to calculate “combined total sedentary time” the hours for each variable were multiplied by 60 and added to the minutes for each variable to get a total number of minutes per day. The minutes of all variables were then summed to get total combined minutes of sedentary time per day.

A new variable (“combined total moderate and hard physical activity per day”) was created to combine total minutes per day spent on moderate or hard physical activity. To do this, the data collected for hours (scantron bubble options: 0, 1, 2, 3, 4, 5, 6, 7, 8, or 9) and minutes (scantron bubble options: 0, 15, 30, or 45) of hard and moderate physical activity on each of the last seven days

were combined. The survey questions read as follows (see Appendix 2): “Mark how many minutes of HARD physical activity you did on each of the last 7 days. This includes physical activity during physical education class, lunch, after school, evenings, and spare time.” and “Mark how many minutes of MODERATE physical activity you did on each of the last 7 days. This includes physical activity during physical education class, lunch, after school, evenings, and spare time. Do not include time spent doing hard physical activities.” These questions were preceded by the following description: “HARD physical activities include jogging, team sports, fast dancing, jump-rope, and any other physical activities that increase your heart rate and make you breathe hard and sweat. MODERATE physical activities include lower intensity activities such as walking, biking to school, and recreational swimming.” In order to calculate “combined total moderate and hard physical activity per day” the values for hours of moderate and hard physical activity were multiplied by 60 and added to the values for minutes to get total minutes spent on moderate and hard physical activity for each day of the week (over the past 7 days). The number of minutes spent on moderate and hard physical activity for all of the past 7 days were summed and then divided by 7 to get an average number of minutes of hard or moderate physical activity per day.

Other variables in the Sport and Physical Activity category include whether or not youth were taking physical education class, participating in intramurals, participating in competitive school teams, and / or participating in sport outside of school (not specific whether competitive or recreational). For the question, “Are

you taking a physical education class at school this year?” respondents could indicate “Yes, I am taking one this term” or “Yes, I will be taking one or have taken one this school year, but not this term”. For the purpose of analysis these variables were combined into one and the alternative option remained “No, I am not taking a physical education class at school this year”.

For the questions, “Do you participate in before-school, noon hour, or after-school physical activities organized by your school? (e.g., intramurals, non-competitive clubs)” and “Do you participate in competitive school sports teams that compete against other schools? (e.g., junior varsity or varsity sports)” respondents could indicate “Yes”, “No”, or “None offered at my school”. For the question, “Do you participate in league or team sports outside of school?” respondents could indicate “Yes”, “No”, or “There are none available where I live”. For the purpose of analysis the options of “No” and “None offered at my school” / “There are none available where I live” were combined into one variable so that we could then compare students who were or were not sport participants. Those who were considered sport participants had to have answered “yes” to one (or more) of the three sport options. Those who answered no to all three sport options were considered to not be sport participants.

### *Connectedness*

Variables considered for the category of connectedness include: I feel close to people at school, I feel I am part of my school, I am happy to be at my school, I feel teachers at my school treat me fairly, I feel safe in my school. These variables were combined into one variable, labelled “feelings of



connectedness”. Each of these variables is measured as 1=“strongly agree”, 2=“agree”, 3=“disagree”, or 4=“strongly disagree”. The coding of these variables was reversed so that a higher number would indicate stronger feelings of connectedness. Each student’s responses were then summed to give a total number out of a possible score of 20 to indicate feelings of connectedness.

If a student feels more connected and supported at school this indicates that they are more engaged. The school setting is only one environment contributing to PYD as a whole, but this rating provides an indication of the experiences of the youth surveyed in terms of their engagement and development related to the school setting. Feeling supported and engaged within their schools in a productive and constructive way promotes positive relationships and helps to develop students’ strengths and leadership skills. The connectedness variable is made up of variables associated with the students’ feelings of belonging and perceived support at school which represent internal and external developmental assets. Thus, the variable of combined feelings of connectedness is being used as a proxy for factors that are important influences on PYD.

**Table 1.** Summary of variables used in analyses

<b>Education</b>	Math grade  English grade
<b>Sport / Physical Activity</b>	“Combined total sedentary time” (made up of time spent: watching tv / streaming tv shows or movies, playing video / computer games, doing homework, talking on the phone, surfing the internet, and texting, messaging or emailing)

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“Combined total moderate and hard physical activity per day” (hours and minutes of hard and moderate physical activity on each of the last seven days were combined)

“Are you taking a physical education class at school this year?”

“Do you participate in before-school, noon hour, or after-school physical activities organized by your school? (e.g., intramurals, non-competitive clubs)”

“Do you participate in competitive school sports teams that compete against other schools? (e.g., junior varsity or varsity sports)”

“Do you participate in league or team sports outside of school?”

**Connectedness**

“Feelings of connectedness” (made up of the following combined: I feel close to people at school, I feel I am part of my school, I am happy to be at my school, I feel teachers at my school treat me fairly, I feel safe in my school.)

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**Analyses**

For each relative age quartile, survey answers related to grades for math and English, physical activity, time spent on sedentary activities, and connectedness to school were collated. The results across relative age quartiles were then compared for each variable to identify trends correlated to the relative age quartiles. The statistical significance threshold for the current research is  $p < .05$ . SPSS software (IBM Corp., 2016) was used to analyze the data. Specific analyses are described below for the four categories of analyses: Education, Sport and Physical Activity Participation, Connectedness, and Combined.

### *Education*

Chi-square tests of independence were carried out to compare the proportion of students in each grade category (90-100%, 80-89%, 70-79%, 60-69%, and less than 59%) stratified by relative age quartile for self-reported math and English grades. Results were analyzed both between and within relative age quartiles. These tests were performed for all survey respondents who answered the related survey questions, and then the same test was performed for females and males separately. These tests were performed in order to investigate whether relative age had an influence on academic achievement (math and English grades). Differences in the effects of relative age on academic achievement for male vs. female students were also investigated to establish if there were differences between these groups.

### *Sport and Physical Activity Participation*

Chi-square tests of independence were calculated comparing the percentage of students in each quartile participating in competitive school sport, intramural physical activities, and league or team sports outside of school. Effects both between and within relative age quartiles were examined. These tests were then performed for females and males separately. These tests were performed in order to examine whether there were RAEs for each of these different categories and if so whether the effect was different for the different sport participation contexts considered.

A one-way between participants ANOVA was conducted to compare the effect of relative age quartile on sedentary time per day. A one-way between

participants ANOVA was conducted to compare the effect of relative age quartile on minutes of moderate or hard physical activity per day.

### *Connectedness*

A one-way between participants ANOVA was conducted to compare the effect of relative age quartile on feelings of connectedness. The same test was then performed for females only and males only as separate groups. These tests were performed in order to explore whether relative age had an effect on feelings of connectedness (related to PYD).

### *Combined*

#### **RAE - Education & Sport**

Chi-square tests of independence were calculated comparing math and English grades for students in each quartile who answered yes to currently participating in sport. These tests were then performed for students in each quartile who answered no to currently participating in sport.

A logistic regression analysis was conducted to quantify the likelihood (odds ratio) of participation in sport based on respondents' relative age quartiles and math grades as predictors. This test was conducted using all students who responded to the related survey questions and then for females and males separately. The same analysis was conducted with English grades as predictors. This test was performed using data from all respondents who answered the related survey questions and was subsequently performed for females and males considered as separate groups. These tests were performed in order to examine

whether there was a relationship between academic achievement and sport participation related to relative age. The relationship for males and females were also considered separately.

### **RAE - Sport / Physical Activity & Connectedness**

A one-way between participants MANOVA was conducted to compare the effect of relative age quartile on combined feelings of connectedness, time per day spent on moderate or hard physical activity, and daily sedentary time.

A factorial ANOVA was conducted to compare the effect of relative age quartile and sport participation on feelings of connectedness. A two-way (4 x 2) analysis of variance was conducted on the influence of two independent variables, relative age quartile and sport participation on feelings of connectedness. Relative age included 4 quartiles and sport participation consisted of two levels (yes or no). This test was performed to see whether sport participation had an effect on feelings of connectedness related to relative age, and if there was an interaction effect between relative age and sport participation.

A logistic regression analysis was conducted to predict the likelihood of sport participation using relative age quartiles and feelings of connectedness as predictors. This test was performed using data from all respondents who answered the relevant survey questions and was then performed for females and males as separate groups. This test was performed in order to explore whether there was a relationship between sport participation and feelings of connectedness related to relative age. The relationship for males and females were also considered separately.

## **RAE - Education & Connectedness**

A factorial ANOVA was conducted to compare the effect of relative age quartile and math grade achievement on feelings of connectedness. A two-way (4 x 5) analysis of variance was conducted on the influence of two independent variables, relative age quartile and math grade achievement on feelings of connectedness. Relative age included 4 quartiles and math grade achievement consisted of five levels (90-100%, 80-89%, 70-79%, 60-69%, and less than 59%). This test was performed to see whether math grade achievement had an effect on feelings of connectedness related to relative age, and if there was an interaction effect between relative age and math grade achievement.

A factorial ANOVA was conducted to compare the effect of relative age quartile and English grade achievement on feelings of connectedness. A two-way (4 x 5) analysis of variance was conducted on the influence of two independent variables, relative age quartile and English grade achievement on feelings of connectedness. Relative age included 4 quartiles and English grade achievement consisted of five levels (90-100%, 80-89%, 70-79%, 60-69%, and less than 59%). This test was performed to see whether English grade achievement had an effect on feelings of connectedness related to relative age, and if there was an interaction effect between relative age and English grade achievement.

## RESULTS

The overall sample size of student respondents was 22,915. Of the overall sample 5436 (23.7%) had birthdates within Quartile 1, 6094 (26.6%) were born within Quartile 2, 6035 (26.3%) had birthdates within Quartile 3, and 5350 (23.3%) were born within Quartile 4. Of the total sample, 11,501 (50.2%) of respondents were female and 11,414 (49.8%) were male. For the 22,897 students who provided their age all were between 13 and 18 years old. The average age of respondents was 15.67 years (SD = 1.25).

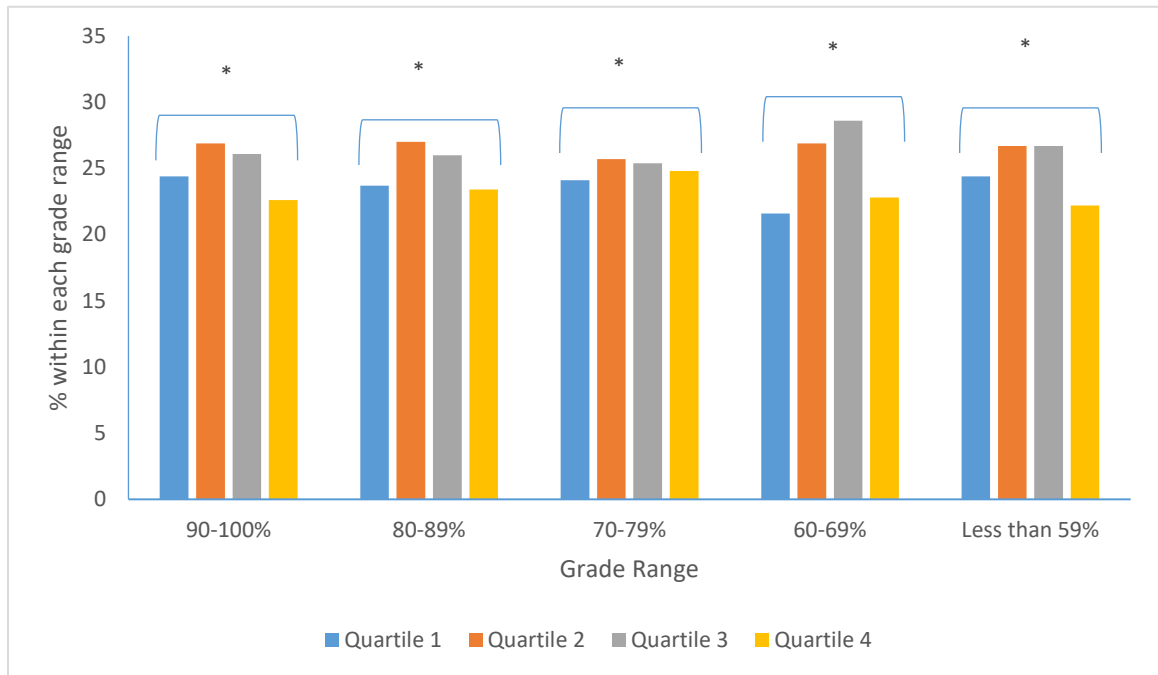
### **Education**

Of the total 22,915 students, 22,312 provided their most recent math mark and 22,268 provided their most recent English mark. For math 17.5% were in the 90-100% range, 28.3% were in the 80-89% range, 25.1% were in the 70-79% range, 13.9% were in the 60-69% range, and 12.6% achieved 59% or less. For English 11.7% were in the 90-100% range, 36.2% were in the 80-89% range, 31.4% were in the 70-79% range, 11.7% were in the 60-69% range, and 6.3% achieved 59% or less.

### **Math**

A Chi-square test of independence was carried out comparing the proportion of students in each math grade category stratified by relative age quartile. A statistically significant effect was found ( $\chi^2(12) = 27.57, p < .01$ ). Quartile 2 and 3 were over represented compared to Quartiles 1 and 4 for all grade ranges (see Figure 2).

**Figure 2.** Percentage of students in each relative age quartile within each grade range for Math (\* =  $p < .01$ )



No distinct RAE pattern was observed for math grades between or within quartiles (see Figure 2 and Table 2).

**Table 2.** Percentage of students by quartile (within quartiles) within each Math grade range

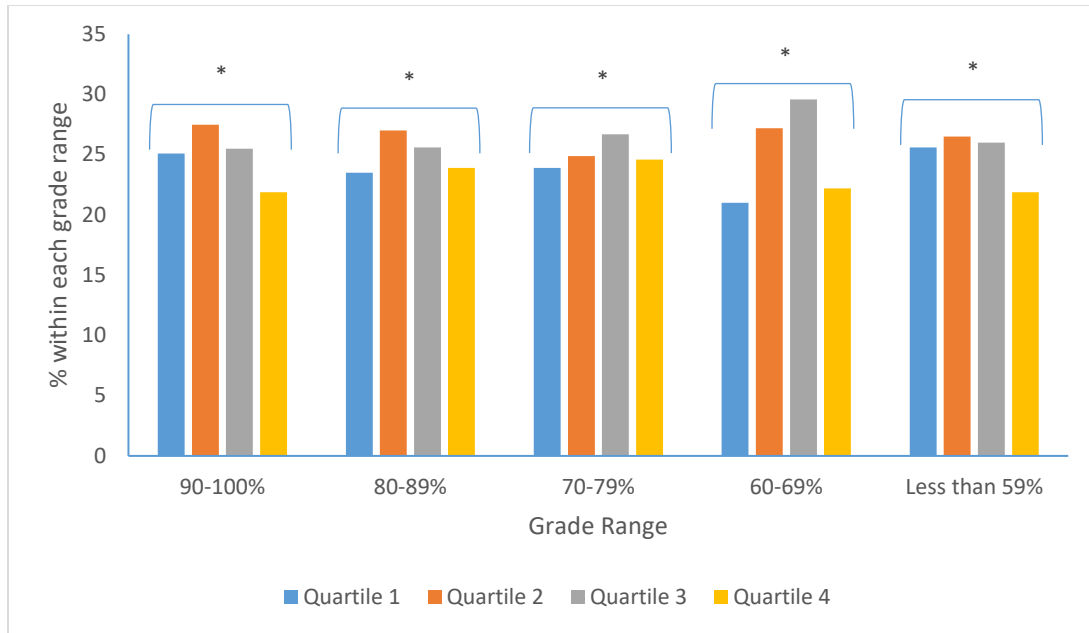
Quartile	Grade Category				
	90-100%	80-89%	70-79%	60-69%	Less than 59%
1	18.0%	28.2%	25.4%	12.7%	15.7%
2	17.6%	28.7%	24.2%	14.1%	15.4%
3	17.3%	27.9%	24.2%	15.2%	15.5%
4	16.9%	28.3%	26.6%	13.6%	14.6%

Statistically significant results for all quartiles across all grade ranges

A Chi-square test of independence was calculated comparing the math grades of female students in each quartile. A statistically significant effect was found ( $\chi^2(12) = 27.25, p < .01$ ). Quartile 2 and 3 were over represented compared to Quartiles 1 and 4 for all grade ranges (see Figure 3).



**Figure 3.** Percentage of students in each relative age quartile within each grade range for Math (Females only) (\* =  $p < .01$ )



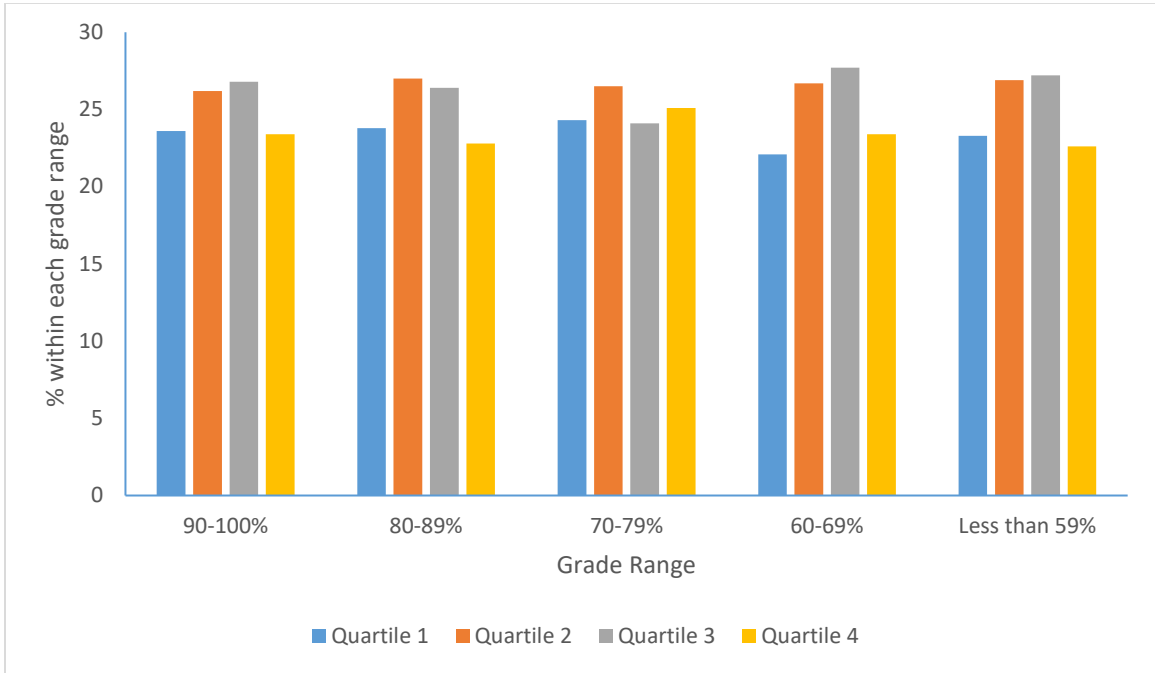
**Table 3.** Percentage of female students by quartile (within quartiles) within each grade range (Math)

Quartile	Grade Category				
	90-100%	80-89%	70-79%	60-69%	Less than 59%
1	19.5%	28.6%	25.0%	12.0%	15.0%
2	19.2%	29.5%	23.4%	14.0%	13.9%
3	17.8%	28.0%	25.2%	15.2%	13.7%
4	17.5%	29.9%	26.5%	13.0%	13.1%

Statistically significant results for all quartiles across all grade ranges

A Chi-square test of independence was calculated comparing the math grades of male students in each quartile. No statistically significant interaction was found ( $\chi^2(12) = 13.96, p > .05$ ). Quartile 2 and 3 were over represented compared to Quartiles 1 and 4 (see figure 4).

**Figure 4.** Percentage of students in each relative age quartile within each grade range for Math (Males only)



**Table 4.** Percentage of male students by quartile (within quartiles) within each grade range (Math)

Quartile	Grade Category				
	90-100%	80-89%	70-79%	60-69%	Less than 59%
1	16.4%	27.8%	25.9%	13.4%	16.5%
2	16.1%	27.8%	25.0%	14.3%	16.8%
3	16.7%	27.7%	23.2%	15.1%	17.3%
4	16.3%	26.7%	26.8%	14.2%	16.0%

No statistically significant results for any quartiles across all grade ranges

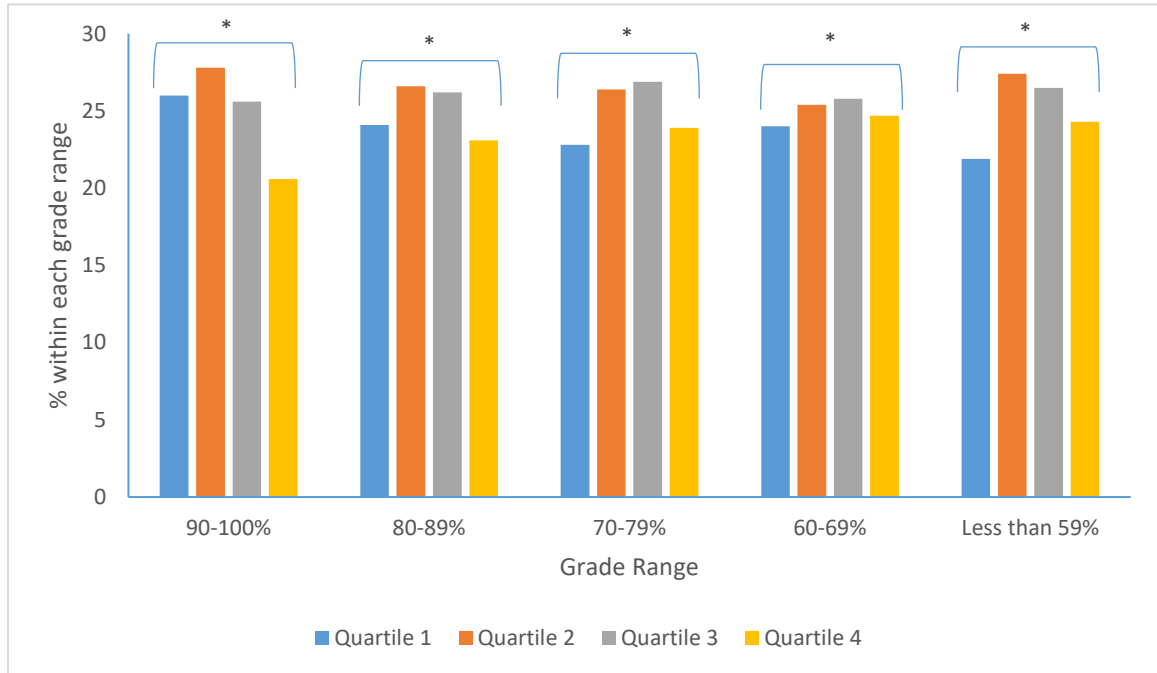
No discernable RAE pattern was observed for math grades within each quartile for male students (see Table 4).

### **English**

A Chi-square test of independence was calculated comparing the English grades of students in each quartile. A statistically significant effect was found ( $\chi^2$

(12) = 28.89,  $p < .01$ ). Quartile 2 and 3 were over represented compared to Quartiles 1 and 4 (See Figure 5).

**Figure 5.** Percentage of students in each relative age quartile within each grade range for English (\* =  $p < .01$ )



Small differences were seen with more students achieving higher grades in Quartiles 1 and 2 than in Quartiles 3 and 4 (see Table 5).

**Table 5.** Percentage of students by quartile (within quartiles) within each grade range (English)

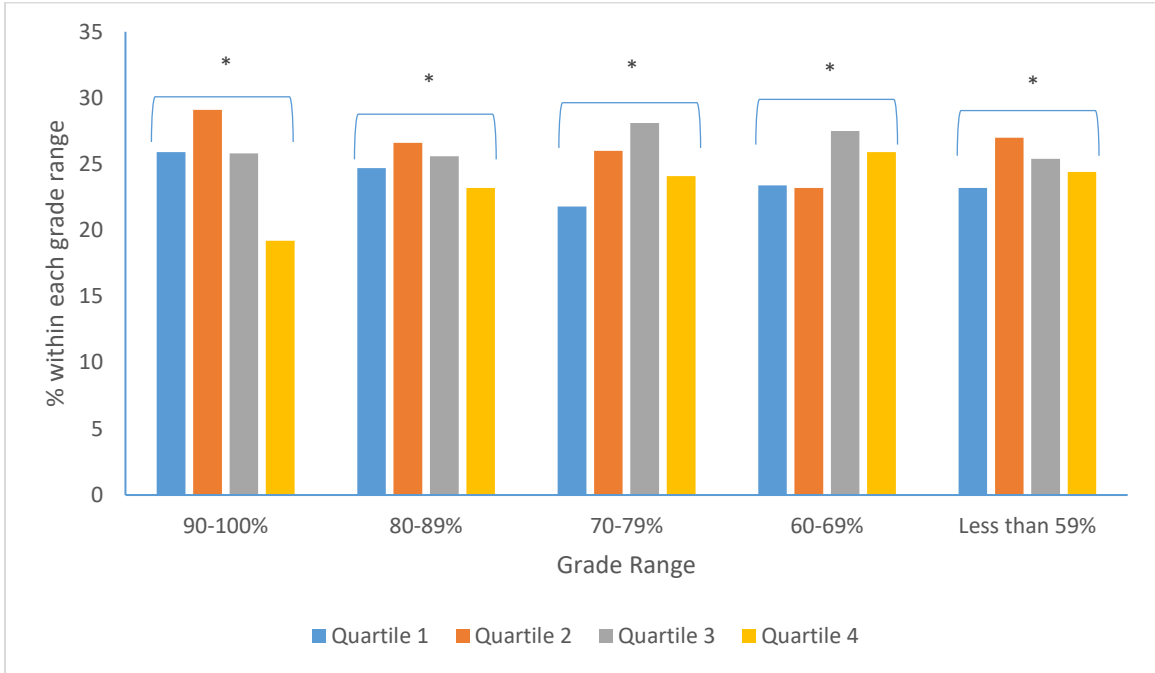
Quartile	Grade Category				
	90-100%	80-89%	70-79%	60-69%	Less than 59%
1	12.8%	36.7%	30.3%	11.8%	8.3%
2	12.2%	36.1%	31.2%	11.2%	9.3%
3	11.4%	36.0%	32.1%	11.5%	9.1%
4	10.3%	35.8%	32.1%	12.4%	9.4%

Statistically significant results for all quartiles across all grade ranges

A Chi-square test of independence was calculated comparing the English grades of female students in each quartile. A statistically significant interaction

was found ( $\chi^2(12) = 41, p < .001$ ). Quartile 2 and 3 were over represented compared to Quartiles 1 and 4 (see Figure 6).

**Figure 6.** Percentage of students in each relative age quartile within each grade range for English (Females only) (\* =  $p < .001$ )



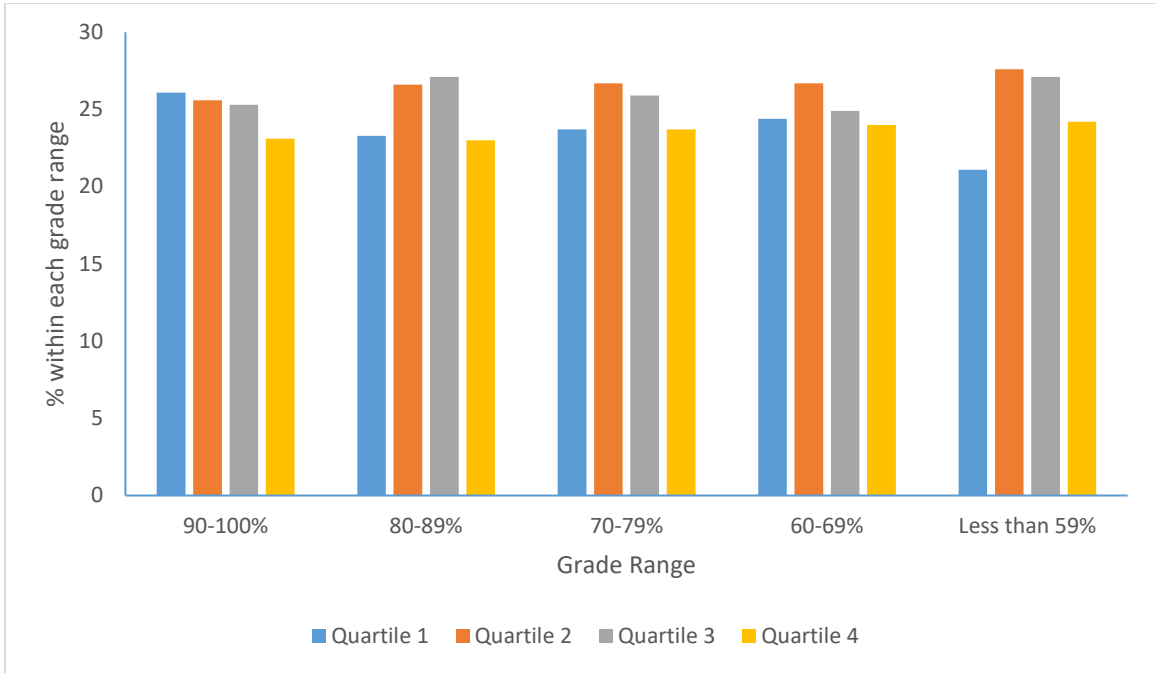
**Table 6.** Percentage of female students by quartile (within quartiles) within each grade range (English)

Quartile	Grade Category				
	90-100%	80-89%	70-79%	60-69%	Less than 59%
1	16.1%	43.2%	25.6%	8.5%	6.5%
2	16.2%	41.8%	27.6%	7.6%	6.8%
3	14.4%	40.4%	29.8%	9.0%	6.4%
4	12.3%	41.7%	29.3%	9.7%	7.1%

Statistically significant results for all quartiles across all grade ranges

A Chi-square test of independence was calculated comparing the English grades of male students in each quartile. No statistically significant effect was found ( $\chi^2(12) = 11.56, p > .05$ ). Quartile 2 and 3 were over represented compared to Quartiles 1 and 4 (see Figure 7).

**Figure 7.** Percentage of students in each relative age quartile within each grade range for English (Males only)



**Table 7.** Percentage of male students by quartile (within quartiles) within each grade range (English)

Quartile	Grade Category				
	90-100%	80-89%	70-79%	60-69%	Less than 59%
1	9.5%	30.1%	35.0%	15.2%	10.2%
2	8.2%	30.4%	34.9%	14.8%	11.8%
3	8.3%	31.6%	34.4%	14.0%	11.8%
4	8.4%	29.8%	35.0%	15.0%	11.7%

No statistically significant results for any quartiles across all grade ranges

## Sport and Physical Activity Participation

Of the 22,915 total respondents in this study, 22,750 were valid (responded either yes or no to currently participating in sport). 15,156 answered yes to currently participating in sport and 7,594 answered no. This equates to 66.6% of respondents currently participating in sport. Of the 22,756 respondents who answered, 49.0% were participating in sport outside of school. Of the 22,798

respondents who answered, 37.7% were currently participating in intramural sport. Of the 22,799 respondents who answered, 41.6% were participating in competitive school sport.

Of the females who responded either yes or no to currently participating in sport, 4,963 (44.0%) were participating in sport outside of school, 4,061 (36.9%) were currently participating in intramural sport, and 4,069 (36.1%) were participating in competitive school sport.

Of the males who responded either yes or no to currently participating in sport, 6,256 (56.0%) were participating in sport outside of school, 4,580 (42.1%) were currently participating in intramural sport, and 5,454 (48.9%) were participating in competitive school sport.

A Chi-square test of independence was calculated comparing the number of students in each quartile participating in competitive school sport. A statistically significant effect was found ( $\chi^2(6) = 60.91, p < .001$ ). Within each quartile the greatest percentage of students who participated in competitive sports were found in Quartile 1, followed by Quartiles 2 and 3, and Quartile 4 had the lowest percentage of students participating in competitive sport (see Table 8).

**Table 8.** Percentage of students by quartile (within and between quartiles) who participate in competitive school sports teams (compete against other schools)

Quartile	% within quartile	% between quartiles
1	44.7%	25.4%
2	43.4%	27.6%
3	40.4%	25.5%
4	38.5%	21.5%

Statistically significant results for all quartiles

A Chi-square test of independence was calculated comparing the number of students in each quartile participating in intramural physical activity. A statistically significant interaction was found ( $\chi^2 (3) = 20.12, p < .001$ ). Within each quartile there were proportionately more youth who participated in intramural and non-competitive clubs organized by their school found in Quartiles 1 and 2, followed by Quartile 3, and Quartile 4 had the lowest percentage of students participating (see Table 9).

**Table 9.** Percentage of students by quartile (within and between quartiles) who participate in before-school, noon hour or after school PAs organized by school (intramural, non-comp clubs)

Quartile	% within quartile	% between quartiles
1	40.9%	24.6%
2	40.8%	27.4%
3	38.8%	25.9%
4	37.3%	22.0%

Statistically significant results for all quartiles

A Chi-square test of independence was calculated comparing the number of students in each quartile participating in league or team sport outside of school. A statistically significant interaction was found ( $\chi^2 (3) = 8.80, p < .05$ ). Within each quartile the greatest percentage of students who participated in league or team sport outside of school were found in Quartile 2, followed by Quartiles 3 and 1, and Quartile 4 had the lowest percentage of students participating in sport outside of school (see Table 10).

**Table 10.** Percentage of students by quartile (within and between quartiles) who participate in league or team sport outside of school

Quartile	% within quartile	% between quartiles
1	49.8%	23.7%
2	51.4%	27.4%
3	49.9%	26.3%
4	48.6%	22.7%

Statistically significant results for all quartiles

### **Females**

A Chi-square test of independence was calculated comparing the number of female students in each quartile participating in competitive school sport. A statistically significant effect was found ( $\chi^2 (3) = 23.08, p < .001$ ). Within each quartile the greatest percentage of female students who participated in competitive sports were found in Quartiles 1 and 2, followed by Quartile 3, and Quartile 4 had the lowest percentage of female students participating in competitive sport (see Table 11).

**Table 11.** Percentage of female students by quartile (within and between quartiles) who participate in competitive school sports teams (compete against other schools)

Quartile	% within quartile	% between quartiles
1	37.4%	24.8%
2	38.5%	28.3%
3	35.3%	25.8%
4	32.7%	21.0%

Statistically significant results for all quartiles

A Chi-square test of independence was calculated comparing the number of female students in each quartile participating in intramural physical activity. A statistically significant interaction was found ( $\chi^2 (3) = 14.69, p < .01$ ). Within each



quartile there were proportionately more females who participated in intramural and non-competitive clubs organized by their school found in Quartiles 1 and 2, followed by Quartile 3, and Quartile 4 had the lowest percentage of female students participating (see Table 12).

**Table 12.** Percentage of female students by quartile (within and between quartiles) who participate in before-school, noon hour or after school PAs organized by school (intramural, non-comp clubs)

Quartile	% within quartile	% between quartiles
1	38.1%	24.7%
2	38.8%	27.9%
3	35.9%	25.8%
4	34.3%	21.6%

Statistically significant results for all quartiles

A Chi-square test of independence was calculated comparing the number of female students in each quartile participating in league or team sport outside of school. A statistically significant interaction was found ( $\chi^2(3) = 13.80 p < .01$ ). Within each quartile the greatest percentage of female students who participated in league or team sport outside of school were found in Quartiles 2 and 3, followed by Quartile 1, and Quartile 4 had the lowest percentage of female students participating in sport outside of school (see Table 13).

**Table 13.** Percentage of female students by quartile (within and between quartiles) who participate in league or team sport outside of school

Quartile	% within quartile	% between quartiles
1	43.0%	23.3%
2	45.6%	27.6%
3	45.5%	27.4%
4	41.5%	21.8%

Statistically significant results for all quartiles

## **Males**

A Chi-square test of independence was calculated comparing the number of male students in each quartile participating in competitive school sport. A statistically significant effect was found ( $\chi^2 (3) = 35.84, p < .001$ ). Within each quartile the greatest percentage of male students who participated in competitive sports were found in Quartile 1, followed by Quartiles 2 and 3, and Quartile 4 had the lowest percentage of male students participating in competitive sport (see Table 14).

**Table 14.** Percentage of male students by quartile (within and between quartiles) who participate in competitive school sports teams (compete against other schools)

<b>Quartile</b>	<b>% within quartile</b>	<b>% between quartiles</b>
1	53.1%	25.8%
2	49.8%	27.1%
3	47.0%	25.2%
4	45.6%	21.8%

Statistically significant results for all quartiles

A Chi-square test of independence was calculated comparing the number of male students in each quartile participating in intramural physical activity. A statistically significant interaction was not found ( $\chi^2 (3) = 7.23, p = .06$ ).

A Chi-square test of independence was calculated comparing the number of male students in each quartile participating in league or team sport outside of school. A statistically significant interaction was not found ( $\chi^2 (3) = 5.5 p = .14$ ).

### ***Sedentary Time & Moderate / Hard Physical Activity***

A one-way between participants ANOVA was conducted to compare the effect of relative age quartile on sedentary time per day (for all participants).

There was no statistically significant effect of relative age quartile on sedentary time per day [ $F(3, 22911) = 0.35, p = 0.79$ ]. A one-way between participants

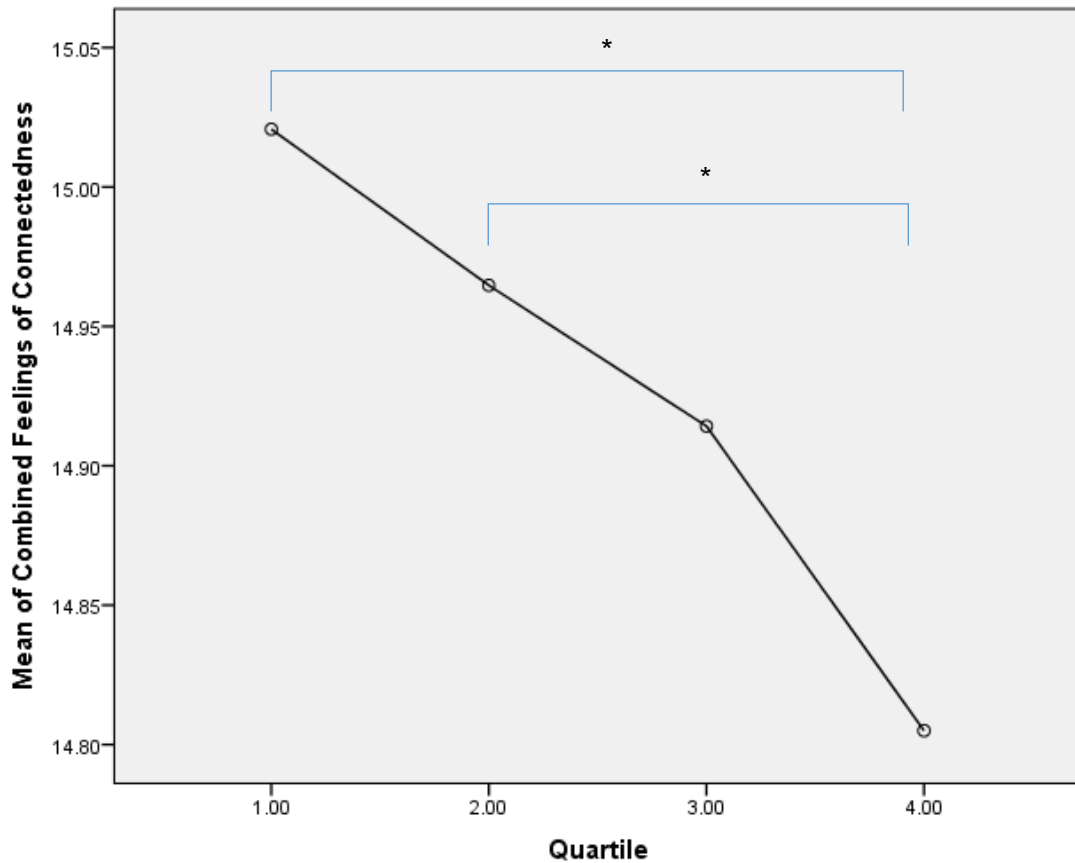
ANOVA was conducted to compare the effect of relative age quartile on minutes of moderate or hard physical activity per day (for all participants). There was no statistically significant effect of relative age quartile on minutes of moderate or hard physical activity per day [ $F(3, 8786) = 1.35, p = 0.26$ ].

### **Connectedness**

There were 21,982 valid responses for feelings of connectedness. The overall average score was 14.9 (SD = 2.83), with the lowest possible score being 5 and the highest possible score being 20.

A one-way between participants ANOVA was conducted to compare the effect of relative age quartile on feelings of connectedness. There was a statistically significant effect of relative age quartile on feelings of connectedness [ $F(3, 21978) = 5.50, p = 0.001$ ] (see Figure 8).

**Figure 8.** Combined feelings of connectedness by quartile (\* =  $p = .001$ )

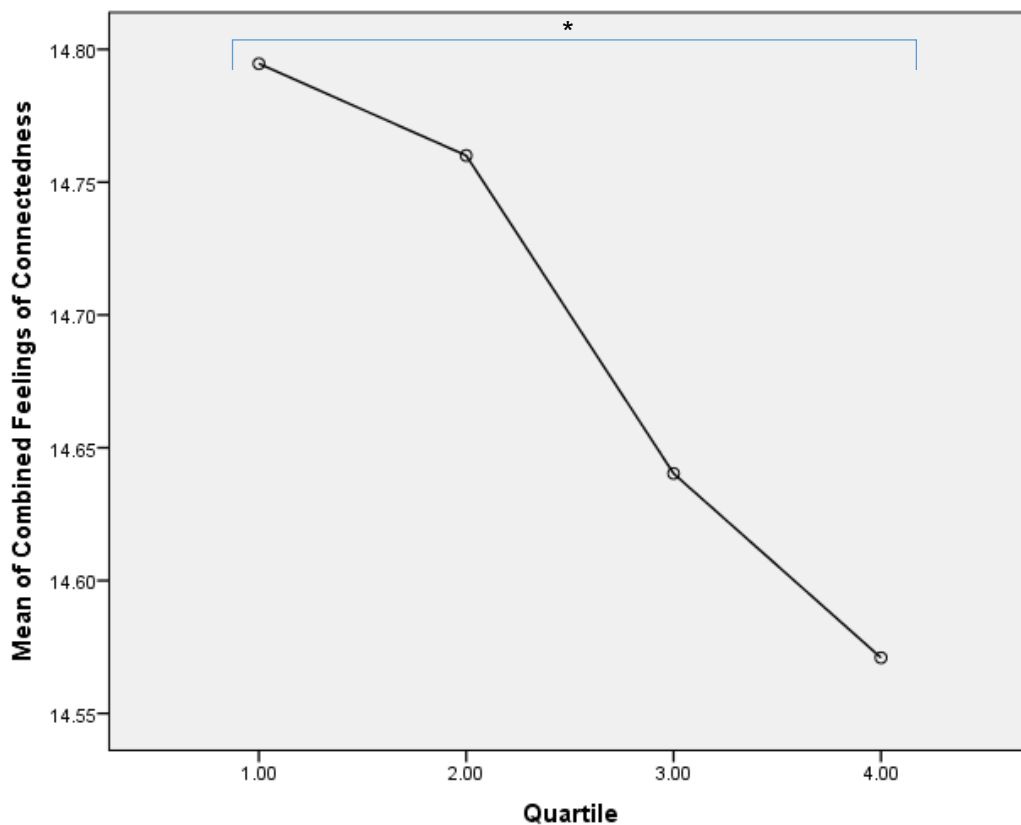


Post hoc comparisons using the Tukey HSD test indicated that the mean score for Quartile 1 ( $M = 15.02$ ,  $SD = 2.82$ ) and Quartile 2 ( $M = 14.96$ ,  $SD = 2.83$ ) were significantly different from Quartile 4 ( $M = 14.80$ ,  $SD = 2.82$ ).

Students in Quartile 1 and 2 reported higher ratings of feeling connected to their schools, while students in Quartile 4 reported lower levels of feelings of connectedness to their school. However, it should be noted that feelings of connectedness reported by students in Quartile 3 were not significantly different from feelings of connectedness reported by students in the other quartiles.

A one-way between participants ANOVA was conducted to compare the effect of relative age quartile on feelings of connectedness for females. There was a statistically significant effect of relative age quartile on feelings of connectedness at the  $p < .05$  level [ $F(3, 11,104) = 3.57, p = 0.01$ ] (see Figure 9).

**Figure 9.** Combined feelings of connectedness by quartile for females (\* =  $p = .01$ )

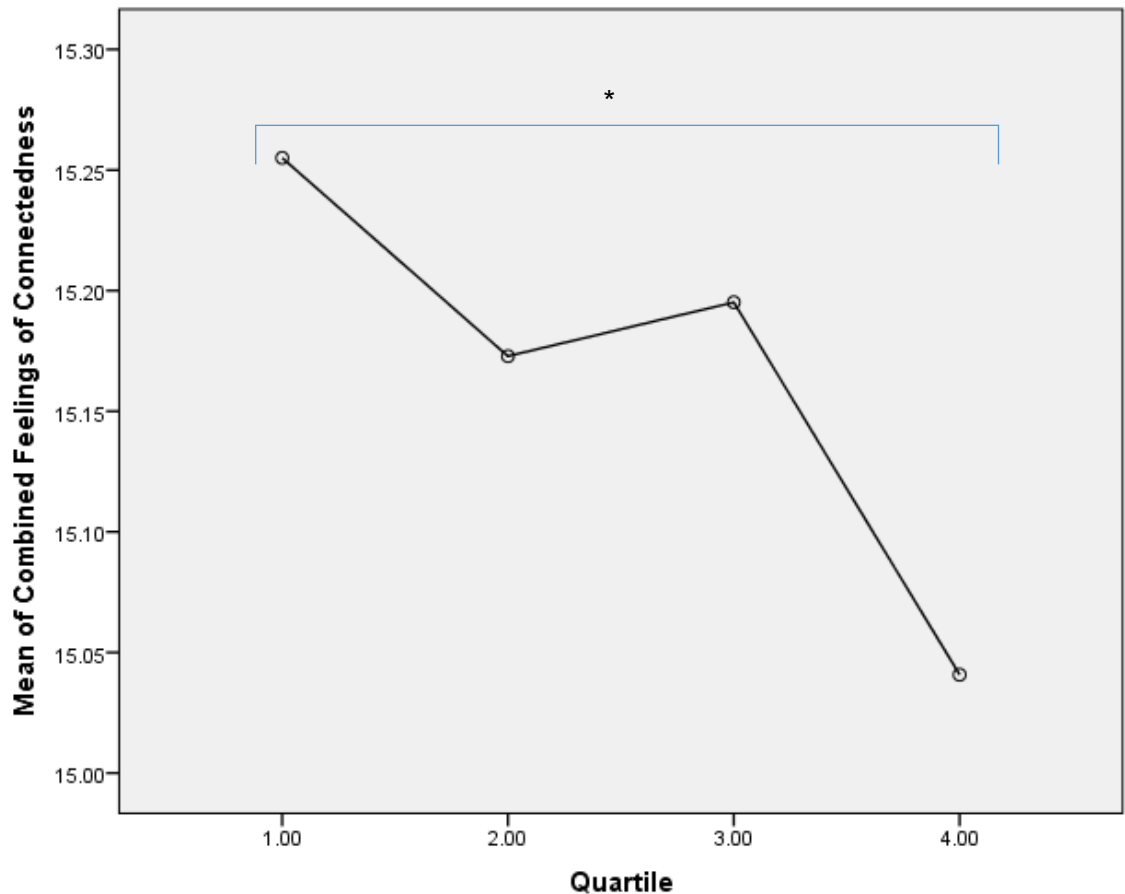


Post hoc comparisons using the Tukey HSD test indicated that the mean score for Quartile 1 ( $M = 14.79, SD = 2.89$ ) was significantly different from Quartile 4 ( $M = 14.57, SD = 2.82$ ). Feelings of connectedness reported by

students in Quartiles 2 and 3 were not significantly different from feelings of connectedness reported by students in other quartiles.

A one-way between participants ANOVA was conducted to compare the effect of relative age quartile on feelings of connectedness for males. There was a statistically significant effect of relative age quartile on feelings of connectedness at the  $p < .05$  level [ $F(3, 10,870) = 2.73, p = 0.04$ ] (see Figure 10).

**Figure 10.** Combined feelings of connectedness by quartile for males (\* =  $p = .04$ )



Post hoc comparisons using the Tukey HSD test indicated that the mean score for Quartile 1 ( $M = 15.26, SD = 2.73$ ) was significantly different from

Quartile 4 (M = 15.04, SD = 2.80). Feelings of connectedness reported by students in Quartiles 2 and 3 were not significantly different from feelings of connectedness reported by students in other quartiles.

## Combined

### ***RAE - Education & Sport***

A Chi-square test of independence was calculated comparing math grades for students in each relative age quartile who answered yes to currently playing sport. Results were not statistically significant. ( $\chi^2(12) = 18.31, p > .05$ ). A Chi-square test of independence was calculated comparing math grades for students in each relative age quartile who answered no to currently playing sport. ( $\chi^2(12) = 22.20, p < .05$ ). For the higher grade ranges, there were higher percentages of students across all quartiles who answered yes to participating in sport than answered no. For the lower grade ranges, more students were not participating in sport. Table 15 shows the difference in percentage of students by quartile within each grade range for math who answered yes or no to currently participating in sport (see Table 15).

**Table 15.** Difference in percentage of students by quartile (within quartiles) within each grade range (math) who answered yes or no to currently participating in sport

Quartile	Grade Category				
	90-100%	80-89%	70-79%	60-69%	Less than 59%
	$\Delta$ (yes-no)	$\Delta$ (yes-no)	$\Delta$ (yes-no)	$\Delta$ (yes-no)	$\Delta$ (yes-no)
1	1.7%	1.3%	0.4%	-0.8%	-1.9%
2	1.9%	1.4%	0.7%	-0.5%	-2.2%
3	2.1%	1.3%	0.4%	-1.2%	-2.6%
4	1.4%	0.3%	0.5%	-0.5%	-1.5%

A Chi-square test of independence was calculated comparing English grades for students in each relative age quartile who answered yes to currently playing sport. A statistically significant interaction was found ( $\chi^2(12) = 29.95, p < .005$ ). A Chi-square test of independence was calculated comparing English grades for students in each relative age quartile who answered no to currently playing sport. A statistically significant interaction was found ( $\chi^2(12) = 21.86, p < .05$ ). Except for the 90-100% grade range, there were higher percentages of students across all quartiles who said yes to participating in sport than said no for the higher grade ranges (80-89%, 70-79%). For the lower grade ranges (60-69% and less than 59%), more students were not participating in sport. Table 16 shows the difference in percentage of students by quartile within each grade range for English who answered yes or no to currently participating in sport (see Table 16).

**Table 16.** Difference in percentage of students by quartile (within quartiles) within each grade range (English) who answered yes or no to currently participating in sport

Quartile	Grade Category				
	90-100%	80-89%	70-79%	60-69%	Less than 59%
	$\Delta$ (yes-no)	$\Delta$ (yes-no)	$\Delta$ (yes-no)	$\Delta$ (yes-no)	$\Delta$ (yes-no)
1	-4.1%	10.0%	4.3%	-1.8%	-8.4%
2	-4.1%	8.6%	6.7%	-3.5%	-7.9%
3	-4.5%	9.4%	8.5%	-4.6%	-8.5%
4	-5.7%	7.8%	6.0%	-2.1%	-5.7%

A logistic regression analysis was conducted to quantify the likelihood (odds ratio) of sport participation using relative age quartiles and math grades as predictors. A test of the full model against a constant only model was statistically significant, indicating that the predictors as a set reliably distinguished between



those who participate in sport and those who do not ( $\chi^2 = 244.93$ ,  $p < .001$  with  $df = 7$ ).

Nagelkerke's  $R^2$  of .015 indicated a relatively weak relationship between prediction and grouping. Prediction success overall was 66.6% (0% for no to sport and 100% for yes to sport). The Wald criterion demonstrated that Quartile 1, 2, and 4 were significant predictors ( $p = < 0.01$ ). Odds ratio values indicate that compared to youth in Quartile 4 those in Quartile 1 and 2 were 1.14 times more likely to be participating in sport. Quartile 3 did not differ significantly from Quartile 4. Compared to those with grades 59% and below those in the 60-69%, 70-79%, 80-89%, and 90-100% were increasingly more likely to be participating in sport (see Table 17).

**Table 17.** Binary logistic regression demonstrating the relationship between relative age, math grades, and likelihood of being a sport participant

		Odds Ratio	95% CI
Relative age	Q1	<b>1.14</b>	1.05 - 1.23
	Q2	<b>1.14</b>	1.06 - 1.24
	Q3	1.06	.98 - 1.15
	Q4	REF	REF
Math grade	90-100%	<b>1.97</b>	1.79 - 2.17
	80-89%	<b>1.64</b>	1.50 - 1.79
	70-79%	<b>1.42</b>	1.30 - 1.54
	60-69%	<b>1.23</b>	1.11 - 1.36
	Below 59%	REF	REF

\*adjusted odds ratios did not differ meaningfully from unadjusted. Cox & Snell  $R^2 = .01$ ; Nagelkerke  $R^2 = .02$ ; \* $P < .001$ ; **Bold** = statistically significant; CI = confidence interval; -2 log likelihood = 28731.23 ; REF= referent

A logistic regression analysis was conducted to predict sport participation of females using relative age quartiles and math grades as predictors. A test of the full model against a constant only model was statistically significant,

indicating that the predictors as a set reliably distinguished between those who participate in sport and those who do not ( $\chi^2 = 157.50$ ,  $p < .001$  with  $df = 7$ ).

Nagelkerke's  $R^2$  of .019 indicated a relatively weak relationship between prediction and grouping. Prediction success overall was 61.8% (4% for no to sport and 97.6% for yes to sport). The Wald criterion demonstrated that all quartiles were significant predictors ( $p = < 0.05$ ). Odds ratio values indicate that compared to youth in Quartile 4 those in Quartile 1, 2, and 3 were 1.15, 1.21, and 1.14 times more likely to be participating in sport.

Compared to those with grades 59% and below those in the 60-69%, 70-79%, 80-89%, and 90-100% were increasingly more likely to be participating in sport (see Table 18).

**Table 18.** Binary logistic regression demonstrating the relationship between relative age, math grades, and likelihood of being a sport participant for females

		Odds Ratio	95% CI
Relative age	Q1	<b>1.15</b>	1.03 - 1.28
	Q2	<b>1.21</b>	1.08 - 1.34
	Q3	<b>1.14</b>	1.02 - 1.27
	Q4	REF	REF
Math grade	90-100%	<b>2.06</b>	1.80 - 2.36
	80-89%	<b>1.72</b>	1.53 - 1.95
	70-79%	<b>1.35</b>	1.19 - 1.52
	60-69%	<b>1.26</b>	1.09 - 1.45
	Below 59%	REF	REF

\*adjusted odds ratios did not differ meaningfully from unadjusted. Cox & Snell  $R^2 = .01$ ; Nagelkerke  $R^2 = .02$ ; \* $P < .001$ ; **Bold** = statistically significant; CI = confidence interval; -2 log likelihood = 15043.98 ; REF= referent

A logistic regression analysis was conducted to predict sport participation of males using relative age quartiles and math grades as predictors. A test of the

full model against a constant only model was statistically significant, indicating that the predictors as a set reliably distinguished between those who participate in sport and those who do not ( $\chi^2 = 126.83$ ,  $p < .001$  with  $df = 7$ ).

Nagelkerke's  $R^2$  of .016 indicated a relatively weak relationship between prediction and grouping. Prediction success overall was 71.5% (0% for no to sport and 100% for yes to sport). The Wald criterion demonstrated that all quartiles were significant predictors ( $p = < 0.05$ ). Odds ratio values indicate that compared to youth in Quartile 4 those in Quartile 1 were 1.13 times more likely to be participating in sport. Quartiles 2 and 3 did not differ significantly from Quartile 4.

Compared to those with grades 59% and below those in the 60-69%, 70-79%, 80-89%, and 90-100% were increasingly more likely to be participating in sport (see Table 19).

**Table 19.** Binary logistic regression demonstrating the relationship between relative age, math grades, and likelihood of being a sport participant for males

		Odds Ratio	95% CI
Relative age	Q1	<b>1.13</b>	1.00 - 1.28
	Q2	1.08	.96 - 1.21
	Q3	.99	.88 - 1.11
	Q4	REF	REF
Math grade	90-100%	<b>2.03</b>	1.76 - 2.35
	80-89%	<b>1.65</b>	1.46 - 1.87
	70-79%	<b>1.58</b>	1.40 - 1.79
	60-69%	<b>1.24</b>	1.08 - 1.43
	Below 59%	REF	REF

\*adjusted odds ratios did not differ meaningfully from unadjusted. Cox & Snell  $R^2 = .01$ ; Nagelkerke  $R^2 = .02$ ; \* $P < .001$ ; **Bold** = statistically significant; CI = confidence interval; -2 log likelihood = 13403.62; REF= referent

A logistic regression analysis was conducted to predict sport participation using relative age quartiles and English grades as predictors. A test of the full model against a constant only model was statistically significant, indicating that the predictors as a set reliably distinguished between those who participate in sport and those who do not ( $\chi^2 = 174.91$ ,  $p < .001$  with  $df = 7$ ).

Nagelkerke's  $R^2$  of .011 indicated a relatively weak relationship between prediction and grouping. Prediction success overall was 66.6% (0% for no to sport and 100% for yes to sport). The Wald criterion demonstrated that Quartiles 1, 2, and 4 were significant predictors ( $p = < 0.05$ ). Odds ratio values indicate that compared to youth in Quartile 4 those in Quartile 1 and 2 were 1.12, and 1.13 times more likely to be participating in sport. Quartile 3 did not differ significantly from Quartile 4.

Compared to those with grades 59% and below those in the 60-69%, 70-79%, 80-89%, and 90-100% were increasingly more likely to be participating in sport (see Table 20).

**Table 20.** Binary logistic regression demonstrating the relationship between relative age, English grades, and likelihood of being a sport participant

		Odds Ratio	95% CI
Relative age	Q1	<b>1.12</b>	1.04 - 1.22
	Q2	<b>1.13</b>	1.05 - 1.23
	Q3	1.05	.97 - 1.14
	Q4	REF	REF
English grade	90-100%	<b>1.86</b>	1.64 - 2.10
	80-89%	<b>1.71</b>	1.55 - 1.89
	70-79%	<b>1.49</b>	1.34 - 1.64
	60-69%	<b>1.23</b>	1.09 - 1.38
	Below 59%	REF	REF

\*adjusted odds ratios did not differ meaningfully from unadjusted. Cox & Snell R<sup>2</sup> = .01; Nagelkerke R<sup>2</sup> = .01; \*P < .001; **Bold** = statistically significant; CI = confidence interval; - 2 log likelihood = 28801.25 ; REF= referent

A logistic regression analysis was conducted to predict sport participation for females using relative age quartiles and English grades as predictors. A test of the full model against a constant only model was statistically significant, indicating that the predictors as a set reliably distinguished between those who participate in sport and those who do not ( $\chi^2 = 156.32$ ,  $p < .001$  with  $df = 7$ ).

Nagelkerke's R<sup>2</sup> of .018 indicated a relatively weak relationship between prediction and grouping. Prediction success overall was 61.8% (0% for no to sport and 100% for yes to sport). The Wald criterion demonstrated that all of the quartiles were significant predictors ( $p = < 0.05$ ). Odds ratio values indicate that compared to youth in Quartile 4 those in Quartile 1, 2, and 3 were 1.12 times more likely to be participating in sport.

Compared to those with grades 59% and below those in the 60-69% range did not differ significantly, but those in the 70-79%, 80-89%, and 90-100% ranges were increasingly more likely to be participating in sport (see Table 21).

**Table 21.** Binary logistic regression demonstrating the relationship between relative age, English grades, and likelihood of being a sport participant for females

		Odds Ratio	95% CI
Relative age	Q1	<b>1.12</b>	1.00 - 1.25
	Q2	<b>1.12</b>	1.06 - 1.34
	Q3	<b>1.12</b>	1.01 - 1.25
	Q4	REF	REF
English grade	90-100%	<b>2.17</b>	1.82 - 2.56
	80-89%	<b>1.83</b>	1.57 - 2.14
	70-79%	<b>1.41</b>	1.12 - 1.65
	60-69%	1.09	.91 - 1.32
	Below 59%	REF	REF

\*adjusted odds ratios did not differ meaningfully from unadjusted. Cox & Snell R<sup>2</sup> = .01; Nagelkerke R<sup>2</sup> = .02; \*P < .001; **Bold** = statistically significant; CI = confidence interval; -2 log likelihood = 15045.16 ; REF= referent

A logistic regression analysis was conducted to predict sport participation for males using relative age quartiles and English grades as predictors. A test of the full model against a constant only model was statistically significant, indicating that the predictors as a set reliably distinguished between those who participate in sport and those who do not ( $\chi^2 = 120.84$ ,  $p < .001$  with  $df = 7$ ).

Nagelkerke's R<sup>2</sup> of .015 indicated a relatively weak relationship between prediction and grouping. Prediction success overall was 71.5% (0% for no to sport and 100% for yes to sport). The Wald criterion demonstrated that none of the quartiles were significant predictors ( $p = > 0.05$ ). Odds ratio values indicate that youth in Quartile 1, 2, and 3 did not differ significantly from Quartile 4.

Compared to those with grades 59% and below those in the 60-69%, 70-79%, 80-89%, and 90-100% were 1.32, 1.68, 1.97, and 1.93 times more likely to be participating in sport (see Table 22).

**Table 22.** Binary logistic regression demonstrating the relationship between relative age, English grades, and likelihood of being a sport participant for males

		Odds Ratio	95% CI
Relative age	Q1	1.12	.99 - 1.26
	Q2	1.07	.96 - 1.20
	Q3	.98	.87 - 1.10
	Q4	REF	REF
English grade	90-100%	<b>1.93</b>	1.61 - 2.32
	80-89%	<b>1.97</b>	1.72 - 2.26
	70-79%	<b>1.68</b>	1.48 - 1.92
	60-69%	<b>1.32</b>	1.14 - 1.54
	Below 59%	REF	REF

\*adjusted odds ratios did not differ meaningfully from unadjusted. Cox & Snell  $R^2 = .01$ ; Nagelkerke  $R^2 = .02$ ; \* $P < .001$ ; **Bold** = statistically significant; CI = confidence interval; -2 log likelihood = 13409.61 ; REF= referent

### ***RAE – Sport & Connectedness***

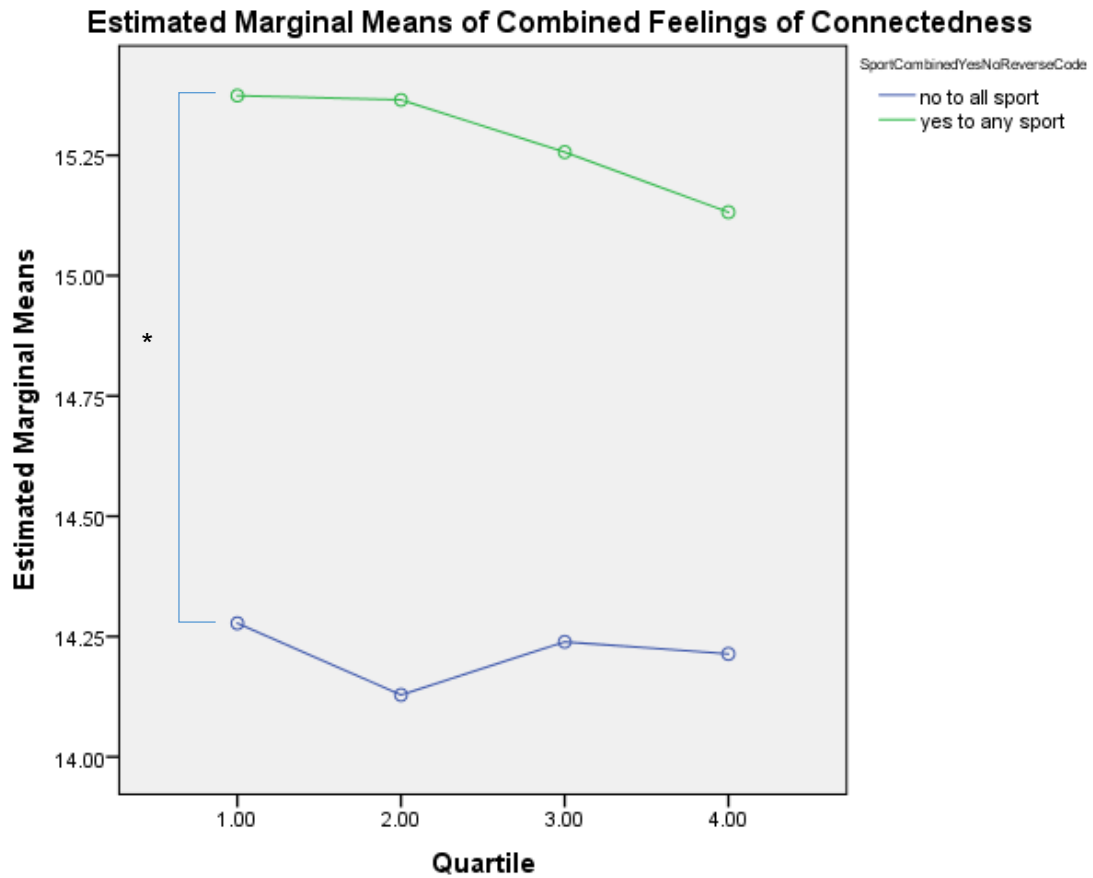
A one-way between participants MANOVA was conducted to compare the effect of relative age quartile on combined feelings of connectedness, time per day spent on moderate or hard physical activity, and daily sedentary time. Using Pillai's trace, there was a statistically significant effect of relative age quartile on combined feelings of connectedness, time per day spent on moderate or hard PA, and daily sedentary time,  $V = .003$ ,  $F(9, 25665) = 2.77$ ,  $p < .005$ .

A factorial ANOVA was conducted to compare the effect of relative age quartile and sport participation on feelings of connectedness. A two-way analysis of variance was conducted on the influence of two independent variables (relative age quartile and sport participation) on feelings of connectedness. Relative age included 4 quartiles and sport participation consisted of two levels (yes or no). The main effect for relative age quartile was not significant [ $F(3,$

21849) = 2.33,  $p > 0.05$ : Quartile 1 (M = 15.02, SD = 2.82), Quartile 2 (M = 14.97, SD = 2.83), Quartile 3 (M = 14.91, SD = 2.82), and Quartile 4 (M = 14.81, SD = 2.82)]. The main effect for sport participation yielded an F ratio of [F(1, 21849) = 714.65,  $p < 0.001$ ], indicating a significant difference between students who participated in sport (M = 15.29, SD = 2.69) and students who did not participate in any sport (M = 14.21, SD = 2.94). The interaction effect was also significant, [F(3, 21849) = 2.86,  $p = 0.035$ ]. Taken together, these results suggest that relative age quartile on its own does not have an effect on feelings of connectedness. However, sport participation does have an effect on feelings of connectedness. While statistically significant, there is no discernable interaction effect between relative age and sport participation on feelings of connectedness (see Figure 11).



**Figure 11.** Combined feelings of connectedness by quartile and sport participation (\* =  $p < .05$ )



A logistic regression analysis was conducted to predict sport participation using relative age quartiles and feelings of connectedness as predictors. A test of the full model against a constant only model was statistically significant, indicating that the predictors as a set reliably distinguished between those who participate in sport and those who do not ( $\chi^2 = 711.20$ ,  $p < .001$  with  $df = 4$ ).

Nagelkerke's  $R^2$  of .044 indicated a moderate relationship between prediction and grouping. Prediction success overall was 66.7% (0% for no to sport and 100% for yes to sport). The Wald criterion demonstrated that Quartiles 1, 2, and 4 were significant predictors ( $p = < 0.05$ ). Odds ratio values indicate

that compared to youth in Quartile 4 those in Quartile 1 and 2 were 1.11 and 1.12 times more likely to be participating in sport, respectively. Quartile 3 did not differ significantly from Quartile 4.

Every one unit increase in connectedness increases the likelihood of being a sport participant by 1.15 times (see Table 23).

**Table 23.** Binary logistic regression demonstrating the relationship between relative age, feelings of connectedness, and likelihood of being a sport participant

		Odds Ratio	95% CI
Relative age	Q1	<b>1.11</b>	1.02 - 1.21
	Q2	<b>1.12</b>	1.04 - 1.22
	Q3	1.05	.97 - 1.14
	Q4	REF	REF
Combined feelings of connectedness (scale)		<b>1.15</b>	1.13 - 1.16

\*adjusted odds ratios did not differ meaningfully from unadjusted. Cox & Snell R<sup>2</sup> = .03; Nagelkerke R<sup>2</sup> = .04; \*P < .001; **Bold** = statistically significant; CI = confidence interval; -2 log likelihood = 27090.22 ; REF= referent

A logistic regression analysis was conducted to predict sport participation of females using relative age quartiles and feelings of connectedness as predictors. A test of the full model against a constant only model was statistically significant, indicating that the predictors as a set reliably distinguished between those who participate in sport and those you do not ( $\chi^2 = 313.92$ ,  $p < .001$  with  $df = 4$ ).

Nagelkerke's R<sup>2</sup> of .038 indicated a moderate relationship between prediction and grouping. Prediction success overall was 61.9% (0% for no to sport and 100% for yes to sport). The Wald criterion demonstrated that all quartiles were significant predictors ( $p = < 0.05$ ). Odds ratio values indicate that

compared to youth in Quartile 4 those in Quartile 1, 2, and 3 were 1.13, 1.19, and 1.12 times more likely to be participating in sport, respectively.

For every one unit increase in connectedness the likelihood of being a sport participant increased by 1.13 times (see Table 24).

**Table 24.** Binary logistic regression demonstrating the relationship between relative age, feelings of connectedness, and likelihood of being a sport participant for females

		Odds Ratio	95% CI
Relative age	Q1	<b>1.13</b>	1.01 - 1.26
	Q2	<b>1.19</b>	1.06 - 1.33
	Q3	<b>1.12</b>	1.01 - 1.25
	Q4	REF	REF
Combined feelings of connectedness (scale)		<b>1.13</b>	1.11 - 1.14

\*adjusted odds ratios did not differ meaningfully from unadjusted. Cox & Snell R<sup>2</sup> = .03; Nagelkerke R<sup>2</sup> = .04; \*P < .001; **Bold** = statistically significant; CI = confidence interval; -2 log likelihood = 14375.53 ; REF= referent

A logistic regression analysis was conducted to predict sport participation of males using relative age quartiles and feelings of connectedness as predictors. A test of the full model against a constant only model was statistically significant, indicating that the predictors as a set reliably distinguished between those who participate in sport and those who do not ( $\chi^2 = 347.62$ ,  $p < .001$  with  $df = 4$ ).

Nagelkerke's R<sup>2</sup> of .045 indicated a moderate relationship between prediction and grouping. Prediction success overall was 71.7% (0% for no to sport and 100% for yes to sport). The Wald criterion demonstrated that no quartiles were significant predictors ( $p = > 0.05$ ). Odds ratio values indicate that Quartiles 1, 2, and 3 did not differ significantly from Quartile 4.

Every one unit increase in connectedness increases the likelihood of being a sport participant by 1.16 times (see Table 25).

**Table 25.** Binary logistic regression demonstrating the relationship between relative age, feelings of connectedness, and likelihood of being a sport participant for males

		Odds Ratio	95% CI
Relative age	Q1	1.10	.97 - 1.24
	Q2	1.06	.94 - 1.19
	Q3	.98	.87 - 1.11
	Q4	REF	REF
Combined feelings of connectedness (scale)		<b>1.16</b>	1.14 - 1.17

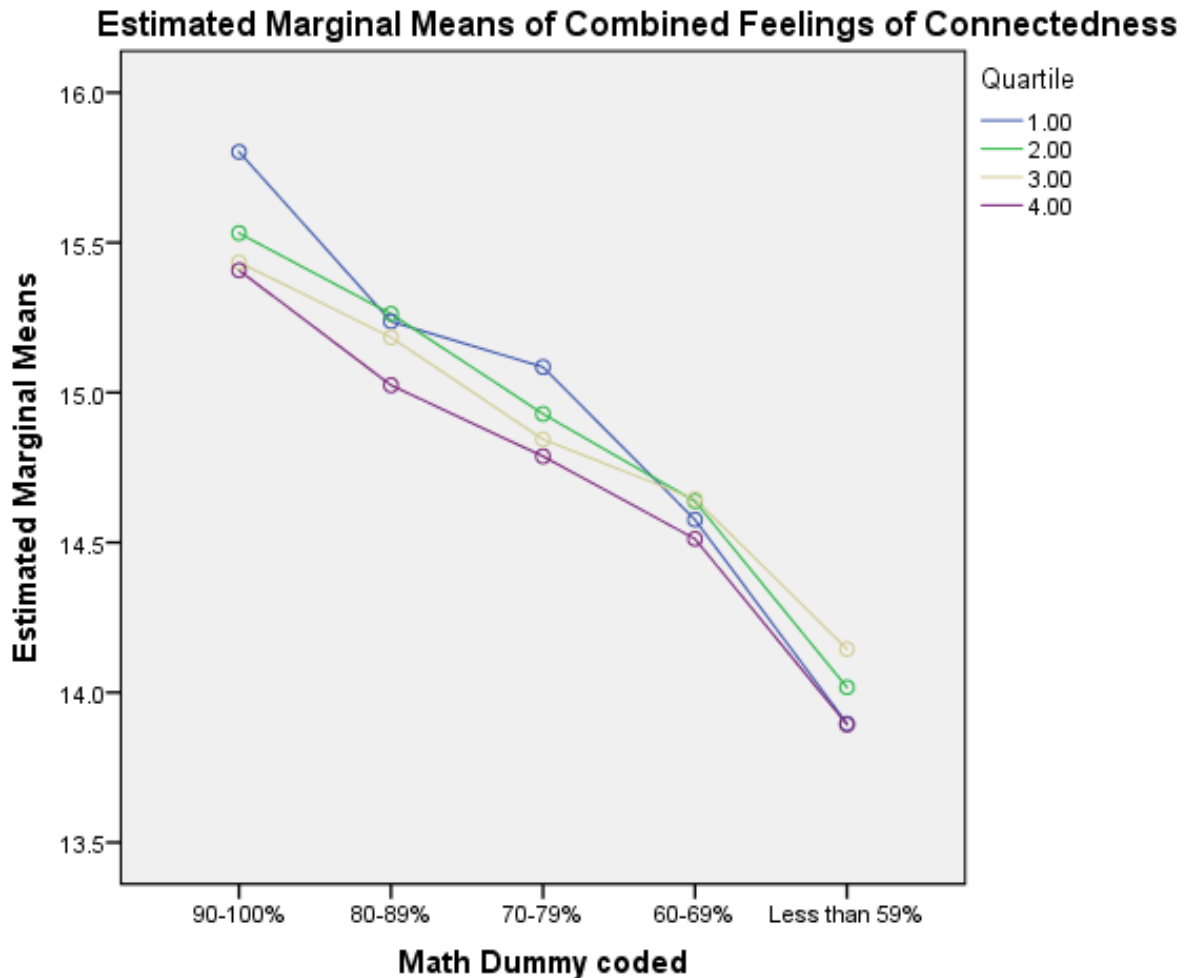
\*adjusted odds ratios did not differ meaningfully from unadjusted. Cox & Snell  $R^2 = .03$ ; Nagelkerke  $R^2 = .05$ ; \* $P < .001$ ; **Bold** = statistically significant; CI = confidence interval; -2 log likelihood = 12524.80 ; REF= referent

### ***RAE - Education & Connectedness***

A factorial ANOVA was conducted to compare the effect of relative age quartile and math grade achievement on feelings of connectedness. A two-way analysis of variance was conducted on the influence of two independent variables (relative age quartile and math grade achievement) on feelings of connectedness. Relative age included 4 quartiles and math grade achievement consisted of five levels (90-100%, 80-89%, 70-79%, 60-69%, and less than 59%). The main effect for relative age quartile was significant [ $F(3, 21962) = 4.22, p < 0.01$ ]: Quartile 1 ( $M = 15.02, SD = 2.82$ ), Quartile 2 ( $M = 14.96, SD = 2.83$ ), Quartile 3 ( $M = 14.91, SD = 2.82$ ), and Quartile 4 ( $M = 14.80, SD = 2.82$ ). The main effect for math grade achievement yielded an F ratio of [ $F(4, 21962) = 158.96, p < 0.001$ ], indicating a significant difference between students at different levels of math grade achievement [90-100% ( $M = 15.55, SD = 2.81$ ), 80-89% ( $M = 15.18, SD = 2.65$ ), 70-79% ( $M = 14.91, SD = 2.70$ ), 60-69% ( $M =$

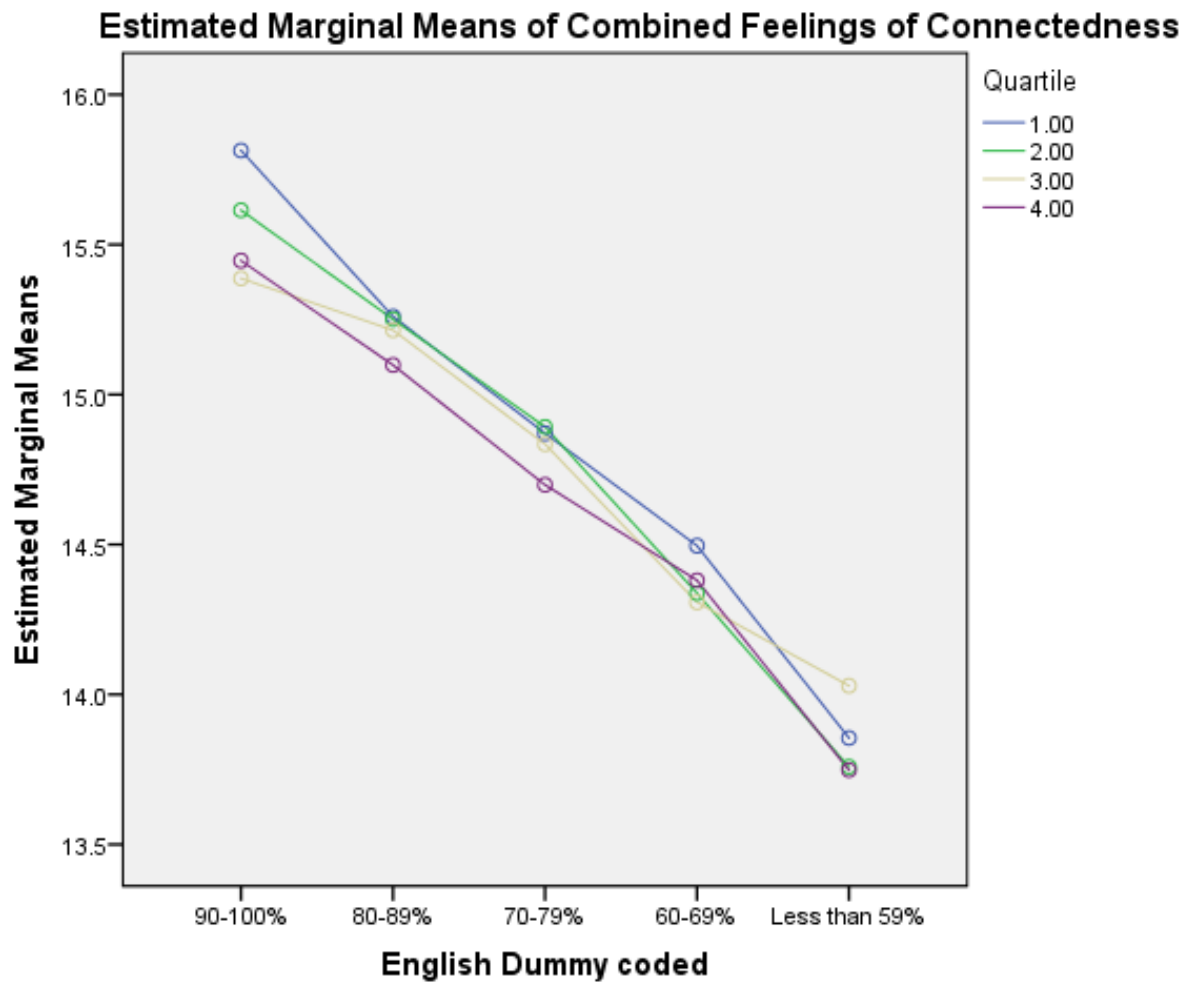
14.60, SD = 2.79) and less than 59% (M = 13.99, SD = 3.14)]. The interaction effect was not significant, [F(12, 21962) = 1.32, p = 0.20]. Taken together, these results suggest that relative age quartile and math grade achievement on their own each have an effect on feelings of connectedness. However, there was not a significant interaction effect between relative age and math grade achievement on feelings of connectedness (see Figure 12).

**Figure 12.** Combined feelings of connectedness by quartile and math grade achievement (\* = p < .05)



A factorial ANOVA was conducted to compare the effect of relative age quartile and English grade achievement on feelings of connectedness. A two-way analysis of variance was conducted on the influence of two independent variables (relative age quartile and English grade achievement) on feelings of connectedness. Relative age included 4 quartiles and English grade achievement consisted of five levels (90-100%, 80-89%, 70-79%, 60-69%, and less than 59%). The main effect for relative age quartile was significant [ $F(3, 21962) = 2.68, p < 0.05$ ]: Quartile 1 ( $M = 15.02, SD = 2.82$ ), Quartile 2 ( $M = 14.96, SD = 2.83$ ), Quartile 3 ( $M = 14.91, SD = 2.82$ ), and Quartile 4 ( $M = 14.80, SD = 2.82$ ). The main effect for English grade achievement yielded an F ratio of [ $F(4, 21962) = 144.55, p < 0.001$ ], indicating a significant difference between students at different levels of English grade achievement [90-100% ( $M = 15.57, SD = 2.98$ ), 80-89% ( $M = 15.21, SD = 2.71$ ), 70-79% ( $M = 14.83, SD = 2.70$ ), 60-69% ( $M = 14.38, SD = 2.76$ ) and less than 59% ( $M = 13.85, SD = 3.25$ )]. The interaction effect was not significant, [ $F(12, 21962) = 0.92, p = 0.53$ ]. Taken together, these results suggest that relative age quartile and English grade achievement on their own each have an effect on feelings of connectedness. However, there was not a significant interaction effect between relative age and English grade achievement on feelings of connectedness (see Figure 13).

**Figure 13.** Combined feelings of connectedness by quartile and English grade achievement (\* =  $p < .05$ )



## DISCUSSION & CONCLUSIONS

The purpose of this study was to examine how relative age influences Ontario secondary school students' academic achievement, sport participation, daily physical and sedentary activity, and feelings of connectedness to their school. The overall aim was to gain a better understanding of how relative age influences the multidimensional pattern of youth's curricular and extracurricular

activity engagement and to explore the impact of those patterns of participation on developmental outcomes.

The data collected from all students was analyzed and then males and females were analyzed as separate groups in order to gain a better understanding of how relative age affects female and male groups differently. Research to date on RAEs for females specifically is limited (Musch & Grondin, 2001) and more research is needed to expand our knowledge on this aspect of RAEs. Differences were found between the males and females who participated in this study in terms of their patterns of participation and the impact of sport on their academic achievement and feelings of connectedness.

Based on the findings of previous research centred on the effects of relative age on academic and sport outcomes it was hypothesized that relatively younger students would be disadvantaged in all aspects. Motivations for undertaking this research included addressing the gaps in the literature on RAEs in order to better understand how these phenomena affect youth development with the ultimate goal of informing changes in policy to better support youth. For the sake of clarity the study's findings are discussed in four sections: education, sport and physical activity participation, connectedness, and these variables combined.

## **Education**

Our data analysis indicated no clear RAE within levels of academic achievement. However, when you look at academic achievement within each



quartile there were slight differences. These results differ from previous research on academic achievement done in the US and the UK. Previous research has found that relatively older students are more likely to attain higher grades than their relatively younger peers across a range of different subjects (Bell & Daniels, 1990; Massey et al., 1996; Sharp et al., 1994; Cobley et al., 2009b). Our Canadian education system is different than the systems used in the US and the UK, which could explain differences in RAEs observed in these different education systems. Canadians are advantaged by better trained teachers, greater equity for all population groups, generally better social services for students and their families (health care and social services), much less disparity in funding across districts (and generally more spending in higher need areas), and consistency across schools and districts in terms of curriculum and teacher methods (Levin, 2011). The US education system tends to be more focused on standardized testing, while Canada has a greater focus on equity and equal opportunities for success for all students (Coughlan, 2017). The UK education system differs from Canada's in that they experience more influence from the private sector (privately funded schools), less support and acceptance from the middle class for publicly funded schools, and earlier selection and streaming of students (Evans, 2011). These differences between education systems might influence the likelihood of relative age having an influence on academic achievement.

Another explanation is that the schools participating in the study may provide more support for students. There may be a correlation between higher

support for students and the willingness of the school to participate in such a study. There is also the possibility that the schools participating are higher SES schools. However, since the identity of the schools is protected for privacy there is no way for us to know their SES. Better quality schools, schools that offer more support for students, and/or higher SES schools may mitigate the effects of relative age. This is only one theory and the link between SES, school quality and support, and RAEs should be explored in future research.

One interesting observation from the analyses performed is that chi squared tests were significant for the math and English grades (versus relative age quartile) of female students, but not significant for male students. In the younger grades there may be more distinct maturational differences between the females and males as females tend to develop earlier than males (Lim, Han, Uhlhaas, & Kaiser, 2015). However, with an average age of 15.7 (SD = 1.25) it is likely that there were larger maturational differences for the male participants in this study than for the females. It could also be that females were more honest with their survey answers, as grades were self reported.

## **Sport and Physical Activity Participation**

Overall, 22,750 students responded either yes or no to currently participating in sport (out of a total of 22,915 students surveyed), leaving only 0.7% missing responses. Of the 22,750 respondents who answered, 15,156 answered yes to currently participating in sport. This represents 66.6% of valid respondents currently participating in sport. Because overall participation is

rather high (66.6%) this could explain why some RAEs were not found in this sample. High overall participation in sport could indicate higher SES of respondents overall (as compared to general population), as previous research has shown a higher SES to be correlated to higher participation rates for youth (Fairclough, Boddy, Hackett, & Stratton, 2009).

A pattern was observed within quartiles for competitive school sport participation and intramural physical activity participation, with participation being highest for Quartile 1 students and lowest for Quartile 4 students. Previous studies have shown that relatively older students are more likely to be selected to school sports teams (Wilson, 1999; Copley et al., 2008). However, this pattern was not observed for sport outside of school, where Quartile 2 students had slightly higher levels of participation than Quartiles 1 and 3. When considered separately, the female students in this study showed a similar trend to the entire sample, while results for the male only group were not significant. This indicates that relative age was more of a factor for females than males (in terms of sport participation) in this study. This is very interesting considering that previous research (though limited for RAEs and females) indicates that RAEs are more prevalent in male sport contexts. This could be in part due to the smaller number of females participating in sport. Although 50% of the respondents were female, only 4,963 (44.0%) were participating in sport outside of school, compared to 6,256 (56.0%) males. There were 4,061 (36.9%) females currently participating in intramural sport, compared to 4,580 (42.1%) males. There were 4,069 (36.1%) females participating in competitive school sport, compared to 5,454 (48.9%)

males. Furthermore, the age of participants in this study ranged from 13 to 18 years old and we know that by age 14, females are dropping out of sports at two times the rate of males (Sabo & Vilez, 2008). Perhaps the smaller number of females participating in sport amplifies the effect of relative age for this group, whereas for the males in this study the larger group of sport participants abates the RAE.

No significant relationship was found between relative age quartile and time spent on moderate or hard physical activity. There was also no significant relationship found between relative age quartile and time spent on sedentary activity. This is interesting considering that there was a significant relationship found between relative age quartile and sport participation. Perhaps the students who are not participating in sport are participating in physical activities other than sport. In one study performed on adult participants it was found that the systemic RAEs found in other studies for competitive sports such as hockey and soccer were not as prevalent in leisure physical activities during adulthood. The researchers speculated that their results may have been a reflection of lower competitive selection and attrition in population physical activity compared with competitive sports in younger athletes (Larouche, Laurencelle, Grondin, & Trudeau, 2010). A possible direction for future research could be to explore relative age and activities outside of sport (physical activities as well as other activities such as music, arts, etc.).

## Connectedness

Based on our data analysis, relatively older students reported higher levels of connectedness to their school. The increases observed were small in scale across relative age quartiles, and were likely statistically significant because the sample size was so large. It is difficult to establish what a meaningful difference is in terms of lived experience for youth; how do the experiences of those students who reported higher levels of feelings of connectedness differ from those who reported lower levels? This is something that could be investigated with qualitative research methods (such as interviews) in future RAE research. Indeed, there has been a lack of qualitative studies in the relative age literature.

Overall the connectedness scores were high ( $M = 14.9$ ,  $SD = 2.83$ ), with the lowest possible score being 5 and the highest possible score being 20. This overall average of the entire sample is quite high. This indicates that the schools participating in this research study likely have strong support systems for students in place. This potentially suggests the importance of the environmental influence of school quality on RAEs, in that across quartiles the majority of students at these schools experienced high feelings of connectedness.

Not a lot of research has been done related to RAEs and indicators of PYD. Most relative age studies to date have focused primarily on sport or academic outcomes. Some studies have shown mixed results in terms of psychosocial and wellbeing oriented outcomes. Previous research shows that relatively younger students are more likely to be among the lowest 20% of

attainment and attendance (Cobley et al., 2009b). Our findings indicate that relatively younger students have lower levels of feelings of connectedness to their school and it would make sense that students feeling less connected to their schools would be inclined to be absent more often. Relatively younger students are also known to experience higher dropout rates from sport (Lemez, Baker, Horton, Wattie, & Weir, 2014). This is an indication of negative experience and when considering school sport could also be linked to (lack of) feelings of connectedness at school. It would be worth looking into this connection further with future research, perhaps with methods that are more sensitive (qualitative interviews, for example).

Previous studies have really taken a problem-based approach. PYD could offer an interesting perspective by describing *positive* psychosocial development. For example, the impact of feelings of connectedness and engagement, caring adults, positive peer groups, strong sense of self, and engagement in school and community activities may have positive implications for youth independent of relative age.

## **Combined**

The purpose of this study was to look at multiple aspects of youths' development, including education, sport / physical activity participation, and connectedness and to examine how these aspects interact with each other and with relative age. The relationships between these aspects are considered below.

## ***RAE – Education & Sport***

Overall students achieving higher grades in math and English were more likely to be participating in sport. These findings indicate that overall sport participation may have a positive impact on academic achievement in math and English for all quartiles. It is important to note that the positive outcomes achieved applied to students in all quartiles. Previous research has linked sport participation and physical activity to higher academic outcomes for secondary school students (Fox, Barr-Anderson, Neumark-Sztainer, & Wall, 2010).

For English, among those who reported the highest level of grade achievement (90-100%) more students were not participating than were participating in sport (difference of -4.1% for Quartile 1 and 2, -4.5% for Quartile 3, and -5.7% for Quartile 4). This does not follow the trend for the rest of the grade categories for English grade achievement (and all of the categories for math grade achievement), where the higher the grade category the more students there were who were sport participants. A possible explanation for this irregularity is that perhaps the students not participating in sport have more time for English homework. The work involved for math courses may be less time consuming than the time required for reading and writing in order to excel in English courses. It is also possible that those not participating in sport have more interest in other hobbies like reading and/or writing or may be more creatively inclined, in which case English would align more with their interests / strengths. It should be noted that for all other grade ranges the pattern held where a greater

proportion of the students getting higher grades were sport participants for all quartiles.

Interestingly, when males and females were considered separately relative age quartiles were not significant predictors of sport participation for males when the other predictor was math grades or English grades. For females, relative age quartile was a significant predictor of sport participation when the other predictor was math grades or English grades. It appears that relative age matters more for females in terms of sport participation than it does for males in this sample. Previous research has found that the impact of physical activity and sport participation on academic achievement differs for male and female secondary school students. Fox et al. (2009) found that for high school girls, both physical activity and sports team participation were each independently associated with a higher GPA, but for high school boys only sports team participation was independently associated with a higher GPA. Little research has been done to investigate RAEs for females specifically, and the majority show marginal effects, if any, for both educational outcomes (Grondin, Proulx, & Zhou, 1993) and sport outcomes (Baxter-Jones, 1995; Vincent & Glamser, 2006). More research needs to be done on female athletes and students to gain a clearer picture of how relative age influences sport participation and academic achievement. There are obvious growth and maturational differences between adolescent males and females. Girls tend to develop and mature at a younger age than boys (Malina, Bouchard, & Bar-Or, 2004). This has been shown to result in earlier dropout from sport for females than for males (Canadian



Association for the Advancement of Women and Sport and Physical Activity, 2016). In addition, society places a greater value on male sport opportunities than those available to females (as evidenced by the career opportunities and money available to male athletes versus the lack thereof for female athletes). This may be one reason that, in general, female athletes tend to focus on academics as well as athletics, whereas male student-athletes may lack focus on academics.

### ***RAE – Sport / Physical Activity & Connectedness***

The relationship between relative age quartile and sport participation on feelings of connectedness was analyzed to investigate whether sport participation impacted feelings of connectedness across relative age quartiles. Sport participation was found to have a positive effect on feelings of connectedness. This is consistent with previous research that indicate youth sport programs lead to PYD outcomes (Fraser-Thomas, Côté, & Deakin, 2005). Results of the factorial ANOVA conducted to compare the effect of relative age quartile and sport participation on feelings of connectedness suggest that relative age quartile on its own does not have an effect on feelings of connectedness. However, sport participation does have an effect on feelings of connectedness. These results contradict findings of the one way ANOVA carried out to compare the effect of relative age quartile on feelings of connectedness. This could be because the sample size is slightly different as the factorial ANOVA only includes participants who answered yes or no to currently participating in sport. It is important to note that sport participation results in increased feelings of

connectedness across all quartiles. This implies that fostering feelings of connectedness, perhaps through participation, may help to mitigate RAEs for all quartiles. As such, promoting feelings of connectedness should perhaps be a focus of education systems and school policy.

Relative age quartile and feelings of connectedness were found to be significant indicators of sport participation. For females and males combined, every one unit increase in connectedness increases the likelihood of being a sport participant by 1.15 times. For females only, every one unit increase in connectedness resulted in the likelihood of being a sport participant increasing by 1.13 times. For males only, every one unit increase in connectedness increases the likelihood of being a sport participant by 1.16 times. These findings demonstrate the positive relationship between feelings of connectedness and sport participation.

When considering the effect of relative age quartile on sport participation, those in Quartile 1 and 2 were 1.11 and 1.12 times more likely to be participating in sport compared to youth in Quartile 4, respectively. Quartile 3 did not differ significantly from Quartile 4. For females only, those in Quartile 1, 2, and 3 were 1.13, 1.19, and 1.12 times more likely to be participating in sport compared to youth in Quartile 4, respectively. For males only, those in quartiles 1, 2, and 3 did not differ significantly from Quartile 4. These findings indicate that for all students together and for females only relative age quartile was a predictor of sport participation. However, for males relative age was not a significant predictor of sport participation. This differs from the observations of previous research where

RAEs tend to be larger for males than females. The percentage of male students in this sample participating in sport was rather large and perhaps this influenced these results. It is also possible that the students surveyed were from higher SES schools and that SES may mitigate the influence of RAEs.

### ***RAE – Education & Connectedness***

Results of the factorial ANOVAs conducted indicate that higher grade achievement categories for both math and English were associated with higher feelings of connectedness for students in all quartiles. These findings add further support to the suggestion that feelings of connectedness are important for PYD outcomes (ex. academic achievement). Schools that foster feelings of connectedness and provide increased opportunities for sport participation (which has been linked to feelings of connectedness – see above) are likely to see students achieve higher grades. However, it is unclear whether feelings of connectedness lead to higher grade achievement or students who achieve higher grades feel more connected to their schools.

### **Limitations**

One limitation of this study is that answers were self-reported. This may have influenced results in several ways. For example, students may not have understood the questions or may have left scantron bubbles un-filled when they should have entered a “0”. It was assumed that this is what happened when the student would fill in the “minutes” bubble, but leave the “hours” bubble blank

rather than filling the “0” option. This applies to the variables of “time spent on sedentary activities” and “time spent on moderate / vigorous physical activity”.

In addition, although answers were anonymous, responses may have been biased. For example, students may have reported more time spent on physical activity than they actually did or less time spent on sedentary activities than they did in reality. Furthermore, reported grades may have been inflated due to responder bias related to self-perception (students’ perception and reporting of their academic achievement may not have been a true reflection of the grade they actually received). In fact, an American meta-analysis of 60,926 subjects performed by Kuncel, Credé, & Thomas (2005) found that self-reported grades are less construct valid than many academics believe. Furthermore, self-reported grade validity was strongly moderated by actual levels of school performance and cognitive ability. These findings suggest that self-reported grades may not be valid in all applications.

As stated throughout the discussion, there is no way of knowing which schools the respondents are from. This could be a confounding variable and could introduce some bias into our findings. For example, students from areas of higher SES would be more likely to have access to and participate in extracurricular activities (Cauley, Donfield, Laporte, & Warhaftig, 1991). Students from higher quality schools may also be more likely to experience success academically (Education and socioeconomic status, n.d.). Future studies of relative age need to consider more aspects of the multidimensional nature of development.

Another limitation of most relative age studies, including this study, is that the quartile method assumes that being born on January 1st is equivalent to being born on March 30th (both dates fall within Quartile 1), but someone born on March 30th (Quartile 1) is somewhat arbitrarily seen as being different than someone born on April 1st (Quartile 2). Therefore, in some instances a day (or month) may mean nothing, but in others may be seen as quantitatively different. Therefore, the method of describing relative age in quartiles is somewhat arbitrary (Wattie, 2013). In application, youth do need to be separated based on development to group individuals with similar physical and cognitive maturity. Perhaps youth could be identified on a scale with 365 “categories” based on birthdates, rather than grouping them into 4 quartiles for future studies. This may provide a more detailed view of what is happening with regard to the effects of relative age on an individual level.

## **Implications**

This study has linked feelings of connectedness to increased sport participation and higher academic achievement. These findings suggest that schools would be well-served to implement strategies to promote feelings of connectedness for students. Because higher feelings of connectedness are associated with older relative age, perhaps schools should focus resources on ensuring that all students (especially relatively younger students) are provided with opportunities to engage with their schools and experience increased feelings of connectedness.

Although participation in competitive school sport and intramural physical activity is higher for relative older students, students across the relative age quartiles are all participating in sport outside of school. It is good that the relatively younger students who do not make their competitive school teams, or are perhaps intimidated to participate in intramurals alongside their more-skilled peers, are finding a place to participate in sport outside of the school setting. To maintain opportunities for participation for all youth communities should make sure that there are non-selection based (recreational) teams available in a variety of sports. In order to encourage participation efforts should be made to promote these opportunities to students who may not consider themselves “athletes” or who may not have “made the cut” for school teams.

Any policy change has to be specific to the particular school environment. Although analysis of our results did not indicate a clear RAE for academic achievement, schools should consider the impact that sport participation has on connectedness and the link between feelings of connectedness on academic achievement for all quartiles. Moreover, it is possible that the results of the current study are not generalizable to all schools and school boards. As such, policies may be needed in some environments more than others. Policy changes cannot be broadly applied everywhere because there may be important differences in each unique environment. RAEs are an unintended result of policy in the first place. There could be unintended consequences as a result of a blanket policy change intended to eradicate RAEs, particularly when RAEs are not evident.

## **Future Directions**

Gaps that exist within the current research include a lack of longitudinal studies to address dropout rates and a lack of studies on the impact of RAEs on diverse developmental outcomes, such as mental health, social skills, quality of life, and PYD. The current research also fails to address how RAEs impact participation in activities other than sport (i.e. music, arts). Future directions for research could include exploring how relative age influences participation in activities other than sport (such as music, arts, or independent exercise), and how this interacts with grade achievement and feelings of connectedness for students. Other future research could take a longitudinal approach to following students who take up sport or quit sport and what impact this might have on their development and future physical activity patterns of participation.

There is a need for studies on RAEs using objective measures, rather than self-reporting. Qualitative analysis such as interviews may also be valuable in expanding our knowledge of the effects of relative age and what it means for youth's lived experiences.

Overall there is a lack of research on RAEs and females and on RAEs as related to PYD. These are both areas of potential for future research in the field. The studies considering relative age and PYD that have been done tend to take a problem-based approach, whereas future research focused on the positive influence of indicators of PYD could offer new insights.

Other avenues identified in this thesis as possible opportunities for future research include: SES and school quality and support related to RAEs, dropout as related to lack of feelings of connectedness, and a focus on connectedness for education systems / school policy. Data collected on students from private schools could also offer further perspective on how sport participation may affect feelings of connectedness and PYD outcomes. For example, are there notable differences for students who attend private schools with mandatory sport or extracurricular participation requirements versus public schools where participation is optional?

In Ontario, children with late birthdays typically attend school with their peers born in the same calendar year, but the province's Education Act allows students whose birthdays are after the first day of school to be held back a year (Alphonso, 2017). It would be interesting to see how these students who are held back a year in order to start school as the relatively oldest rather than the relatively youngest (as they would be if not held back) fare in comparison to their peers. They would almost need to be considered as a new separate "quartile" (Quartile 0?).

In summary, the purpose of this study was to explore the relationships between relative age, academic achievement, sport participation, and feelings of connectedness. It is clear that these factors influence each other to create a complex pattern of youth development. The lack of RAEs observed for educational outcomes suggests that variation exists in RAEs based on context. There is a need for further research to take a multidimensional and positive



approach to youth development in order to further clarify how various factors interact with relative age to impact a range of developmental outcomes.

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# Chapter 4

## STUDY 2: SYSTEMATIC REVIEW OF PROPOSED SOLUTIONS

**Relative age effects in sport: A systematic review of proposed solutions**



## CO-AUTHORSHIP STATEMENT

Preliminary results were presented at SCAPPS Conference in Waterloo, Ontario in 2016. A peer-reviewed abstract has been published (Ottenbrite et al., 2016). Although this is a working draft of what will be submitted for publication, co-authors have not yet reviewed or edited the manuscript (with the exception of the graduate supervisor Dr. Wattie).

## ABSTRACT

**Background:** Though the existence of Relative Age Effects (RAEs) has been documented through a multitude of studies spanning various sports and levels of play, application of solutions related to RAEs has been limited. In this review, the strengths and weaknesses of various proposed solutions to RAEs in youth sport are considered. Our objective was to identify, collate, and disseminate a comprehensive list of solutions related to the prevalence of RAEs in youth sport.

**Methods:** English language, peer-reviewed articles were searched using the SPORTDiscus database. Keywords “relative age”, “relative age effect\*”, and sport\* were used to locate research articles. The inclusion criteria were the following: (1) publication date between January 1980 and May 2016; (2) the study examined youth sport; (3) solutions were suggested related to RAEs.

**Results:** Forty-one peer-reviewed publications and three articles from online sources met the criteria for inclusion. A variety of solutions have been proposed to address RAEs in sport. However, most are theoretical and there has been no attempt made to implement them.

**Conclusions:** Future research should seek to test possible proposed solutions to RAEs in sport. However, implementing these solutions has the potential to both positively and / or negatively affect career and life outcomes for those athletes involved. Therefore, it is important to be cautious in how these possible solutions are tested.

**Key Words:** Relative age effects, sport, youth.

## INTRODUCTION

In almost all sporting activities cut-off dates are used to group youth by chronological age to provide developmentally appropriate instruction, fair competition, and equal opportunity (Musch & Grondin, 2001). The selection period is often the calendar year or the school year, where individuals born within the cut-off dates are included in the cohort, while individuals born on either side of the cut-off dates are excluded from the cohort. Grondin, Deshaies, and Nault (1984) and Barnsley, Thompson, and Barnsley (1985) first proposed a possible relationship between cut-off dates, age and sport participation. They argued that the advanced age of youth born early in the competition year gives them a competitive advantage over their younger peers. Grondin et al. (1984) revealed a highly skewed distribution of birthdates among ice hockey players in competitive youth hockey leagues and in the National Hockey League (NHL): those born in the first months of the year were overrepresented, whereas there was underrepresentation of players born in the last months of the year. Grondin et al. (1984; cf. Barnsley et al., 1985) suggested that this uneven distribution was the result of the cut-off date (January 1<sup>st</sup>) determining age grouping in minor hockey. Subsequently, a person's age within a cohort has been designated as their relative age. Relative age effects (RAEs) generally refer to the advantages bestowed upon those born earlier within their cohort (and proportionately the disadvantages conferred onto the relatively younger individuals within the group).

Studies show that relatively older students receive higher grades in physical education classes (Cobley, Abraham, & Baker, 2008; Bell, Massey, &

Dexter, 1997) and are more likely to be selected to school sports teams (Wilson, 1999, Cogley et al., 2008). In competitive youth sport 20% more youth than expected (compared to population statistics) are born within the first three months of the selection year and approximately 20% less youth than expected are born in the last three months of the selection year. These RAEs emerge as early as 8-9 years of age (Barnsley & Thompson, 1988; Barnsley, Thompson, & Legault, 1992; Grondin et al., 1984).

The majority of sport-related RAE studies have been conducted on hockey and soccer (Cogley, Baker, Wattie, & Mckenna, 2009). RAEs exist internationally and have been identified among youth and elite soccer players in France, England, Germany, Sweden, Netherlands, Brazil, Japan, Australia, Spain, and United States (Carling, Le Gall, Reilly, & Williams, 2009; Edgar & O'Donoghue, 2004; Dudink, 1994; Brewer, Balsom, & Davis, 1995; Musch & Grondin, 2001; Simmons & Paull, 2001; Jimenez & Pain, 2008; Vincent & Glamser, 2006; Mujika et al., 2002; Helsen, Van Winckel, & Williams, 2005). Over-representations of relatively older players have also been documented for other sports including: baseball in the United States (Thompson, Barnsley, & Stebelsky, 1991; Côté, MacDonald, Baker, & Abernethy, 2006) and Japan (Grondin & Koren, 2000), rugby union in Australia (Abernethy & Farrow, 2005), competitive youth rugby league in England (Till et al., 2010), professional race car (NASCAR) drivers (Abel & Kruger, 2007), and shooting sports (Delorme & Raspaud, 2009). Interestingly, gymnastics shows an opposite RAE where late-born athletes benefit from later onset of physical maturity (Malina, 1994; Baxter-Jones, 1995).

These RAEs are lasting and have been shown to persist into elite adult (professional) levels of play in ice hockey (Grondin & Trudeau, 1991; Montelpare, Scott, & Pelino, 1998; Wattie, Baker, Cobley, & Montelpare, 2007).

Where cut-off dates are imposed, relatively older participants are advantaged because of their advanced development both physically and cognitively as compared to their relatively younger peers grouped within the same cohort (Barnsley et al., 1988). The difference in maturity between those participants who are relatively older and those who are relatively younger can cause a performance gap that persists over time (Barnsley et al., 1988). Ability streaming and selection pressures from a young age appear to foster RAEs in youth sport (Grondin et al., 1984; Musch & Grondin, 2001). It should be noted that the increased likelihood that relatively older youth are of advanced maturity, cognitive and/or physical, affords them a probabilistic (not deterministic) advantage (Wattie, Schorer & Baker, 2015).

It has been hypothesized that RAEs are most likely to occur in highly popular sports and are due to maturation differences and selection of athletes within the developmental tiers of a sport (Barnsley et al., 1988; Helsen, Starks, & Van Winckel, 1998; Sherar, Baxter-Jones, & Faulkner, 2007). The cultural popularity and the degree of physicality of a sport are also potential catalysts of RAEs (Musch & Grondin, 2001).

Considerable attention has been given to RAEs in the sport science literature (see Cobley et al., 2009; Musch & Grondin, 2001; Wattie et al., 2015);

most researchers agree that this is a pervasive influence on athlete development that results in biases and errors in talent identification and development practice. Malcolm Gladwell's popular book *Outliers* (2008) also brought this issue to light for many coaches, parents and practitioners who may not otherwise have become aware of what RAEs are and how pervasive the problem is. Although the existence and causes of RAEs in sport have been researched since the 1980s, to our knowledge very few studies have attempted to implement solutions (cf. Mann et al. 2016).

The purpose of this study was to provide the first systematic review of proposed solutions to RAEs in sport. These findings may be useful to practitioners and researchers considering interventions to resolve RAEs, and may stimulate discussions leading to new interventions. Although RAEs also exist in education, this review is limited to solutions proposed in sport (although naturally solutions are not necessarily mutually exclusive between the domains). Our aim was to collate a comprehensive list of all studies published between January 1980 and May 2016 that have proposed solutions to RAEs in youth sport. We sought to address the following questions: (1) What are the strengths and weaknesses of each proposed solution, and (2) which solutions are the most suitable / realistic to test / implement in youth sport settings?

# METHODS

## **Literature Search**

A PRISMA systematic review of literature was performed using the SPORTDiscus database (1 January 1980 – 31 May 2016). SPORTDiscus was chosen as our primary citation index as it contained over 1,660,000 records from more than 670 full-text journals, which would have made searches into smaller citation indexes largely redundant. Further, given the objective of this review, SPORTDiscus appeared to be the most relevant to this study. Keywords including “relative age”, “relative age effect\*”, and sport\* were used to locate research articles. One thousand, four hundred and eighty-three articles were located (see Figure 1).

## **Inclusion Criteria**

Of the 1483 articles located, those that met the following criteria were included: (1) publication between January 1980 and May 2016; (2) full text availability; (3) English text availability; (4) study conducted on humans (RAEs are often considered for race horses); (5) peer reviewed; (6) youth sport; (7) suggests solutions for relative age effects. Duplicates and studies that only cited solutions already proposed by other authors were excluded. This left 117 records. After review of title and abstract, 4 of the 117 records were excluded (duplicates n= 3; not in English n=1).

## **Data Extraction**

The remaining 113 records were each searched for the following keywords: solution, fix, reduce, strategy, eliminate, prevent. A further 52 records were excluded because none of these keywords were found within the articles. Twenty more records were excluded because they were not relevant (most commonly due to studies not examining solutions), which left 41 eligible full text articles from the SPORTDiscus database search. Three additional articles were found from a general web search and from searching the reference lists of eligible articles. In total, 44 studies were included (see Figure 2).

## **Analyses**

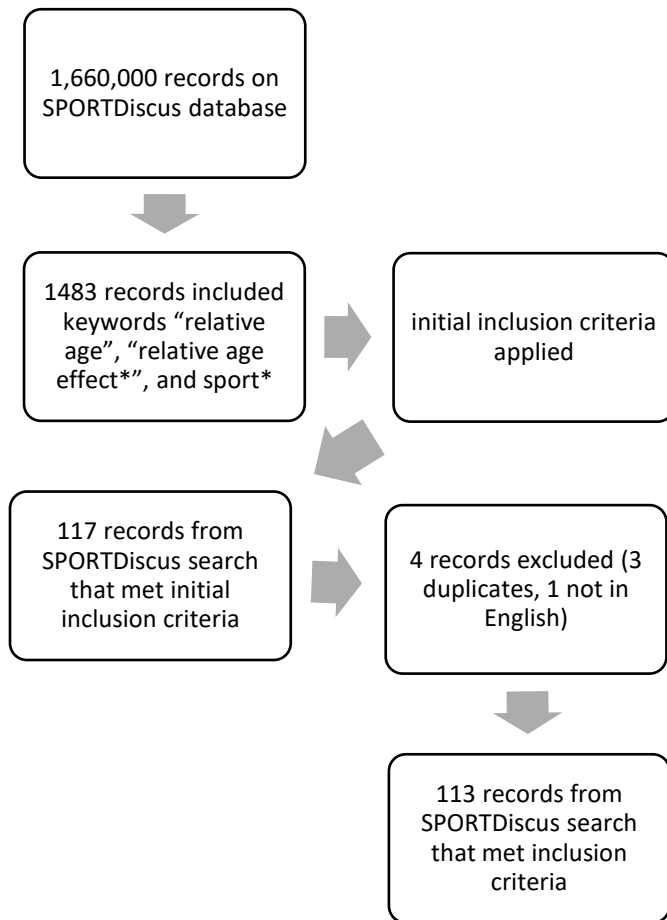
All unique solutions were qualitatively categorized and described in two ways. First, individual solutions were grouped according to common higher order themes by the first author (KW). Solutions were categorized as either technical or pedagogical. Technical solutions are those that seek to change the system (for example, altering cut-off dates). Pedagogical solutions include those that seek to inform or educate influential stakeholders such as parents and coaches. Project members were asked for input on the thematic categories until consensus was reached.

Furthermore, we also sought to classify proposed solutions to RAEs in sport according to the developmental constraints that they address. Wattie and colleagues utilized Newell's model of constraints (see Newell, 1986) to create a

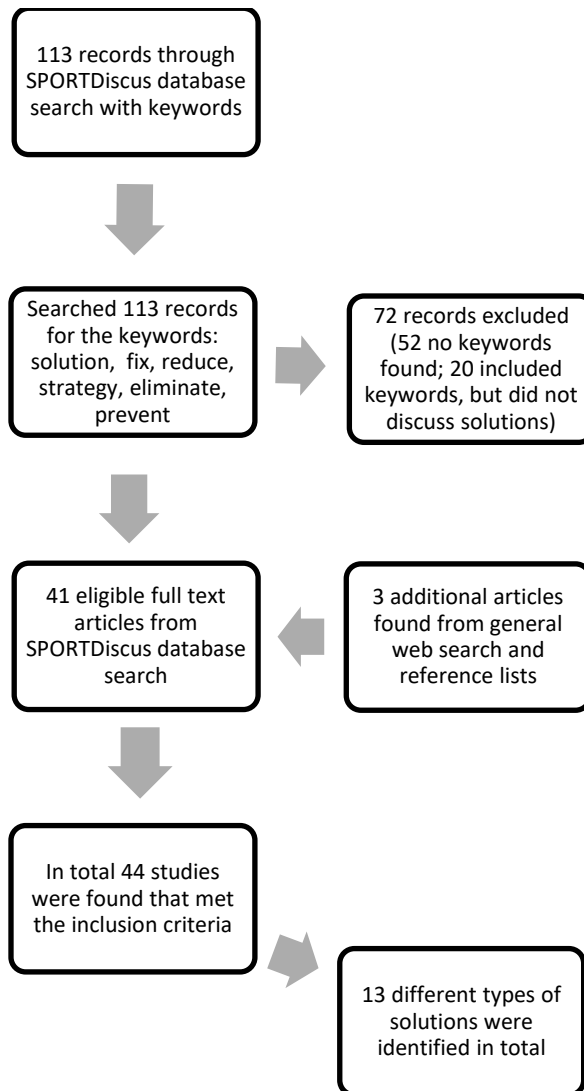


constraints-based theoretical model for understanding RAEs in sport (Wattie et al., 2015). Three types of constraints were described as responsible for developmental outcomes; individual (performer) constraints, task constraints, and environmental constraints. Constraints, or characteristics, with these three categories can act to improve performance/development or hamper it. In this case, organismic constraints describe factors that relate to the individual qualities of humans, and can be termed 'individual constraints'. Task constraints can include the demands of the sport, such as whether or not task success is dependent on strength, speed, agility, flexibility, technical ability, as well as the objectives and rules of a sport. Environmental constraints refer to the broader social constructs that affect development, including the physical environment, socio-cultural norms, policies, and the role of important influences in athletes' lives such as coaches, family members, and friends. Generally, environmental constraints do not change the nature of a task. Each project member independently classified each individual solution based on what the proposed solution modified: task, individual, environmental constraint or a combination of multiple constraints (e.g., individual-task or task-environmental). There was a 100% consensus between project members on which constraint category each solution belonged to.

**Figure 1. PRISMA Systematic Review and Data Extraction**



**Figure 2. Step 2: Keyword search within systematic review results articles**



## RESULTS

Forty-one peer-reviewed publications and three articles from online sources met the criteria for inclusion. Thirteen independent types of solutions were identified from the 41 peer-reviewed publications. The proposed solutions ranged from non-technical pedagogical and coach-education initiatives to numerous technical solutions (e.g. different ways of rotating cut-off dates and cohorts, and age-standardized performance weighting). Table 1 summarizes the proposed solutions. Eight suggested solutions were labelled as *technical*, and involved: corrective adjustments, such as shifting cut-off dates or bands, cycling cut-offs year to year, varying cut-offs across different sports, player quotas (certain number per quartile)/regulating average age of team, height/weight categories, delay selection to 15/16 years of age, and grade fail exemption (allowed to play with younger peers if you fail a grade). Five proposed solutions were *pedagogical*: tests focused on technical and tactical skills instead of overemphasis on physical size, age-ordered shirt numbering, raising awareness (coaches), additional support for relatively young players, and increased opportunities for relatively younger players. Most proposed solutions are theoretical and there have been few attempts to implement them.

**Table 1. Summary of Proposed Solutions to RAEs in Sport**

<b>SOLUTION</b>	<b>DESCRIPTION</b>	<b>STRENGTHS</b>	<b>WEAKNESSES</b>
<b>Corrective adjustments<sup>18</sup></b>	Corrective Adjustments applied to athletic sprinting effectively removed RAEs.	<ul style="list-style-type: none"> <li>· Can be easily applied to sport and education.</li> </ul>	<ul style="list-style-type: none"> <li>· May not be feasible in team sports.</li> <li>· Ignores inter-individual variability.</li> </ul>
<b>Shift bands to 9/15/21 months<sup>16, 5</sup></b>	Instead of 12 month bands for dividing age groups, use 9, 15, or 21 month bands.	<ul style="list-style-type: none"> <li>· In theory a narrower band (9 months) could equal more homogenous group.</li> </ul>	<ul style="list-style-type: none"> <li>· Just results in transfer/shift of RAEs.</li> <li>· Larger groups (21 months) could result in bigger RAEs.</li> </ul>
<b>Cycle cut-off dates year to year<sup>3, 13, 14</sup></b>	Each year change the cut-off dates so that the individuals change quartiles each year. If the cut-off was shifted by 3 months each year then every 4 <sup>th</sup> year an individual would be in quartile 1.	<ul style="list-style-type: none"> <li>· Individuals would experience being in each different quartile and would therefore be advantaged some years and disadvantaged other years.</li> </ul>	<ul style="list-style-type: none"> <li>· Complex to implement in leagues.</li> <li>· Athletes would always be playing with different teammates (wouldn't get to play with friends).</li> <li>· Timing of relative age during the major recruitment years may impact athlete development.</li> <li>· Rather than eliminate social disadvantage, spreads it to more individuals.</li> </ul>
<b>Vary cut-off dates across different sports<sup>16</sup></b>	Across various sport contexts make the cut-off dates different.	<ul style="list-style-type: none"> <li>· Would prevent generic RAEs across sports contexts.</li> <li>· May reduce the likelihood of persistent negative experiences of sporting</li> </ul>	<ul style="list-style-type: none"> <li>· Does not eliminate relative age disadvantages.</li> </ul>

		involvement relative to age-matched peers.	
<b>1. Player quotas- certain number per quartile<sup>2</sup></b> <b>2. Regulating average age of team<sup>10, 11</sup></b>	Coaches / scouts would only be able to select a certain number of athletes born per quartile for each team, or would have to maintain a particular average age per team.	<ul style="list-style-type: none"> <li>· More sensitive to individual variability in physical characteristics.</li> </ul>	<ul style="list-style-type: none"> <li>· May prove difficult to integrate into sport systems.</li> <li>· May create health risks if smaller athletes are selected to participate with larger athletes.</li> </ul>
<b>Height/weight categories<sup>4, 16</sup></b>	Introducing height and weight categories in sports where size is beneficial to performance.	<ul style="list-style-type: none"> <li>· More sensitive to individual variability in physical characteristics during early development.</li> </ul>	<ul style="list-style-type: none"> <li>· Difficult to integrate into sport systems and are as yet unproven in their value for resolving RAEs.</li> </ul>
<b>Delay selection to 15/16 years of age<sup>6</sup></b>	Eliminate early specialization in sport and rep / elite teams until the age of 15/16.	<ul style="list-style-type: none"> <li>· Illustrates concern for the physiological and psychosocial welfare of athletes.</li> <li>· Youth of all ages have a better chance of experiencing and enjoying sport prior to involvement in any selection system.</li> </ul>	<ul style="list-style-type: none"> <li>· May not be well received by parents, coaches, and/or athletes.</li> <li>· May put our youth at a disadvantage in terms of the level of coaching and training they receive at younger ages.</li> <li>· May limit our success on an international scale as compared with other countries who may be specializing at a young age.</li> </ul>
<b>Raise awareness of coaches<sup>6</sup></b>	Increase education and awareness of the effects of relative age among	<ul style="list-style-type: none"> <li>· In theory, if coaches are more aware of the tendency to select relatively older athletes they may</li> </ul>	<ul style="list-style-type: none"> <li>· In Mann's study (2016) being aware of RAEs and knowledge of player birthdates did not help to reduce the</li> </ul>

	coaches and team managers.	be more likely to select more relatively younger athletes.	selection bias of coaches.
<b>Grade fail exemption<sup>7</sup></b>	This applies to student athletes who have failed a grade and have been kept back who are allowed to compete in sport with their academic peers who are a year younger.	<ul style="list-style-type: none"> <li>· Gives relatively younger students (compared to peers in the grade they should be in) the opportunity to compete with younger age grouping and to be noticed.</li> </ul>	<ul style="list-style-type: none"> <li>· Student athletes aware of RAEs may intentionally fail academically for the opportunity of an advantage playing with relatively younger or same age peers.</li> </ul>
<b>Additional support/ increased opportunities for relatively younger players<sup>1, 17</sup></b>	Provide relatively younger athletes with increased support and opportunities to participate within sport systems.	<ul style="list-style-type: none"> <li>· May help the younger players to improve and become more competitive.</li> <li>· More opportunities and different levels of play available may encourage more athletes to become or stay involved in their sport long-term.</li> </ul>	<ul style="list-style-type: none"> <li>· Affected by availability of coaches and facilities.</li> <li>· Players may still drop out if not selected for more competitive teams (i.e. drop out rather than play “house league”).</li> </ul>
<b>Tests focused on technical and tactical skills, not size and development<sup>9, 12</sup></b>	Including tests focused on technical and tactical skills would even the playing field and allow the relatively younger athletes to better compete.	<ul style="list-style-type: none"> <li>· May create a more equal playing field in terms of skill evaluation.</li> </ul>	<ul style="list-style-type: none"> <li>· May still favour relatively older athletes as advanced cognitive development and experience may result in greater tactical skill.</li> </ul>

## Age-ordered shirt numbering<sup>15</sup>

When jerseys were numbered in order of the relative ages of players this had an effect on coaches selecting more relatively young players.

· Shown in one study to effectively reduce RAE bias in selection by talent scouts.

· Only one study has tested this strategy.

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<sup>1</sup>Baker, J., Schorer, J., Cobley, S., Brautigam, H., & Busch, D. (2009). Gender, depth of competition and relative age effects in team sports. *Asian Journal of Exercise & Sports Science*, 6(1). <sup>2</sup>Barnsley, R. H. & Thompson, A. H. (1988). Birthdate and success in minor hockey: the key to the NHL. *Canadian Journal of Behavioural Science*, 20, 167-176. <sup>3</sup>Barnsley, R. H., Thompson, A. H. & Legault, P. (1992). Family planning: football style - relative age effects in football. *International Review for the Sociology of Sport*, 27, 77- 88. <sup>4</sup>Baxter-Jones A. (1995). Growth and development of young athletes: should competition levels be age related? *Sports Med*, 20: 59-64. <sup>5</sup>Boucher J & Halliwell W. (1991). The Novem system: a practical solution to age grouping. *Can Assoc Health Phys Educ Recreation J*, 57: 16-20. <sup>6</sup>Cobley, S., Baker, J., Wattie, N. & Mckenna, J. (2009). Annual Age-Grouping and Athlete Development: A meta-analytical review of relative age effects in sport. *Sports Medicine*, 39, 235-256. <sup>7</sup>Côté, J., Macdonald, D. J., Baker, J. & Abernethy, B. (2006). When 'where' is more important than 'when': birthplace and birthdate effects on the achievement of sporting expertise. *Journal of Sports Sciences*, 24, 1065-1073. <sup>8</sup>Grondin, S., Deschaies, P. & Nault, L. P. (1984). Trimester of birth and school output [in French]. *Apprentissage Social*, 16, 169-174. <sup>9</sup>Hancock, D.J., Ste-Marie, D.M., & Young, B.W. (2013). Coach selections and the relative age effect in male youth ice hockey. *Research Quarterly for Exercise and Sport*, 84 (1) 126-130. <sup>10</sup>Helsen, Wf, Starkes, JI, & Van Winckel, J. (2000). Effect of a change in selection year on success in male soccer players. *Am J Hum Biol*, 12: 729-35. <sup>11</sup>Helsen Wf, Starkess JI, & Van Winckel J. (1998). The influence of relative age on success and dropout in male soccer players. *Am J Hum Biol*, 10: 791-8. <sup>12</sup>Horn, R., & Okumura, M. (2011). It's time to eliminate the relative age effect in American soccer. *Soccer Journal*, 56(2), 38-40. <sup>13</sup>Hurley W, Lior D, & Tracze S. (2001). A proposal to reduce the age discrimination in Canadian minor hockey. *Can Public Policy*, 27 (1): 65-75. <sup>14</sup>Hurley, W. J. (2009). Equitable birthdate categorization systems for organized minor sports competition. *European Journal of Operational Research*, 192(1), 253-264. <sup>15</sup>Mann, D.L. & Van Ginneken, P.J. (2016). Age-ordered shirt numbering reduces the selection bias associated with the relative age effect. *Journal of Sports Sciences*, 1-7. <sup>16</sup>Musch, J. & Grondin, S. (2001). Unequal Competition as an Impediment to Personal Development: A Review of the Relative Age Effect in Sport. *Developmental Review*, 21, 147-167. <sup>17</sup>Pierson, K., Addona, V., & Yates, P. (2014). A behavioural dynamic model of the relative age effect. *Journal of sports sciences*, 32(8), 776-784. <sup>18</sup>Romann, M. & Cobley, S. (2015). Relative age effects in athletic sprinting and corrective adjustments as a solution for their removal. *PloS one*, 10(4), e0122988. <sup>19</sup>Wattie, N., Schorer, J., & Baker J. (2015). The relative age effect in sport: A developmental systems model. *Sports Medicine*, 45(1), 83-94.

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## Technical Solutions

*Corrective adjustments.* Romann and Cobley (2015) suggest applying corrective adjustments after performance, similar to a handicap in golf, allowing the performance of a relatively younger athlete to be scored higher than the performance of a relatively older athlete (This strategy was first proposed by



Crawford, Dearden, & Meghir, 2007 and Peña, 2014 for RAEs in education, whereby grades or test scores would be inflated for relatively younger students). The authors analyzed secondary data of sprinting results and corrective adjustments were applied to aggregated relative age-related differences in performances, which removed RAEs. An advantage of this proposed solution is that it can be easily applied to sport. However, this may not be feasible in team sports. This solution is also problematic because it ignores inter-individual variability. It assumes, rather deterministically, that relatively younger youth are always disadvantaged.

Implementing this solution would also change the competitive environment entirely. To provide an illustrative example, after crossing the finish line first a runner could be denied first place after corrective adjustments are applied based on relative age and the runner is then reclassified as a result. For obvious reasons this would be deemed unacceptable by many athletes, coaches, and spectators.

*Cut-off date/Age band modifications.* A number of solutions were found in this category. For example, instead of 12 month bands some suggest dividing age groups, use 9, 15, or 21 month bands. Grondin et al. (1984) proposed a 15-month or 21-month category system to break the structure based on multiples of 12 (cf. Boucher & Halliwell, 1991). This would have the advantage of constantly cycling the cutoff date throughout the year, thereby eliminating a systematic bias against children born late in a fixed competition year. Brewer et al. (1995) argued that 1-year or 2-year periods typical for most team sports are too great an age

band from which to select squads. A shorter 9-month period, as suggested by Boucher and Halliwell (1991), would reduce the age difference between the youngest and oldest children. Similarly, cycling cut-off dates year to year would ensure that individuals change quartiles each year (Barnsley et al., 1992; Hurley, Lior, & Tracze, 2001; Hurley, 2009). If the cut-off was shifted by 3 months each year then every 4th year an individual would get to experience being in 'quartile 1', and therefore relatively older. Another suggestion is to vary cut-off dates across different sports so that the same youth are not advantaged in all sports and activities (Musch & Grondin, 2001). This solution would only impact athletes competing in more than one sport. A smaller age band—as well as a rotating cutoff date—might prove to be difficult to run on a practical basis due to organizational problems and the lower number of players. In theory, a narrower band (9 months) could equal a more homogeneous group; however, this would be difficult to implement and would likely just result in a transfer or shift of RAEs. Meanwhile, larger groups (21 months) could result in even larger RAEs (see Schorer, Baker, Büsch, Wilhelm, & Pabst, 2009).

These strategies could be very complex to implement in sport leagues. Athletes would always be playing with different teammates, which could undermine the intrinsic motivational reasons to participate (would not get to play with friends). The timing of relative age during the major recruitment years may also impact athlete development. If you happened to be allocated to quartile one in major selection years it may result in greater chances of selection and advancement (see Schorer et al., 2009).

Aside from practical issues, there is also a more general, and perhaps philosophical, limitation to the solutions that seek to distribute relative age advantages and disadvantages. To our minds this must be one of the few examples of solutions to social inequalities that propose distributing inequality rather than eliminating inequality. This strikes us as a rather unambitious goal, and one which parents would likely object to.

*Relative age quotas.* There were also proposed solutions that involved modifications to the inclusion criteria for teams and leagues. One group of proposed solutions involved regulating the relative age distribution on a team. These solutions include mandating a certain number of players per quartile (Barnsley & Thompson, 1988), or regulating the average age on teams (Helsen, Starkes, & Van Winckel, 2000; Helsen et al., 1998). For example, coaches / scouts would only be able to select a certain number of athletes born per quartile for each team, or would have to maintain a particular average age per team. This proposed solution is more sensitive to individual variability in physical characteristics, but may prove difficult to integrate into sport systems. There is a possibility that this strategy could create health/safety risks if smaller athletes were selected to participate with larger athletes for the sake of meeting a quota.

*Height/weight categories.* Introducing height and weight categories in sports where size is beneficial to performance (Baxter-Jones, 1995; Musch & Grondin, 2001). Also called bio-banding, this approach would involve athletes being grouped by height and/or weight as well as age cut-off dates. These categories would take into account individual variability in physical characteristics

during early development. Although height/weight categories are as yet unproven in their value for resolving RAEs, no relative age effects were found for American Football in the NFL (MacDonald, Cheung, Côté, & Abernathy, 2009), which lends credibility to this possible solution (because youth football utilizes age and height/weight categories).

*Grade fail & delayed entry exemptions.* This applies to student athletes who have failed a grade or have delayed entry to school. Either event allows youth to compete in sport with the age cohort that is a year younger (Côté, Macdonald, Baker, & Abernathy, 2006). This exemption gives relatively younger students (compared to peers in the grade they should be in) the opportunity to compete with a younger age group. Ultimately, this difference between assigned and observed relative age may result in performance advantages for athletes (relative to the peers they are competing with and against) and the potential to avoid a relative age disadvantage. It has also been suggested that student athletes aware of RAEs may intentionally fail academically for the opportunity of an advantage playing with relatively younger (or same age as opposed to relatively older) peers (Côté et al., 2006).

### Pedagogical & Informational Solutions

*Delay selection/competitive streaming.* This solution centers on the idea of eliminating early specialization and competitive streaming until approximately 15-16 years of age (Cobley et al., 2009). With this suggestion, Cobley et al. (2009) highlight concern for the physical and psychosocial welfare of athletes. Given the opportunity to participate in a more recreational capacity, youth of all ages would

have a better chance of experiencing and enjoying sport prior to involvement in any selection system. Moreover, delaying competitive streaming until a developmental period when most youth have matured (physically and cognitively), would allow the growth and maturational differences probabilistically associated with older relative age to exert less of an influence than they do at earlier stages of development. However, this change may not be well received by parents, coaches, and/or athletes with their aim set on achieving higher levels of competition. It may also put youth at a disadvantage in terms of the level of coaching and training they receive at younger ages, and as a result it may have a negative influence on high performance athlete development compared with other countries who may be specializing at a young age.

*Augment selection practices.* This solution suggests that selection should emphasize technical and tactical skills, not only size (Hancock, Ste-Marie, & Young, 2013; Horn & Okumura, 2011). Including tests focused on technical and tactical skills may even the playing field and allow the relatively younger athletes to better compete (Hancock et al., 2013; Horn & Okumura, 2011). This may create a more equal playing field in terms of skill evaluation. Alternatively, this may still favour relatively older athletes as advanced cognitive development and experience may result in greater technical and tactical skill. Multidimensional approaches to talent identification seem to be supported in the literature (Robinson, Wattie, Schorer, & Baker, 2018), but whether such approaches mitigate the creation of RAEs remains unknown.

*Age-ordered shirt numbering.* According to our results, this was the only intervention that has actually been empirically tested and published in the peer review literature. In this study, junior games were watched by talent scouts from an elite football club who ranked players on the basis of their potential. The scouts were provided with (1) no age information, (2) players' birthdates or (3) knowledge that the numbers on the playing shirts corresponded to the relative age of the players (Mann & Van Ginneken, 2016). For example, the oldest of the cohort was numbered 1, the second oldest 2, and so on. This simple but explicit prompt had an effect on team selection. Mann and Van Ginneken (2016) found that when jerseys were numbered in order of the relative ages of players, coaches selected more relatively young players. This strategy was shown in one study to effectively reduce relative age bias in selection by talent scouts. It is important to note that although this study is noteworthy and the results are promising, only one study has tested this strategy and more studies need to be done to ensure that the results are replicable.

*Raise awareness of coaches.* Cobley et al. (2009) suggested increasing education and awareness of the effects of relative age among coaches and team managers. In theory, if coaches are more aware of the tendency to select relatively older athletes they may be more likely to select more relatively younger athletes. However, in Mann and Van Ginneken's study (2016), being aware of RAEs and knowledge of player birthdates did not help to reduce the selection bias of coaches. Moreover, popular books (i.e., Gladwell, 2008), scientific resources, and public presentations have been disseminating information about

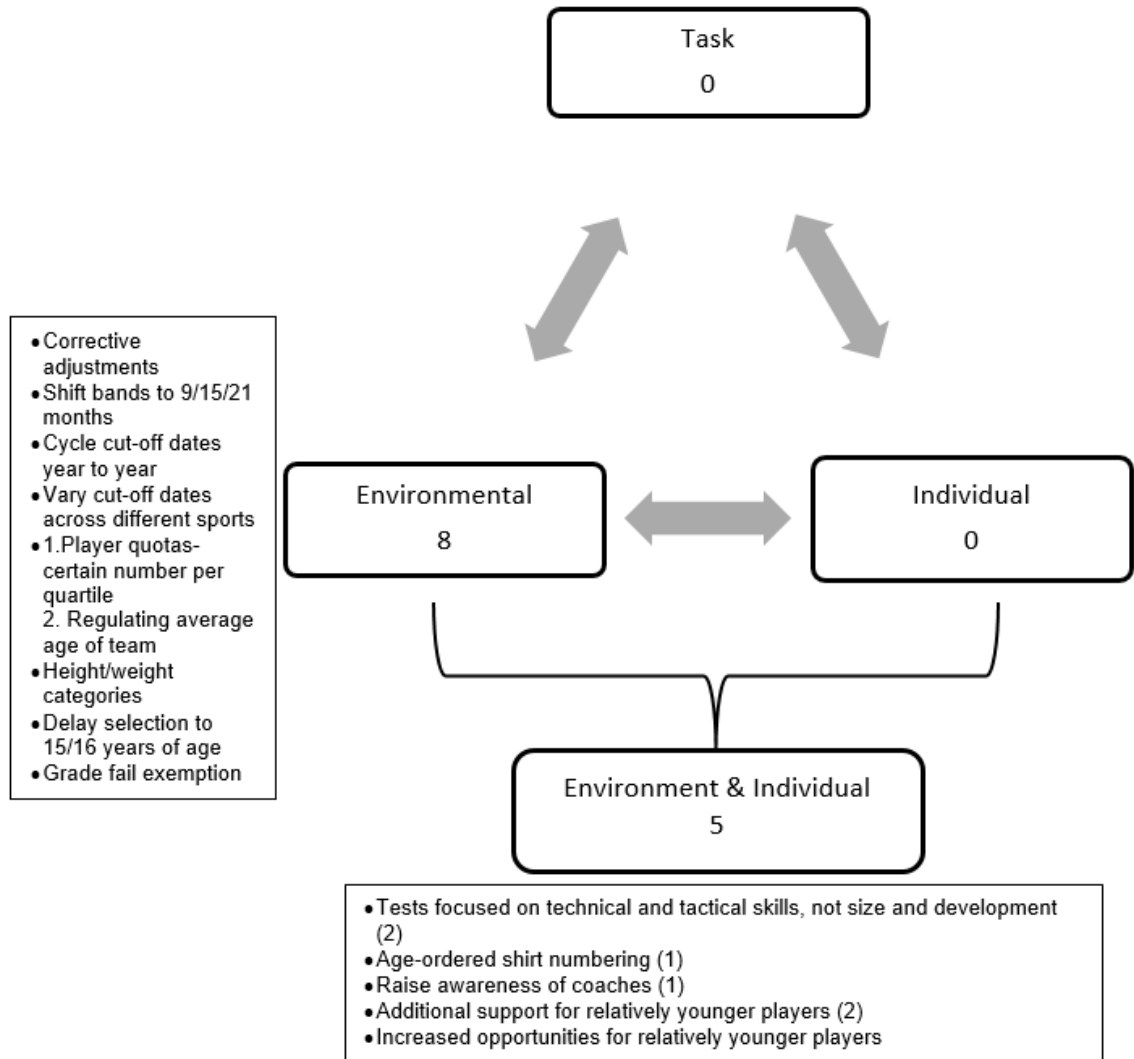
RAEs for years, and there is no evidence that these informational efforts have been effective. Therefore, while raising awareness certainly seems logically necessary for addressing RAEs, it is likely far from sufficient in and of itself.

*Additional support/ increased opportunities for relatively younger players.*

Baker, Schorer, Cogley, Brautigam, and Busch, (2009) and Pierson, Addona, and Yates (2014) suggest providing relatively younger athletes with increased support and opportunities to participate within sport systems. This may help the younger players to improve and become more competitive. More opportunities and different levels of play being made available may encourage more athletes to become or stay involved in their sport long-term. This is likely already impacted on an individual basis by SES and parental engagement. The feasibility of this solution on a broader scale may be affected by availability of resources such as funding, coaches and facilities. Besides, players may still drop out if not selected for more competitive teams rather than play recreationally (i.e. “house league”).

The 13 solutions themes identified were also categorized based on the constraints which they address. Of the solutions identified in the currently available literature, 8 addressed environmental constraints and 5 were aimed at a combination of the environment and the individual. None of the proposed solutions were identified as addressing the task or solely the individual (see Figure 3).

**Figure 3. Solutions categorized based on constraint category**



## DISCUSSION & CONCLUSIONS

The purpose of this study was to provide the first systematic review of proposed solutions to RAEs in sport. These findings may be useful to practitioners and researchers considering interventions to resolve RAEs, and may stimulate discussions leading to new interventions. Our aim was to collate a comprehensive list of all studies published between January 1980 and May 2016



that have proposed solutions to RAEs in youth sport. Further, we sought to address the following questions: (1) What are the strengths and weaknesses of each proposed solution, and (2) which solutions are the most suitable, realistic to test, and realistic to implement in youth sport settings?

Few of the proposed solutions have been empirically tested or applied within sport leagues. Aside from shirt numbering, most solutions have not been tested. Future research should seek to test possible solutions to RAEs in sport. However, testing solutions to RAEs is difficult in reality because the test could potentially be putting youths' future athlete development at risk. Some solutions may have the potential to both positively and/or negatively affect athlete development. For example, to test the cycling of cut-off dates this would have to be implemented and may confer an advantage to those athletes who happen to be the oldest in their cohort at the time of elite level team selection (and alternately a disadvantage to those who are relatively youngest at the time).

Furthermore, very few solutions recognize unique individual, environmental, and task constraints that contribute to RAEs (Wattie et al., 2015). They often address only one factor, while ignoring the holistic nature of athlete development. Most contemporary theories of youth development – ecological systems theories – posit a need to understand individual, environment, and context. However, the proposed solutions are only looking at one aspect. We should look at other aspects when looking for solutions.

Some solutions proposed might not be feasible to implement. The majority of solutions explored are technical in nature, while few suggested solutions emphasize pedagogy/education initiatives. Most solutions do not involve changing the task, rather most are policy changes, and very few have anything to do with the individual. None of the proposed solutions modify activities (task constraints) to better align with children of different relative age. Most solutions address environmental constraints through changes to policy or league structure.

Mann and Van Ginneken's (2016) study with age-ordered shirt numbering is still environmental, but also involves coach awareness. This age-ordered shirt numbering strategy worked in soccer in Mann and Van Ginneken's study, but would it work in other sport settings? For example, in a more physical sport like hockey where size and strength are more of an asset, shirt numbering may have a different impact. Does this strategy still work in a sport that is different from soccer? Only one study has been done so far utilizing this strategy. As such, while the results of this study are very promising, the study needs to be replicated and applied in different sport settings before we can accept it as an effective solution.

In summary, though solutions have been proposed for youth sport, few have been tested or implemented. Furthermore, after analyzing the strengths and weaknesses of the solutions proposed in the available literature it seems that there are many foreseeable issues with implementing these as sweeping blanket solutions. Youth sport organizations and systems may have to consider different solutions in different contexts or the answer may lie in utilizing multiple solutions

(i.e. height / weight categories and age-ordered shirt numbering for selection purposes).

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## Chapter 5 – Overall Discussion

## OVERALL DISCUSSION & CONCLUSIONS

The purpose of the systematic review was to collate the research to date in which solutions for relative age effects (RAEs) are suggested and to critically analyze the solutions put forward. A PRISMA systematic review of published peer-reviewed studies was performed. A goal was to understand whether the proposed solutions were related to the individual, the task, or environmental characteristics. The purpose of the data analysis of the COMPASS dataset was to explore interactions between participation in sport, grade achievement and feelings of connectedness among Ontario secondary school students. A secondary data analysis was performed using survey data collected from secondary school students across Ontario.

For both studies we have focused on a multifaceted approach to relative age research. Previous research has taken an isolated and specific approach to looking at each aspect individually, rather than a more ecologically representative approach considering how multiple developmental influences may impact each other and the individual as a whole. Most studies to date have taken a one-dimensional view of RAEs, but it is clear that more research needs to be done taking a multidimensional view of RAEs. In support of this multidimensional view, our systematic review found that most solutions investigated addressed environmental constraints, rather than individual or task constraints (8 environment, 0 individual, 0 task, 5 environment & task). Furthermore, most of those solutions were technical as opposed to pedagogical.

Researchers have found that youth are more likely to experience positive outcomes when positive asset building is promoted and protective factors are developed (Lerner, Almerigi, Theokas, & Lerner, 2005). Also, youth who experience positive youth development (PYD) are more likely to be protected from negative developmental outcomes and have enhanced likelihood of positive developmental outcomes and trajectories (Lerner et al., 2005). Many factors contribute to PYD, relative age being just one of them. For example, there is not a linear relationship between relative age and grades. There is notable variation in the influence of relative age and many other mitigating factors to consider (i.e. support from teachers and parents). In the COMPASS data analysis study, we have explored variables related to academic achievement in English and math, sport and physical activity participation, and feelings of connectedness to the student's school. Aspects that we did not look at include cigarette, alcohol and marijuana use, healthy eating, bullying, absenteeism, socioeconomic status (SES), and activities other than sport, all of which could influence PYD. Both the gaps and the imbalances in previous research highlight the complexity and heterogeneity of RAEs. These would be promising avenues to investigate with further research. It would be interesting to explore how these factors interact with the factors we analyzed in order to understand the effects of relative age on youth and PYD.

We did not find RAEs for some things that we expected to based on the results of previous studies (e.g., academic achievement). This suggests that there is variation in RAEs and that we cannot assume that they exist everywhere.

This has implications for solutions as well as broadly applied policy change. Organizations should individually consider if RAEs exist in their environment, and if so which solutions option is most appropriate. Studying where RAEs do *not* exist may be quite important going forward. Multidimensional studies of such contexts could provide insights for how to reduce or eliminate RAEs in other similar contexts.

While future research may benefit from more multidimensional approaches, research may also benefit from more diverse methodological approaches as well. No qualitative research has been done regarding RAEs so we rely on the results of quantitative analyses. Qualitative research, such as interviews, would help to provide a more thorough picture of the influence of relative age on the lived experiences of youth. The COMPASS study results suggest that relative age may have an influence on feelings of connectedness, sport and physical activity participation in school settings, and academic achievement. It would be unrealistic to try to eliminate relative age in school settings, as students need to be divided based on developmental stages. The results of the current thesis suggest that we could consider implementing strategies to increase feelings of connectedness and opportunities for participation in school sport settings for the relatively younger students. This may have an indirect positive influence on RAEs for educational and sport outcomes. However, additional research with expanded multidimensional variables and methods is needed to better inform such strategies.

Though many solutions have been theorized to mitigate or eliminate RAEs in sport, few have been implemented or tested. Moreover, solutions have been relatively homogeneous in their qualitative nature and in the constraints they propose to modify. One strategy that shows promise and has been tested (age-ordered shirt numbering) is related to team selection and thus limited to competitive sport environments. While various solutions may not apply equally to different sports and different environments, the age-ordered shirt strategy could also be used in educational contexts. Perhaps individual learning plans/approaches in Ontario education system effectively do this. Differentiated learning is not implemented to address 'relative age', but it does address 'the individual', which gets to the same outcome. This may be why no RAEs were found for educational outcomes in this study. If tested going forward, it may also be useful to consider how interventions for one area, for example educational achievement, influence other areas such as PYD and sport participation.

Perhaps a potential "solution" is not to adjust cut-off dates or systemic technical features, but rather to focus policy on promoting connectedness and participation as these have the potential to mitigate RAEs. This could be implemented by creating "introductory" level or recreational teams within school settings alongside the more competitive opportunities offered. The idea of promoting connectedness and increasing participation should be endorsed to students / athletes, parents, and coaches as all play a role in PYD. Schools and teachers could play an integral role in disseminating and promoting this message (as the average parent or coach may not read peer-reviewed journal articles).

It may also be important to consider the impact of broader social inequalities on the degree to which relative age has an influence on youth development. For example, factors such as SES and parental education level may mitigate the effects of relative age. This could be due to increased access to resources for the youth or the fact that such parents are themselves more likely to be physically active / participate in sport. Perhaps focusing on other factors outside of the home, like fostering feelings of connectedness at school and through sport, could moderate the effects of relative age and provide relatively younger students and athletes with a more level playing field.

It is important to consider RAEs and the impact they have on PYD in terms of keeping more children active, promoting feelings of connectedness among youth, and fostering academic achievement. Most of the solutions proposed to date are related to eliminating asymmetries in relative age distributions. However, solutions aimed at other outcomes may also be valuable. For example, efforts to increase PYD and connectedness could potentially decrease dropout rates (in academic and sport systems). If we want to cultivate resilient, well-rounded, happy youth we need to consider the many aspects influencing their development and what we can do to best promote positive asset building.

The purpose of this thesis was to identify solutions to RAEs found in the currently available research as well as to explore relationships between relative age, academic achievement, sport participation, and feelings of connectedness (related to PYD). Though theoretical solutions have been proposed, there has

been little attempt made to implement these solutions or consideration given to the potential consequences of implementing the proposed solutions. More reflection needs to be given as to the most practical way to mitigate RAEs, and it is likely that solutions are numerous and should be specific to the sport and organization (environment). Furthermore, relative age is associated with sport participation, academic achievement, and feelings of connectedness, and these factors impact each other. As such, perhaps we should strive not to change the systems (cut-off dates) within which our youth find themselves, but to focus resources on best supporting all students through fostering feelings of connectedness, providing multiple opportunities for participation in various levels of sport, and delivering differentiated learning. There is a need for further research that takes a multivariate and multidimensional view of youth development going forward, and that utilizes a wider variety of methodological approaches.

## REFERENCES

Lerner, R. M., Almerigi, J. B., Theokas, C., & Lerner, J. V. (2005). Positive youth development a view of the issues. *The journal of early adolescence, 25*(1), 10-16.



# APPENDICES

**1. Funding**

**2. COMPASS Questionnaire**

## APPENDIX 1: FUNDING

*The COMPASS study was supported by a bridge grant from the Canadian Institutes of Health Research (CIHR) Institute of Nutrition, Metabolism and Diabetes (INMD) through the "Obesity - Interventions to Prevent or Treat" priority funding awards (OOP-110788; grant awarded to S. Leatherdale) and an operating grant from the Canadian Institutes of Health Research (CIHR) Institute of Population and Public Health (IPPH) (MOP-114875; grant awarded to S. Leatherdale).*

## APPENDIX 2: COMPASS QUESTIONNAIRE

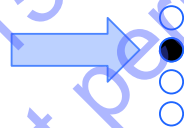


- This is **NOT** a test. All of your answers will be kept **confidential**. No one, not even your parents or teachers, will ever know what you answered. So, please be honest when you answer the questions.
- Mark only **one option per question** unless the instructions tell you to do something else.
- Choose the option that is the **closest** to what you think/feel is true for you.



Please, use a pencil to complete this questionnaire 

Please mark all your answers with full, dark marks like this:



START HERE



Please read each sentence below carefully. Write the correct letter, number, or word on the line and then fill in the corresponding circle.

The first letter of your <b>middle</b> name (if you have more than one middle name use your first middle name; if you don't have a middle name use "Z" ): _____	The name of the month in which you were born: _____	The <b>last</b> letter of your full <b>last</b> name: _____	The <b>second</b> letter of your full <b>first</b> name: _____	The <b>first</b> initial of your <b>mother's</b> first name (think about the mother you see the most): _____
(A) (J) (S) (B) (K) (T) (C) (L) (U) (D) (M) (V) (E) (N) (W) (F) (O) (X) (G) (P) (Y) (H) (Q) (Z) (I) (R)	① January ② February ③ March ④ April ⑤ May ⑥ June ⑦ July ⑧ August ⑨ September ⑩ October ⑪ November ⑫ December	(A) (J) (S) (B) (K) (T) (C) (L) (U) (D) (M) (V) (E) (N) (W) (F) (O) (X) (G) (P) (Y) (H) (Q) (Z) (I) (R)	(A) (J) (S) (B) (K) (T) (C) (L) (U) (D) (M) (V) (E) (N) (W) (F) (O) (X) (G) (P) (Y) (H) (Q) (Z) (I) (R)	(A) (J) (S) (B) (K) (T) (C) (L) (U) (D) (M) (V) (E) (N) (W) (F) (O) (X) (G) (P) (Y) (H) (Q) (Z) (I) (R)



[serial]

# About You

## 1. What grade are you in?

- Grade 9
- Grade 10
- Grade 11
- Grade 12

## 2. How old are you today?

- 13 years or younger
- 14 years
- 15 years
- 16 years
- 17 years
- 18 years or older

## 3. Are you female or male?

- Female
- Male

## 4. How would you describe yourself? (Mark all that apply)

- White
- Black
- Asian
- Aboriginal (First Nations, Métis, Inuit)
- Latin American/Hispanic
- Other

## 5. About how much money do you usually get each week to spend on yourself or to save?

(Remember to include all money from allowances and jobs like baby-sitting, delivering papers, etc.)

- Zero
- \$1 to \$5
- \$6 to \$10
- \$11 to \$20
- \$21 to \$40
- \$41 to \$100
- More than \$100
- I do not know how much money I get each week

## 6. How do you usually travel to and from school? (If you use two or more modes of travel, choose the one that you spend most time doing)

### To school

- By car (as a passenger)
- By car (as a driver)
- By school bus
- By public bus, subway, or streetcar
- By walking
- By bicycling
- Other

### From school

- By car (as a passenger)
- By car (as a driver)
- By school bus
- By public bus, subway, or streetcar
- By walking
- By bicycling
- Other

## 7. Did you attend this school last year?

- Yes, I attended the same school last year
- No, I was at another school last year



# Physical Activity

**HARD** physical activities include jogging, team sports, fast dancing, jump-rope, and any other physical activities that increase your heart rate and make you breathe hard and sweat.

**MODERATE** physical activities include lower intensity activities such as walking, biking to school, and recreational swimming.

11. Mark how many minutes of **HARD** physical activity you did on each of the last 7 days. This includes physical activity during physical education class, lunch, after school, evenings, and spare time.

	Hours					Minutes			
Monday	0	1	2	3	4	0	15	30	45
Tuesday	0	1	2	3	4	0	15	30	45
Wednesday	0	1	2	3	4	0	15	30	45
Thursday	0	1	2	3	4	0	15	30	45
Friday	0	1	2	3	4	0	15	30	45
Saturday	0	1	2	3	4	0	15	30	45
Sunday	0	1	2	3	4	0	15	30	45

**For example:** If you did 45 minutes of hard physical activity on Monday, you will need to fill in the 0 hour circle and the 45 minute circle, as shown below:

	Hours					Minutes			
Monday	●	1	2	3	4	0	15	30	●

12. Mark how many minutes of **MODERATE** physical activity you did on each of the last 7 days. This includes physical activity during physical education class, lunch, after school, evenings, and spare time. Do not include time spent doing hard physical activities.

	Hours					Minutes			
Monday	0	1	2	3	4	0	15	30	45
Tuesday	0	1	2	3	4	0	15	30	45
Wednesday	0	1	2	3	4	0	15	30	45
Thursday	0	1	2	3	4	0	15	30	45
Friday	0	1	2	3	4	0	15	30	45
Saturday	0	1	2	3	4	0	15	30	45
Sunday	0	1	2	3	4	0	15	30	45

**For example:** If you did 1 hour and 30 minutes of moderate physical activity on Monday, you will need to fill in the 1 hour circle and the 30 minute circle, as shown below:

	Hours					Minutes			
Monday	0	●	2	3	4	0	15	●	45

13. Were the last 7 days a typical week in terms of the amount of physical activity that you usually do?

- Yes
- No, I was *more* active in the last 7 days
- No, I was *less* active in the last 7 days

14. Your closest friends are the friends you like to spend the most time with. How many of your closest friends are physically active?

- None
- 1 friend
- 2 friends
- 3 friends
- 4 friends
- 5 or more friends

15. Are you taking a physical education class at school this year?

- Yes, I am taking one **this term**
- Yes, I will be taking one or have taken one this school year, **but not this term.**
- No, I am not taking a physical education class at school this year

16. Do you participate in before-school, noon hour, or after-school physical activities organized by your school? (e.g., intramurals, non-competitive clubs)

- Yes
- No
- None offered at my school

17. Do you participate in competitive school sports teams that compete against other schools? (e.g., junior varsity or varsity sports)

- Yes
- No
- None offered at my school

18. Do you participate in league or team sports outside of school?

- Yes
- No
- There are none available where I live

19. On how many days in the last 7 days did you do exercises to strengthen or tone your muscles? (e.g., push-ups, sit-ups, or weight-training)

- 0 days
- 1 day
- 2 days
- 3 days
- 4 days
- 5 days
- 6 days
- 7 days

20. How do you describe your weight?

- Very underweight
- Slightly underweight
- About the right weight
- Slightly overweight
- Very overweight

21. Which of the following are you trying to do about your weight?

- Lose weight
- Gain weight
- Stay the same weight
- I am not trying to do anything about my weight

22. How much do your parents, step-parents, or guardians encourage you to be physically active?

- Strongly encourage
- Encourage
- Do not encourage or discourage
- Discourage
- Strongly discourage

23. How much do your parents, step-parents, or guardians support you in being physically active? (e.g., driving you to team games, buying you sporting equipment)

- Very supportive
- Supportive
- Unsupportive
- Very unsupportive





# Healthy Eating

24. If you do not eat breakfast every day, why do you skip breakfast? (Mark all that apply)

- I eat breakfast every day
- I don't have time for breakfast
- The bus comes too early
- I sleep in
- I'm not hungry in the morning
- I feel sick when I eat breakfast
- I'm trying to lose weight
- There is nothing to eat at home
- Other

25. In a *usual* school week (Monday to Friday), on how many days do you do the following?

	None	1 day	2 days	3 days	4 days	5 days
a) Eat breakfast	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) Eat breakfast provided to you <b>as part of a school program</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) Eat lunch at school - lunch packed and brought <u>from home</u>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) Eat lunch at school - lunch <u>purchased in the cafeteria</u>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) Eat lunch purchased at a fast food place or restaurant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f) Eat snacks purchased from a vending machine <b>in your school</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g) Eat snacks purchased from a vending machine, corner store, snack bar, or canteen <b>off school property</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h) Drink sugar-sweetened beverages (soda pop, Kool-Aid, Gatorade, etc.) <u>Do not include diet/sugar-free drinks</u>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i) Drink high-energy drinks (Red Bull, Monster, Rock Star, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
j) Drink coffee or tea <b>with sugar</b> (include cappuccino, frappuccino, iced-tea, iced-coffees, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
k) Drink coffee or tea <b>without sugar</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

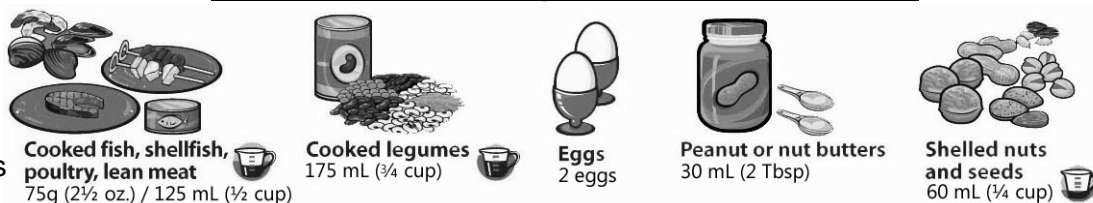
26. On a *usual* weekend (Saturday and Sunday), on how many days do you do the following?

	None	1 day	2 days
a) Eat breakfast	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) Eat lunch	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) Eat foods purchased at a fast food place or restaurant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) Eat snacks purchased from a vending machine, corner store, snack bar, or canteen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) Drink sugar-sweetened beverages (soda pop, Kool-Aid, Gatorade, etc.) <u>Do not include diet/sugar-free drinks</u>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f) Drink high energy drinks (Red Bull, Monster, Rock Star, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g) Drink coffee or tea <b>with sugar</b> (include cappuccino, frappuccino, iced-tea, iced-coffees, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h) Drink coffee or tea <b>without sugar</b>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**27. YESTERDAY, from the time you woke up until the time you went to bed, how many servings of meats and alternatives did you have? One 'Food Guide' serving of meat and alternatives includes cooked fish, chicken, beef, pork, or game meat, eggs, nuts or seeds, peanut butter or nut butters, legumes (beans), and tofu.**

- None
- 1 serving
- 2 servings
- 3 servings
- 4 servings
- 5 or more servings

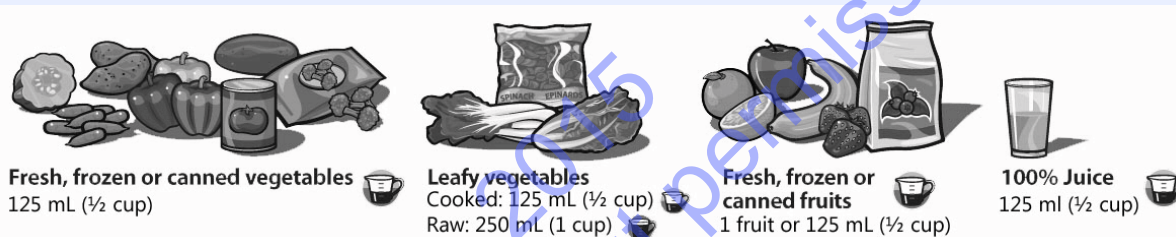
**Canada's Food Guide Serving Sizes of Meats and Alternatives**



**28. YESTERDAY, from the time you woke up until the time you went to bed, how many servings of vegetables and fruits did you have? One 'Food Guide' serving of vegetables and fruit includes pieces of fresh vegetable or fruit, salad or raw leafy greens, cooked leafy green vegetables, dried or canned or frozen fruit, and 100% fruit or vegetable juice.**

- None
- 1 serving
- 2 servings
- 3 servings
- 4 servings
- 5 servings
- 6 servings
- 7 servings
- 8 servings
- 9 or more servings

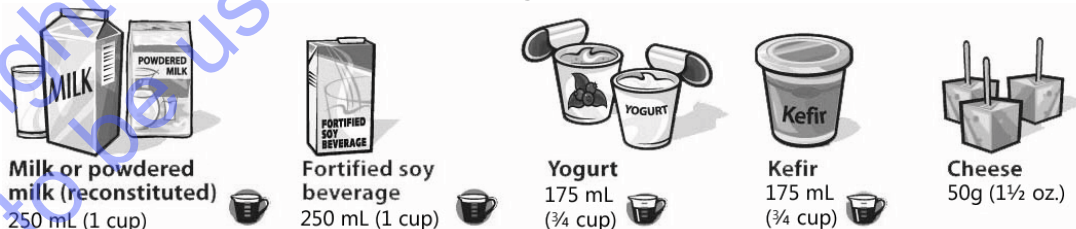
**Canada's Food Guide Serving Sizes of Vegetables and Fruits**



**29. YESTERDAY, from the time you woke up until the time you went to bed, how many servings of milk and alternatives did you have? One 'Food Guide' serving of milk or milk alternatives includes milk, fortified soy beverage, reconstituted powdered milk, canned (evaporated) milk, yogurt or kefir (another type of cultured milk product), and cheese.**

- None
- 1 serving
- 2 servings
- 3 servings
- 4 servings
- 5 servings
- 6 or more servings

**Canada's Food Guide Serving Sizes of Milk and Alternatives**



**30. YESTERDAY, from the time you woke up until the time you went to bed, how many servings of grain products did you have? One 'Food Guide' serving of grain products includes bread, bagels, flatbread such as tortilla, pita, cooked rice or pasta, and cold cereal.**

- None
- 1 serving
- 2 servings
- 3 servings
- 4 servings
- 5 servings
- 6 servings
- 7 servings
- 8 servings
- 9 or more servings

**Canada's Food Guide Serving Sizes of Grain Products**



# Your Experience with Smoking

31. Have you ever tried cigarette smoking, even just a few puffs?

- Yes
- No

32. How old were you when you first tried smoking cigarettes, even just a few puffs?

- I have never done this
- I do not know
- 8 years or younger
- 9 years
- 10 years
- 11 years
- 12 years
- 13 years
- 14 years
- 15 years
- 16 years
- 17 years
- 18 years or older

33. Do you think in the future you might try smoking cigarettes?

- Definitely yes
- Probably yes
- Probably not
- Definitely not

34. If one of your best friends were to offer you a cigarette, would you smoke it?

- Definitely yes
- Probably yes
- Probably not
- Definitely not

35. At any time during the next year do you think you will smoke a cigarette?

- Definitely yes
- Probably yes
- Probably not
- Definitely not

36. Have you ever smoked 100 or more whole cigarettes in your life?

- Yes
- No

37. On how many of the last 30 days did you smoke one or more cigarettes?

- None
- 1 day
- 2 to 3 days
- 4 to 5 days
- 6 to 10 days
- 11 to 20 days
- 21 to 29 days
- 30 days (every day)

38. Thinking back over the last 30 days, on the days that you smoked, how many cigarettes did you usually smoke each day?

- None
- A few puffs to one whole cigarette
- 2 to 3 cigarettes
- 4 to 5 cigarettes
- 6 to 10 cigarettes
- 11 to 20 cigarettes
- 21 to 29 cigarettes
- 30 or more cigarettes

39. Your closest friends are the friends you like to spend the most time with. How many of your closest friends smoke cigarettes?

- None
- 1 friend
- 2 friends
- 3 friends
- 4 friends
- 5 or more friends

40. Have you ever tried to quit smoking cigarettes?

- I have never smoked
- I have only smoked a few times
- I have never tried to quit
- I have tried to quit once
- I have tried to quit 2 or 3 times
- I have tried to quit 4 or 5 times
- I have tried to quit 6 or more times

41. Have you ever tried an electronic cigarette, also known as an e-cigarette?

- Yes
- No

42. Have you used e-cigarettes for any of the following reasons? (Mark all that apply)

- I have not used e-cigarettes
- Curiosity / to try something new
- I can use e-cigarettes in places where smoking is not allowed
- To smoke fewer cigarettes
- To help me quit smoking cigarettes
- I have used e-cigarettes for some other reason

43. In the last 30 days, did you use any of the following? (Mark all that apply)

- Pipe tobacco
- Cigarillos or little cigars (*plain or flavoured*)
- Cigars (not including cigarillos or little cigars, *plain or flavoured*)
- Roll-your-own cigarettes (tobacco only)
- Loose tobacco mixed with marijuana
- E-cigarettes (electronic cigarettes that look like cigarettes/cigars, but produce vapour instead of smoke)
- Smokeless tobacco (chewing tobacco, pinch, snuff, or snus)
- Nicotine patches, nicotine gum, nicotine lozenges, or nicotine inhalers
- Hookah (water-pipe) to smoke tobacco
- Hookah (water-pipe) to smoke herbal sheesha/shisha
- Blunt wraps (a sheet or tube made of tobacco used to roll cigarette tobacco)
- I have not used any of these things in the last 30 days

44. On how many of the last 30 days did you use an e-cigarette?

- None
- 1 day
- 2 to 3 days
- 4 to 5 days
- 6 to 10 days
- 11 to 20 days
- 21 to 29 days
- 30 days (*every day*)

# Alcohol and Marijuana Use

Please remember that we will keep your answers **completely confidential**.

A **DRINK** means: 1 regular sized bottle, can, or draft of beer; 1 glass of wine; 1 bottle of cooler; 1 shot of liquor (rum, whiskey, etc); or 1 mixed drink (1 shot of liquor with pop, juice, energy drink).

45. In the last 12 months, how often did you have a drink of alcohol that was more than just a sip?

- I have never drunk alcohol
- I did not drink alcohol in the last 12 months
- I have only had a sip of alcohol
- Less than once a month
- Once a month
- 2 or 3 times a month
- Once a week
- 2 or 3 times a week
- 4 to 6 times a week
- Every day

46. How old were you when you first had a drink of alcohol that was more than just a sip?

- I have never drunk alcohol
- I have only had a sip of alcohol
- I do not know
- 8 years or younger
- 9 years
- 10 years
- 11 years
- 12 years
- 13 years
- 14 years
- 15 years
- 16 years
- 17 years
- 18 years or older

47. In the last 12 months, how often did you have 5 drinks of alcohol or more on one occasion?

- I have never done this
- I did not have 5 or more drinks on one occasion in the last 12 months
- Less than once a month
- Once a month
- 2 to 3 times a month
- Once a week
- 2 to 5 times a week
- Daily or almost daily

48. In the last 12 months, have you had alcohol mixed or pre-mixed with an energy drink (such as Red Bull, Rock Star, Monster, or another brand)?

- I have never done this
- I did not do this in the last 12 months
- Yes
- I do not know

49. In the last 12 months, how often did you use marijuana or cannabis? (a joint, pot, weed, hash)

- I have never used marijuana
- I have used marijuana but not in the last 12 months
- Less than once a month
- Once a month
- 2 or 3 times a month
- Once a week
- 2 or 3 times a week
- 4 to 6 times a week
- Every day

50. How old were you when you first used marijuana or cannabis?

- I have never used marijuana
- I do not know
- 8 years or younger
- 9 years
- 10 years
- 11 years
- 12 years
- 13 years
- 14 years
- 15 years
- 16 years
- 17 years
- 18 years or older

51. Do you think it would be difficult or easy for you to get marijuana if you wanted some?

- Difficult
- Easy
- I do not know



[serial]



# Your School and You

52. How strongly do you agree or disagree with each of the following statements?

	Strongly Agree	Agree	Disagree	Strongly Disagree
a) I feel close to people at my school.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) I feel I am part of my school.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) I am happy to be at my school.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) I feel the teachers at my school treat me fairly.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) I feel safe in my school.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f) Getting good grades is important to me.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

53. In the last 30 days, in what ways were you bullied by other students? (Mark all that apply)

- I have not been bullied in the last 30 days
- Physical attacks (e.g., getting beaten up, pushed, or kicked)
- Verbal attacks (e.g., getting teased, threatened, or having rumours spread about you)
- Cyber-attacks (e.g., being sent mean text messages or having rumours spread about you on the internet)
- Had someone steal from you or damage your things

54. In the last 30 days, how often have you been bullied by other students?

- I have not been bullied by other students in the last 30 days
- Less than once a week
- About once a week
- 2 or 3 times a week
- Daily or almost daily

55. In the last 30 days, in what ways did you bully other students? (Mark all that apply)

- I did not bully other students in the last 30 days
- Physical attacks (e.g., beat up, pushed, or kicked them)
- Verbal attacks (e.g., teased, threatened, or spread rumours about them)
- Cyber-attacks (e.g., sent mean text messages or spread rumours about them on the internet)
- Stole from them or damaged their things

56. In the last 30 days, how often have you taken part in bullying other students?

- I did not bully other students in the last 30 days
- Less than once a week
- About once a week
- 2 or 3 times a week
- Daily or almost daily

57. How supportive is your school of the following?

	Very supportive	Supportive	Unsupportive	Very unsupportive
a) Making sure there are opportunities for students to be physically active	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b) Making sure students have access to healthy foods and drinks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c) Making sure no one is bullied at school	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d) Giving students the support they need to resist or quit tobacco	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e) Giving students the support they need to resist or quit drugs and/or alcohol	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

58. What academic level was your current or most recent Math course?

- Applied
- Academic
- Other

