Examining how changes in school-level intramurals impact physical activity among Ontario youth over time: A natural experiment evaluation from the COMPASS study

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Examining Committee Membership

The following will serve on the Examining Committee for this thesis. The decision of the Examining Committee is by majority vote.

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Author's Declaration

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

Statement of Contributions

The manuscripts presented in this thesis, including three that have been submitted or published, are the work of Kathleen Burns, in collaboration with her co-authors and committee members.

Exceptions to sole authorship include:

Chapter 5: Burns, K.E., Chaurasia, A., Carson, V., and Leatherdale S.T. (2021) A quasi-experimental examination of how changes in school-level intramurals are associated with physical activity among a sample of Canadian secondary school students from the COMPASS Study. Social Science and Medicine-Population Health 14. https://doi.org/10.1016/j.ssmph.2021.100805

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As lead author of these three chapters (Chapters 5 to 7), I was responsible for formulating the research questions, preparing the data, conducting the literature review, leading the study design, conducting the statistical analyses, interpreting the study findings, and drafting all three manuscripts. Dr. Leatherdale, Dr. Chaurasia and Dr. Carson provided their guidance, direction and feedback during this process and on all drafts of the manuscripts.

Under Dr. Leatherdale's supervision, I also prepared the remaining chapters of this thesis, which were not written for publication.

Abstract

Introduction: Moderate-to-vigorous physical activity (MVPA) has many health benefits for youth. However, the majority of Canadian youth are falling short of the recommended 60 minutes of MVPA per day. Since youth spend a large proportion of time in school, regardless of socio-economic status, and evidence shows that characteristics of the school environment can influence youth MVPA, schools represent an equitable and effective setting for providing physical activity programming to youth. Intramurals are one example of inclusive school-based physical activity programs given they tend to be accessible, affordable, and less competitive compared to other school-based physical activity programs (e.g., varsity sports). Intramurals address common barriers to youth sport participation and MVPA, and are positively associated with these outcomes, however, there is limited evidence examining if offering intramurals is protective against the declining trajectory of youth MVPA. Despite this lack of evidence to inform intramural offerings, schools continue to add and remove intramurals each year as part of their real-world practice actions to promote activity among students. This research aimed to generate novel practice-based evidence on the effect of intramural offerings by using a quasi-experimental design to evaluate if changes in the number of intramurals associate with youth MVPA over time. More specifically, Study 1 examined how general changes (added, removed, no change) in intramurals were associated with youth MVPA over time, Study 2 examined how changes in the type (team and individual) of intramurals were associated with youth MVPA over time, and Study 3 examined how changes in gender-specific (female-, male-only) and co-ed intramurals were associated with youth MVPA over time.

Methods: This dissertation used three years of longitudinal school- and student-level data from Ontario schools participating in year 5 (Y5: 2016-2017), year 6 (Y6: 2017-2018) and year 7 (Y7:

2018-2019) of the COMPASS study. School-level covariates and intramural data from 55 schools in Ontario, Canada were obtained from the School Programs and Policies (SPP) Questionnaire in Y5 and Y6. Baseline demographics and data on sport participation and MVPA were measured by the student COMPASS Questionnaire (Cq) in Y5, Y6 and Y7 on a sample of 4417 students. A longitudinal quasi-experimental study design was employed, as data on the outcome were measured at pre-intervention (Y5), intervention (Y6) and post-intervention (Y7) time points and were compared between non-randomized intervention and control groups. Hierarchical linear mixed regression models were used to examine if changes in intramurals in Y5 to Y6 were associated with MVPA over time separately for males and females. A novel modeling approach to program evaluation was utilized to create indicator variables representing the yearly intramural changes: (i) intramural changes in year 6 and (ii) intramural changes in year 7 for each study. These indicator variables were included in the models and allowed for the assessment of their effect at those respective years.

Results: Intramural participation was positively associated with youth MVPA over time and youth MVPA decreased over the three-year study period. In Study 1, general changes in intramurals (added, removed, no change) were not associated with youth MVPA over time. In Study 2, adding team and individual intramurals was significantly and positively associated with female MVPA in Y6, regardless of intramural participation. In Study 3, gender-specific and co-ed intramurals were not associated with youth MVPA over time, however the association between adding gender-specific intramurals and female MVPA should be further explored, as the p-value of this association was at the level of significance ($\alpha = 0.05$).

Discussion: The novel findings from this research address important gaps in the literature on intramurals and physical activity, and contribute to our understanding of how real-world changes

in school-level intramurals impact the MVPA of students within these schools over time. In Study 2, we found that adding team and individual intramurals was positively and significantly associated with female MVPA in Y6, regardless of participation. This suggests an indirect association between changes in intramurals at the school-level and individual female student MVPA in those schools. This may be explained by the fact that adding a variety of intramurals creates a supportive and inclusive physical activity environment for females, by targeting female motivations for physical activity (e.g., peer socialization, inclusion and keeping fit) and important intra- and interpersonal factors for female physical activity (e.g., autonomy and self-efficacy). In Study 3, the association between adding gender-specific intramurals and female MVPA was positive, but non-significant. Gender-specific intramurals may promote a supportive physical activity environment and encourage physical activity by fostering self-efficacy, enjoyment and peer support, especially among females. This association should be examined with a larger school sample, as this analysis may have been under-powered at the school-level. Based on Study 1, 2 and 3, changes in intramurals were not significantly associated with male MVPA over time. This suggests that changes in intramurals are not effective at increasing MVPA among males, and may be explained by the fact that the inclusive and supportive nature of intramurals generally do not target male motivations for physical activity, which include competition, strength and winning. Although changes in intramurals were generally not associated with youth MVPA, intramurals are associated with several other important outcomes among youth, such as sport sampling, physical literacy, socialization, school connectedness and reduced substance use. Schools should offer intramurals as inclusive physical activity programs, in addition to other physical activity programs and policies, to encourage equitable access to sport and physical activity and to foster healthy behaviours among youth.

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Dedication

This dissertation is dedicated in loving memory of my father, Jack Patrick Burns. Thank you for passing on your passion for science, academia and research to me.

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Chapter 1: Background

1.1 Moderate-to-Vigorous Physical Activity for Youth

Physical activity is defined as any bodily movement produced by skeletal muscles that expends energy, increases heart rate and breathing.(1,2) Physical activity encompasses a large number of bodily movements including work, play, active transport, recreation and housework.(1) The intensity of physical activity refers to the magnitude of effort required to perform that activity and is measured using metabolic equivalents (METs).(1,2) METs are multiples of resting metabolic rate that correspond to intensity of physical activity.(3) Moderate-intensity physical activity for children and youth refers to activities that are performed at 4.0-6.9 METs (e.g., hiking, cycling, brisk walking and baseball).(2) Vigorous-intensity activities for children and youth refer to activities that are performed at $\geq$ 7.0 METs (e.g., jumping rope, fast cycling, running and soccer).(4) Moderate-to vigorous intensity physical activity (MVPA) refers to activities that are either of moderate or vigorous intensity and are commonly used in physical activity guidelines (5) as well as subjective and objective measures of physical activity.(6)

1.2 Health Benefits of Moderate-Vigorous Physical Activity for Youth

MVPA has a multitude of physiological and psychological health benefits for youth. Physiologically, MVPA is important for healthy development, disease-risk reduction and disease prevention among youth. Firstly, MVPA supports the development of healthy musculoskeletal tissues and a healthy cardiovascular system.(7,8) Secondly, MVPA reduces the risk of disease in youth, by supporting weight control,(6,8,9) improving bone mineral density, reducing markers of metabolic syndrome (8,9) and reducing the likelihood of engaging in negative health behaviours (e.g., tobacco and alcohol use).(10,11) Thirdly, by reducing the risk of disease, MVPA among youth can help prevent future diseases such as heart disease, cancer, type 2 diabetes,

hypertension, osteoporosis and obesity.(8,9) As highlighted in The 2018 ParticipACTION Report Card on Physical Activity for Children and Youth, MVPA also has many psychological benefits, including better brain health and mental health.(12) Specific to brain health, physical activity is associated with higher academic performance,(13,14) supports mental health in children and youth by reducing symptoms of anxiety and depression (8,9) and assists in social development.(7) Higher intensity physical activities have a stronger association with health benefits compared to lower intensity activities,(15) although all intensities, durations and patterns (sporadic, bouts and continuous) of physical activities are associated with health benefits.(15) This suggests that even modest changes to aspects of physical activity behaviours (e.g., intensity, duration or pattern) among youth could positively impact current health and reduce future risk of disease.(15)

1.3 24-Hour Movement Guidelines for Canadian Children and Youth

The Canadian 24-Hour Movement Guidelines for Children and Youth are the most recent movement guidelines released by the Canadian Society for Exercise Physiology (CSEP) for children and youth ages 5-17.(5,16) These guidelines integrate physical activity, sedentary behaviour and sleep recommendations across an entire day (24-hour period),(5,16) because these movement behaviours interact to influence youth health.(6,17) To achieve the many health benefits associated with physical activity, The Canadian 24-Hour Movement Guidelines for Children and Youth recommend an accumulation of 60 minutes of MVPA per day and to incorporate vigorous physical activity and strength training activities at least three days per week.(5) The guidelines also make recommendations to encourage sufficient sleep, to limit sedentary behaviours and to increase light physical activity by participating in a variety of physical activities.(16) These guidelines can be found in Appendix A.

1.4 Youth Adherence to the Canadian 24-Hour Movement Guidelines

A positive association has been observed between meeting the Canadian 24-hour movement guidelines and overall health among youth.(18) Since their introduction in 2016, few studies have estimated the proportion of Canadian youth meeting the 24-hour Movement Guidelines. A cross-sectional study design using objectively measured MVPA data from the Canadian Health Measures Survey (CHMS) found that 35% of youth aged 5-17 years met the guidelines.(19) Similarly, a study using a repeat cross-sectional design and objectively measured MVPA data from the CHMS found that 35% of youth aged 6-17 years met the recommendations.(20) Additionally, a cross-sectional design using self-report measures of MVPA from the Health Behaviour in School-Aged Children Survey (HBSC), found comparable results. Specifically, this study found that 35% of youth aged 10-17 years met the MVPA recommendations.(21) These three studies report similar proportions of youth meeting the Canadian 24-Hour Movement Guidelines, despite differences in: a) the age group of the samples, b) the measures of MVPA (subjective and objective) and c) the study design (cross-sectional and repeat cross-sectional). Taking these differences into consideration, 35% can be considered a reliable and valid estimate of the proportion of youth meeting the guidelines.(19–21) The 2018 ParticipACTION Report Card on Physical Activity for Children and Youth, has summarized these key studies, to give the publicly highlighted approximation that only one-third of children and youth are meeting the MVPA recommendation within the Canadian 24-Hour Movement Guidelines.(12) Considering the modest proportion of Canadian youth meeting these guidelines, strategies to increase physical activity among this population are warranted.(12)

1.5 Youth as a target for physical activity interventions

Youth are an important target population for health interventions because habitual health behaviours (e.g., physical activity, sedentary activity, substance use and diet) continue to develop

and form during this time.(31–34) Youth are of particular interest for physical activity interventions because physical activity tends to decrease with age. For example, studies using objectively measured and longitudinal data found a significant decline in physical activity and a significant increase in sedentary behaviour in youth from 12 to 16 years of age.(26,27) Additionally, longitudinal data using validated self-report measures of physical activity show similar results, as physical activity decreased in youth beginning as early as 9 years of age and continued to 27 years of age.(28–32) Decreases in community sport participation (32,33) and increases in screen time and sedentary behaviour (24,26–28) during adolescence may explain some of the decline of physical activity in this group. A complex combination of biological and environmental factors may further explain this general decline in physical activity with age, although this is not currently well understood.(34) This decline in physical activity has been observed to be greater in females compared to males,(35,36) which may be explained by the fact that females physically mature earlier compared to males,(35) and physical maturation has been negatively associated with physical activity.(37) Conversely, a recent review of published longitudinal physical activity data found a slightly larger decrease in physical activity from adolescence to adulthood in males compared to females.(38) There is research suggesting that the physical activity decline is larger among females at a younger age (9-12 years), while it is greater among boys at older ages (13-16 years),(39) and the inclusion of different age groups in the study samples may help to explain the conflicting findings.(35,36,38,39) The relationship between age and physical activity differs between male and female youth, highlighting the importance of considering gender in youth physical activity research.

The transition from childhood to adolescence is marked by a decline in physical activity that may differ between females and males, and continues until young adulthood. This highlights

an important opportunity for physical activity programming to target this population, as these interventions can help youth maintain and improve physical activity levels. These programs can also help to establish physical activity behaviours in youth that can be maintained later on in life.(31,40) Physical inactivity is a leading modifiable behavioural risk factor for premature mortality and lost life expectancy among Canadian adults,(41–43) therefore interventions to target physical inactivity among youth should be a public health priority.

1.6 School setting and physical activity

More than 5.5 million Canadian children and youth enrolled in elementary and secondary school programs in the 2016-2017 school year,(44) and the average school day lasts 6-7 hours,(45) making schools an ideal setting to offer physical activity programming. Moreover, 97% of Canadian youth attended secondary school in the 2015-2016 school year,(46) and these institutions have the opportunity to offer physical activity programs at a critical time when habitual physical activity behaviours are being formed.(22) Physical activity programs should be integrated in school settings because they are economical and effective for increasing youth physical activity.(45,47,48) Additionally, schools may be able to provide physical activities for all youth, regardless of potential barriers such as socioeconomic status and skillset/athletic ability.(49) The importance of the school setting in addressing the complexities of physical inactivity has been acknowledged by the Canadian Framework for Action to Promote Healthy Weights, as they recommend changes within the school environment through physical education, programming and facilities.(50) Specifically, physical education, physical activity breaks, varsity sports, active transportation and intramural sports are all examples of school-level programs that can encourage youth physical activity.(51) Physical activity programs that use a multidimensional model of school health (e.g., a combination of curriculum, policy,

environmental, community and parental strategies) have shown most effective in maintaining and improving youth physical activity.(48,52,53)

1.7 Intramural programs and physical activity

School-based physical activity programs provide youth with opportunities to be physically active,(54,55) however some of these opportunities may not be available, feasible or attractive to all youth. Firstly, varsity (e.g., extramural) sports are competitive sports played between students from different schools, and these sports are typically limited to those with a particular skill or athletic ability.(56) Secondly, active transportation to school may only be an option for students that live in urban,(57) safe, and walkable neighbourhoods (58) within a relatively close distance to the school.(59,60) In 2011, an average of 19% of Canadians lived in rural areas. More specifically, 14% of Ontarians lived in rural areas and youth aged 15-29 made up 17% of this population.(61) Lastly, although physical education may be positively associated with youth physical activity,(62–66) the modest requirement of physical education credits in Ontario secondary schools may limit these opportunities for students to be active.(67) To mitigate some of these challenges and barriers to physical activity opportunities, schools can offer a variety of intramural programs, which allow students to be physically active in a less-competitive environment outside of instructional time.(68) Intramural programs are played or participated in by students within the same school and are typically less competitive compared to varsity or extramural sports. These programs provide the opportunity for students with a wide variety of skills and interests to participate in sports or activities within their schools compared to varsity sports alone.(69) The perception of a competitive or competition-focused environment is negatively associated with participation in physical education, especially among females and

those with lower athletic ability.(70) This highlights the importance of non-competitive activities and their potential impact on physical activity levels.

Not only do intramural programs provide all students with the opportunity to be physically active,(71) but there is also a positive association between participation in intramural programs and physical activity,(69,72,73) and a review examining the school environment and physical activity among youth found this relationship to be consistent across several studies.(70) Participation in intramurals may also allow youth to participate in a wide variety of activities throughout the school year, which is a concept known as sport sampling.(74,75) Sport sampling may help students find a sport/activity they enjoy participating in, which may promote confidence and participation later in life.(31,74–80) Additionally, participation in intramural sports is associated with positive health behaviours outside of physical activity, including lower screen-time, sedentary behaviour (81) and substance use among youth.(82)

Intramural programs are associated with current youth physical activity, and there is research to suggest that youth participation in sport is associated with physical activity later in life. For example, several longitudinal studies using validated self-report measures found that sport participation in youth was associated with physical activity into adulthood.(31,76–80) Although sport participation tends to decrease with age, sport participation in youth may promote positive physical activity behaviours that continue later in life.(31,77,78) For example, sport participation may foster enjoyment, priority and an appreciation for physical activity that may be carried into adulthood.(31,77,78) If youth participate in intramurals, they may be more active as adults, emphasizing the potential indirect and positive long-term effects of these programs.

1.7.1 Types of intramural programs

Intramural programs can be categorized into individual- (e.g., yoga, running club) and team-based (e.g., soccer, tennis) sports. Both types of programs are associated with youth meeting the physical activity guidelines,(69) however there are different physical and psychological benefits of individual- and team-based sports.(83,84) There are also observed gender differences in the types of physical activities that secondary school students participate in, as girls are more likely to engage in individual activities, while boys are more likely to participate in team activities. To demonstrate, a study of youth in grade 9-12 found more boys compared to girls participated in activities that were classified as team sports (e.g., baseball, basketball, football), weightlifting, or other competitive sports (e.g., Frisbee, soccer, racquetball, tennis, volleyball), while more girls participated in activities that were classified as individual (e.g., jump rope, swimming, walking) with the exception of running.(85) Other research has found similar results, as rates of male participation in team sports was found to be significantly higher than female rates in a US study of residents 15 years of age and older.(86) Additionally, participation in team sports is typically associated with more physical activity compared to individual sports,(87) which highlights that individual and team intramurals may have different effects on youth physical activity.

Female and male youth tend to participate in different types of sports, and the relationship between this sport participation and overall physical activity has been previously studied.(85,86) For example, participation in team sports had a positive association with physical activity participation among boys, while individual activities were positively associated with increased physical activity among girls.(85) Both of these relationships were indirect, and mediated by physical activity enjoyment.(85) Other research highlights the importance of

offering a variety of school-level team and individual intramurals, as offering team sports and games along with individually focused activities, provides youth with a variety of physical activity opportunities that range in the level of competition, strategy, cooperation and skill-building, and encourages more comprehensive participation among youth.(88,89)

Considering the potential benefits of intramural programs, research should be conducted to examine the effect of different types of intramurals, specifically individual- and team-based intramural programs, on youth physical activity. Considering the previously observed gender differences between type of sport participation and physical activity, this research should examine how the type of intramurals associate with physical activity separately for female and male youth.

1.7.2 Gender and intramural programs

As previously discussed, there are differences in physical activity levels between male and female youth,(32,90) and there are important differences between male and female youth on sport participation as well. For instance, there are gender differences related to participating in organized sports, as females tend to have lower participation compared to males (91) and males are more likely to participate in sports compared to females.(86,91,92) Specific to intramurals, two cross-sectional studies using large samples of Canadian secondary school students, suggest that males are more likely to participate in intramural sports compared to females,(72,93) meaning that females may be missing out on opportunities that may increase their physical activity levels.(72) There is research to suggest that gender-specific (e.g., female-only, male-only) intramurals may be important for intramural participation, especially among female students. More specifically, female students attending schools with female-only intramurals were more likely to participate in intramurals compared to females attending schools without these

female-only intramurals, and no such association was observed for males.(94) Additionally, female youth have highlighted their desire for more equal opportunities for physical activity, which includes the offering of gender-specific physical activity programs in addition to co-ed programs.(89) This research suggests that gender-specific intramurals are important for female participation and physical activity, which is important given that female youth are less likely to participate in sports and are consistently less physically activity compared to male youth.

Interventions promoting physical activity should take gender into account, as there are differences in the types of physical activities and the levels of activity between male and female youth, and gender-specific programs may be important to youth intramural participation and physical activity, especially among females. To my knowledge, no previous research has been done to examine how gender-specific and co-ed intramurals associate with physical activity among female and male youth. Examining this relationship would enhance our understanding of how these gender-specific and co-ed intramurals affect youth physical activity. Given that youth are an at-risk population for physical inactivity, this would provide schools with timely and relevant evidence to inform their offerings of these inclusive physical activity programs.

1.8 Correlates of Moderate-to-Vigorous Physical Activity among Youth

Focusing on demographic correlates, sex (male), socioeconomic status (higher), ethnicity (white),(95–97) parental education (higher),(95,97) age (younger),(95–97) and BMI among girls (lower),(95) are all positively associated with youth physical activity. Relating to psychological correlates, perceived competence and intention to be active are positively associated with physical activity among youth,(95–97) while depression (95,97) and perceived barriers (e.g., lack of time) (95) to physical activity are negatively associated. Specific to behavioural correlates, previous physical activity, community sports participation,(95–97) physical education

participation (95) and a healthy diet (95) are positively associated with youth physical activity. Additionally, smoking and sedentary behaviour have been found to be inconsistently correlated with physical activity,(95,97) while a review found outside-of-school sedentary behaviour to be consistently and inversely associated with youth physical activity.(96) Examining interpersonal correlates, parental (95–97) and friend support (95,97) are both positively associated with youth physical activity, while school connectedness has a positive association with youth meeting the guidelines over time.(98) A positive association has been observed between opportunities to exercise, access to programs and facilities,(95,97) time spent outdoors (95) and school-level policies that support active transportation and prioritize physical activity,(99) highlighting the role of the physical environment and school-level policy on MVPA.(97)

Several variables, including demographic, psychological, behavioural, interpersonal, physical and school-level policy are related to youth physical activity. This highlights the many integrated factors determining physical activity behaviours that can be considered in studies involving youth physical activity programs.(95) This is consistent with the social ecological model, a theoretical framework used to understand the multifaceted and interacting effects of individual and environmental factors on behaviours, as individual, interpersonal, community and organizational factors are all associated with youth MVPA.(100)

1.9 Natural Experiments

A natural experiment occurs when an intervention has been implemented, but the circumstances surrounding its implementation has not been manipulated by the researcher.(101–103) For example, circumstances that researchers may not be able to control include: a) when or where an intervention occurs (e.g., changes to the built environment, such as the addition of a fitness room in a secondary school), b) if a new program is implemented (e.g., addition/removal

of intramurals in a secondary school), or c) if changes to a policy are made (e.g., extended before- and after-school hours of a weight room in a secondary school), and these changes would all be considered natural experiments.(102) Two additional aspects of natural experiments include: a) that random allocation of the intervention is not feasible (e.g., for ethical or political reasons) and b) the intervention is not dependent on whether there is a plan to evaluate it or not.(102)

A continuous problem facing many decision makers is the gap between the type of available evidence and the type of evidence they need to inform decisions.(103,104) For example, much evidence to be used in public health is generated from highly controlled studies (e.g., randomized controlled trials), that are used evaluate the efficacy of an intervention. Data generated from these highly controlled research studies generally have low external validity and decision makers may struggle to use such evidence to inform real-world interventions, as these studies tend to ignore important real-world contextual factors.(103,105) Additionally, randomized controlled trials are not feasible to evaluate all health interventions, such as natural experiments, because their implementation is not manipulated by the researcher.(101–103) Natural experimental studies can be used to evaluate the impact of natural experiments.(102) These studies address some of the previously mentioned issues by using robust research methodology to evaluate ongoing natural experiments and generate real-world and relevant evidence to inform public health policy. Natural experimental studies should employ the most robust research design possible,(103,104,106) which will depend on the type of data that are available at the time of the natural experiment.

It is important to note the potential limitations of natural experimental studies which include bias due to confounding and the timing of policy implementation. Due to the lack of

randomization, bias due to confounding is a potential limitation that could lead to an erroneous estimate of effect due to the presence of a third variable.(105,107) Some methods to address this in natural experimental studies include the use of a valid comparison group or by measuring and controlling for important contextual factors through stratification or adjustment.(105–107) Additionally, the timing of natural experiments may complicate the planning of natural experimental studies because their implementation is not in control of the researchers.(106) Early or delayed implementation of programs or policies can complicate any planned collection of pre- and post-intervention data.(106,107) This influences the type of data that are able to be collected and potentially complicates pre-post comparisons, control group selection and the adjustment of important variables.(106,107)

1.10 Summary and gaps in the literature

1.10.1 Summary

MVPA has a multitude of health benefits for youth,(6–13) however only a modest proportion of Canadian youth are meeting the recommended amounts outlined in the 24-hour movement guidelines.(19–21) Youth are an important target population for physical activity interventions because physical activity behaviours are developed and formed (31–34) and tend to decrease (28–32) during this time. Schools are an important setting for physical activity programming, as youth spend a large proportion of their young lives there.(44–46) School physical activity programs can take on many forms (e.g., active transport, varsity sports, physical education), however there may be barriers associated with these activities. Intramural programs provide the opportunity for students with a wide variety of skills and interests to participate in sports or activities within their schools, while eliminating some of the barriers associated with other school-based physical activities.(69) Participation in intramural programs are associated

with physical activity among youth and are associated with youth meeting the physical activity guidelines.(69,72,73,91) More research to examine how changes in intramurals are associated with MVPA longitudinally is warranted. This would address gaps in the literature including: a) a lack of experimental research evaluating the effectiveness of intramural programs on youth physical activity, b) utilizing longitudinal models to examine such relationships, and c) studying these relationships in the Canadian context. Additionally, examining how different intramurals (e.g., individual, team, gender-specific, co-ed) enhances our understanding of how intramural programs impact physical activity outcomes of male and female youth over time and provides schools with practice-based evidence to inform their offering of these programs.

1.10.2 Gaps in the Literature

Despite the lack of scientific evidence available to inform the offering of intramurals, schools continue to add and remove a variety of intramurals each year. This creates a unique opportunity to evaluate a natural experiment and examine how these real-world changes in intramurals are associated with youth physical activity. This dissertation utilized a natural experimental study design to evaluate how these ongoing changes in intramurals are associated with youth MVPA over time. These ongoing changes were examined: (i) generally (added, removed, no change), (ii) by type (individual- and team-sports), and (iii) by gender-specific and co-ed, to provide a comprehensive evaluation intramural changes on MVPA over time. The evaluation of a natural experiment using longitudinal school- and student-level data and addressed important gaps in the literature to provide a robust evaluation of how changes in intramurals associate with youth MVPA over time. This evaluation provides schools with practice-based evidence that can be used to help inform the offering of intramurals, to ultimately increase participation and physical activity among students.

1.11 Overview of COMPASS Study

The COMPASS study (hereafter referred to as COMPASS) is a nine-year study (2012-2021) examining youth health behaviours. The study began in 2012-2013 and is conducted by researchers at the University of Waterloo in partnership with other researchers at the University of British Columbia, University of Alberta, University of Toronto, Laval University and Brock University.(108) Specifically, COMPASS is a school-based prospective cohort study that collects hierarchical (student- and school-level) and longitudinal data from a convenience sample of secondary school students (grades 9-12) and the schools they attend.(109) Student- and school-level data from the cohort of schools within COMPASS are collected over time through annual school data collections.(109)

COMPASS participates in knowledge exchange by providing each school with their school-specific School Health Profile (SHP) after participation.(108,109) Each SHP provides data on the prevalence of student health behaviours and how these rates compare to provincial/national standards, provides evidence-based suggestions for interventions to improve student health and connects the school to their local Public Health Unit for support with implementation of these interventions or for additional resources.(108,109) This allows COMPASS to provide schools with ongoing information that can be used in the development and improvement and evaluation of school-level programs and policies.(109)

Chapter 2: Study Rationale, Research Objectives and Hypotheses

2.1 Study 1: Examining if changes in intramural programs affect youth physical activity over time

Previous research shows that participation in intramural programs is associated physical activity among youth over time,(31,76–80) however there is little research examining the association between intramurals and youth MVPA longitudinally. This study utilized a natural experiment to examine how changes in intramurals are associated with youth MVPA over time. Considering there are differences between males and females on MVPA, this association was examined separately for female and male students. Study 1 addressed important gaps in the literature and contributes to our understanding of how real-world general changes in intramurals affect youth MVPA over time. The objective of Study 1 was to examine how general changes in intramurals were associated with MVPA over time, separately for female and male students. I hypothesized that changes in intramurals would be associated with students' MVPA over time. More specifically:

a. I expected that the addition of intramurals would be positively associated with MVPA over time for both males and females.
b. I expected that removing intramurals would be negatively associated with MVPA over time for both males and females.
c. I expected that no changes in intramurals would be unassociated with students' MVPA over time, for both males and females.

2.2 Study 2: Examining if changes in the type of intramurals affect youth physical activity over time

Previous research suggests that types of sports (e.g., team and individual sports) may be differentially associated with sport participation and MVPA among youth, however there is little research examining this association for intramural sports. This study utilized a natural experiment to examine how changes in the type of intramurals (team and individual) are associated with youth MVPA over time. This association was examined separately for female and male students, considering the differences between female and males on type of sport participation and MVPA. This study adds to the literature by further examining the relationship between intramurals and youth physical activity, and contributes to our understanding of how real-world changes in team and individual intramurals affect youth MVPA over time. The objective of Study 2 was to examine how changes in team and individual intramurals were associated with youth physical activity longitudinally, separately for female and male students. I hypothesized that changes in the types of intramurals would be associated with students' MVPA over time. Additionally, I hypothesized that these associations would differ in magnitude between males and females, because female youth are more likely to participate in individual sports, while males are more likely to participate in team sports,(85,110) and participation in team sports is generally associated with more physical activity compared to individual sports.(87,110) More specifically:

a. I expected that adding individual intramurals would be positively associated with MVPA over time for both males and females. I also expected this relationship to be stronger among female students, as females are more likely to participate in individual sports compared to males.(85)

b. I expected that adding team intramural programs would be positively associated with MVPA over time for both males and females. I also expected this relationship to be stronger for male students, as they are more likely to participate in team sports compared to females.(85)
c. I expected that removing intramurals would be negatively associated with MVPA over time for both males and females.
d. I expected there to be no association between no changes in the types of intramural change and MVPA over time for both males and females.

2.3 Study 3: Examining if changes in gender-specific and co-ed intramural programs affect physical activity over time

Previous research suggests that gender-specific (e.g., female-only, male-only) intramurals may be important for intramural participation,(94) and physical activity (89) especially among female students, however there is limited research examining how gender-specific and co-ed intramurals are associated with youth MVPA. This study addressed this gap in the literature by utilizing a natural experiment to examine how the changes in the gender-specific and co-ed intramurals were associated with youth MVPA over time. The objective of Study 3 was to examine how changes gender-specific and co-ed intramurals were associated with youth physical activity over time, separately for female and male students. I hypothesized that changes in the gender-specific and co-ed intramurals would be associated with students' MVPA over time. More specifically:

a. I expected adding gender-specific intramurals to be positively associated with MVPA over time for both male and female students.

b. I expected that adding co-ed intramurals would be positively associated with MVPA over time for both male and female students.

c. I expected that removing gender-specific and co-ed programs would be negatively associated with MVPA over time for both male and female students.

Chapter 3: Methods

3.1 Sampling

The COMPASS study is designed to facilitate many large-scale school-based data collections using whole-school convenience sampling.(111) It is not designed to be provincially-representative, nationally-representative, nor is it meant to represent geographical populations outside of the participating cohort of schools.(111) The COMPASS recruitment process involves two main steps: 1) approaching school boards that govern eligible schools, 2) approaching individual schools if granted permission from a school board.

School boards from Ontario, Alberta and British Columbia were purposively sampled if they governed schools with the following criteria: 1) English-speaking, 2) had secondary schools with grades 9-12, 3) had a student population of at least 100 students per grade, 4) had schools that operated in a standard school/classroom setting, and 5) allowed the use of active-information passive-consent parental permission protocols.(111) These criteria were validated and the sample was subsequently determined by reviewing the websites of the school boards or by contacting an administrator from the school board.(111)

3.1.1 School-level sampling

School Board Recruitment

Once identified as being eligible by the process described above, a school board was sent a COMPASS board recruitment package via mail or courier. This package contained an invitation letter, project brochure, permission materials and copies of the school- and student-level data collection tools.(111) One-week after the recruitment package was sent, the recruitment coordinator followed up with each school board. If granted approval by their board,

eligible schools were notified of this decision using an email template provided by the COMPASS recruitment coordinator. All board responses and reasons for declining were recorded in an internal online project management system.(111)

School Recruitment

Once a school board granted approval to the COMPASS team, all eligible schools within this board were approached to participate in COMPASS.(111) These eligible schools were sent a standard recruitment package via courier which included an invitation letter, project brochure, a school-response form and copies of the Student Questionnaire.(111) One-week after the recruitment package was sent, the recruitment coordinator followed up with each school. All school responses and reasons for declining participation were recorded in an internal online project management system.(111) The sampling protocol for private schools was slightly different, as they are not supported by a school board and are independently governed. For these schools, the researchers directly approached schools by providing them with a recruitment package.(111)

3.2.1 Student-level sampling

Once a COMPASS school granted approval to the COMPASS team, students within the eligible schools were recruited using an active-permission passive consent (referred to as 'passive consent') procedure.(112) A passive consent procedure was chosen because active consent has been associated with falsely inflated between-school variability, lower student participation rates, biased sample demographics, underestimated substance use estimates and a reduction in student confidentiality.(113) Parents/guardians of eligible students were mailed an information letter or received an automated voice message about the COMPASS study.

Parents/guardians who did not want their child to participate in the study could withdraw their child by contacting the COMPASS recruitment coordinator using a toll-free phone number or email address that were both provided in the information letter and voice message. All students whose parents provided passive consent were eligible to participate in the study, and they were able to withdraw from the study at any point in time.(112)

3.2 Ethics

The COMPASS study was approved by the University of Waterloo Office of Research Ethics and by the internal committee members of the participating school boards.

3.3 Data Sources

The COMPASS study collects student-and school-level data using the following data collection tools: a) the COMPASS Student Questionnaire (Cq), b) the COMPASS School Policies and Practices Questionnaire (SPP), c) the COMPASS School Environment Application (Co-SEA), and d) the COMPASS Built Environment Data (C-BED) tool. (109)

At the student-level, the Cq is used to collect student-level demographic information and data on obesity, physical activity, sedentary activity, eating behaviours, tobacco-use, alcohol-use, marijuana-use, opioid-use, school connectedness, academic achievement, bullying and mental health.(108,109) The Cq is further described in chapter 3.3.1.

At the school-level, data on the programs and policies within each school and the characteristics of the built environment surrounding each school are collected.(109) These data are collected using the SPP, Co-SEA, and C-BED.(109) The SPP is completed by a school administrator with knowledge about the school's programs and policies, and asks about recent and relevant changes to programs, policies and/or resources.(108,109) The SPP is described in more detail in chapter 3.3.2. The Co-SEA is used by COMPASS staff on the day of data

collection to record observations related to the school's built environment that are related to obesity, healthy eating and physical activity, (e.g., vending machines, gymnasiums, sports fields and student eating areas).(108,109) Data on the characteristics of the built environment surrounding each school (e.g., fast-food restaurants, recreation centres and convenience stores) are collected using the C-BED to examine if, and to what extent, these characteristics influence youth health.(108,109)

3.3.1 COMPASS Student Questionnaire (Cq)

The Cq, (found in Appendix B)**,** collects all individual student-level data in COMPASS. The Cq is a 12-page machine-readable paper booklet that is completed in 30-40 minutes during class time.(109) The Cq includes core measures, supplementary measures and demographic measures selected based on scientific and practical significance.(114) The core measures in the Cq are consistent with measures in other self-reported school-based questionnaires used in youth in Ontario and Canada (e.g., the Ontario Student Drug Use and Health Survey [OSDUHS], the Canadian Student Tobacco, Alcohol and Drugs Survey [CSTADS], and the Health Behavior of School Children Survey [HBSC]) and include measures of obesity, physical activity, sedentary activity, tobacco-use, alcohol-use, marijuana-use and mental health.(109,114,115) The supplementary measures in the Cq are priorities that were identified as relevant by school stakeholders. These measures include eating behaviour, bullying, education outcomes, opioid-use and school connectedness.(109,114,115) Lastly, demographic measures for the questionnaire include gender, age, grade, ethnicity and weekly spending money which are consistent with other measures used in self-report school-based studies of Canadian youth in grades 9-12.(109,114,115)

3.3.1.1 Data Linkage

Considering the longitudinal nature of COMPASS, the cohort of schools and students must be followed over time. This research used linked longitudinal school- and student-level data to examine how changes at the school-level (intramurals) affect a student-level outcome (MVPA) over time. School-level data were linked over time by their unique school ID. Student-level data were linked over time using a unique self-generated identification code for each student. This code was generated from student responses to five questions on the cover page of the Cq.(116) The students' responses to these questions do not change over time (e.g., students are asked to indicate the first letter of their middle name), and are not personally identifiable, allowing student-level data to be linked over time while ensuring anonymity of survey participants.(116)

3.3.2 COMPASS School Policies and Practices Questionnaire (SPP)

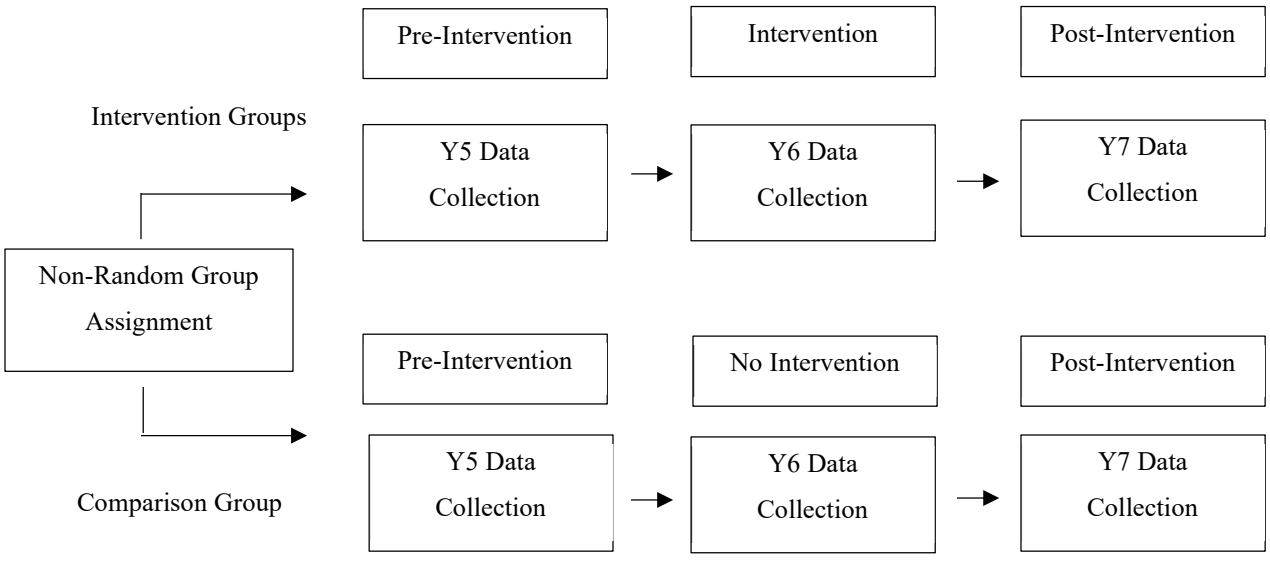
Data on the school-level policies, programs and practices were collected using the SPP. The SPP is an online survey completed by a school administrator that is most knowledgeable about the programs and policies within the school. The SPP measures the presence and absence of practices, programs and/or policies relevant to the student health behaviours collected on the Cq (e.g., physical activity, substance use), as well as changes to these practices, programs and/or policies over time.(109) The SPP had minor changes from 2016-2017 to 2017-2018, and relevant changes to the measures outlined in chapter 3.5.2.

3.4 Natural Experiment Study Design

As previously mentioned, there are many interventions which are not able to be evaluated using a RCT, including changes in school-level physical activity programming (e.g., intramural programs).(106,107) Natural experimental studies provide the opportunity to evaluate

these types of interventions using experimental or non-experimental research designs.(107) The gold standard research methodology in the evaluation of natural experiments is the quasi-experimental design.(107) This design has high internal and external validity because of its pre-intervention and post-intervention measures from non-randomized treatment and non-randomized control groups in a natural setting.(107) This research utilized a longitudinal pre-post quasi-experimental design, as data on the outcome were measured at the pre-intervention (Y5), intervention (Y6) and post-intervention (Y7) time points and were compared between non-randomized intervention and control groups. This design is considered the gold standard research methodology for natural experimental studies, and important school- and student-level covariates were measured and controlled for through stratification and adjustment to mitigate bias due to confounding from lack of randomization.(102) A figure of this research design is found in figure 1 below.

Figure 1: Longitudinal pre-post quasi-experimental design.



3.5 Measures

3.5.1 Outcome

Average Daily MVPA: The average combined moderate and vigorous activity per day is a derived variable calculated by summing the total time in minutes of moderate physical activity for each day (Monday-Sunday) and the total time in minutes of hard (vigorous) physical activity for each day (Monday-Sunday) and dividing this sum by 7 days. The result is a continuous variable for MVPA. Definitions for hard and moderate physical activity are defined in the Cq to improve the accuracy of past seven-day physical activity recall. In the Cq, hard physical activities are defined as "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" and moderate physical activities are defined as "physical activities include lower intensity activities such as walking, biking to school, and recreational swimming". These descriptions align with definitions given by CSEP that are used in physical activity research among youth.(4) Hard and moderate physical activity are assessed over the past seven days by asking students to select the number of hours and minutes of hard and moderate physical activity for each day (Monday-Sunday) as outlined in figure 2 and 3 respectively.

Examining the reliability of the Cq physical activity measures, the test-retest reliability of the self-reported MVPA on the Cq was found to be moderate (ICC-0.75). Compared to other self-report measures of physical activity (e.g., Adolescent Physical Activity Recall and HBSC), the reliability of the Cq physical activity measures were found to be sufficient and appropriate for use in school-level research of youth health behaviours.(117) Regarding the validity of the Cq physical activity measures, the self-reported Cq MVPA was significantly correlated with accelerometer-measured values.(117) Although these correlations were low-to-moderate, these

results are comparable to other studies using accelerometers to validate self-reported physical activity (e.g., Physical Activity Questionnaire for Children and Adolescents), making the Cq an acceptable measure of MVPA for school-level research of health behaviours among youth.(117)

Figure 2: Question 14 of the Cq to assess the duration of hard physical activity for each day in the past seven days.

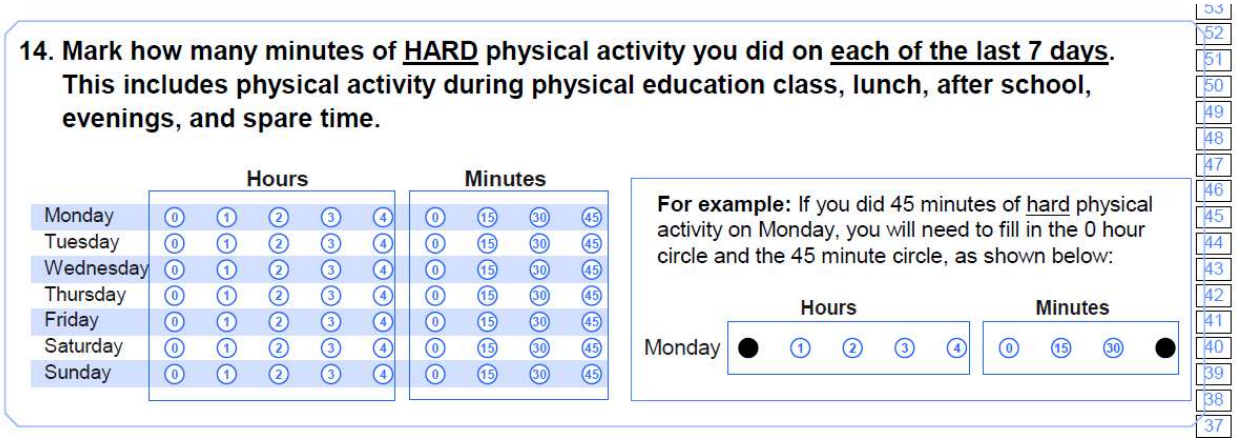
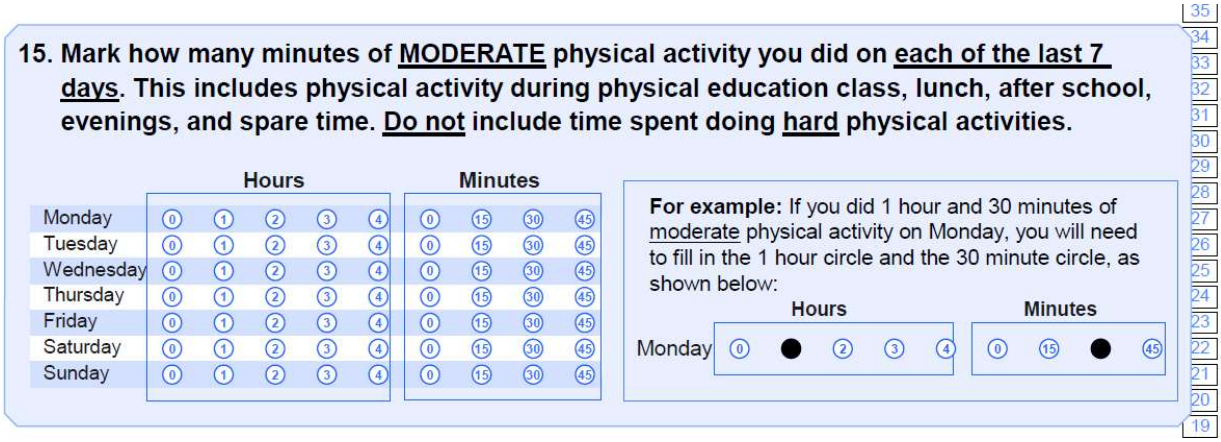


Figure 3: Question 15 of the Cq to assess the duration of moderate physical activity for each day in the past seven days.



3.5.2 Predictors

Study 1:

Changes in intramurals from Y5 to Y6: Changes in intramurals from Y5 to Y6 were determined by asking school contacts to "Please select the intramural programs/club activities involving physical activity that were offered to students at your school during the past 12 months." The intramural program selections include a variety of activities with and allowed space to indicate whether the intramural offerings were for females only, males only, or co-ed and there was space to indicate any activities not listed. This question differed slightly from Y5 (Figure 4) to Y6 (Figure 5), with the addition of Dodgeball and Ultimate Frisbee as potential selections for intramural programs into the Y6 SPP. Changes in intramurals from Y5 to Y6 were determined by comparing the number of intramurals in Y5 to Y6. Schools made many changes from Y5 to Y6, and to ensure cell counts were large enough, these changes were categorized into three main groups: (1) schools that added and removed the same number of intramural programs from Y5 to Y6, (2) schools that added more programs than removed, or only added programs from Y5 to Y6, and (3) schools that removed more programs than added, or only removed programs from Y5 to Y6. These groups were then coded into the following categories: (1) no net change, (2) primarily added programs and (3) primarily removed programs (reference). Schools classified as: (1) no net change described schools that removed an intramural for every intramural they added (e.g., added three intramurals and removed three intramurals).

Study 2:

Type of intramural changes from Y5 to Y6: Type of intramural changes from Y5 to Y6 were determined by asking school contacts to "Please select the intramural programs/club activities

involving physical activity that were offered to students at your school during the past 12 months." See figures 4 and 5. The intramurals were classified as team or individual sports based on the classifications found in Appendix C. Changes in team and individual intramurals from Y5 to Y6 were then determined by comparing the number of intramurals offered between these years. Schools made many changes in team and individual intramurals from Y5 to Y6 (e.g., added and removed a combination of team and individual intramurals), and to ensure cell counts were large enough, these changes were categorized into five groups based on the quantity of types of intramural changes: (1) schools that primarily added team individual intramurals from Y5 to Y6, (2) schools that primarily added individual team intramurals from Y5 to Y6, (3) schools that added the same number of individual and team intramurals from Y5 to Y6, (4) schools that added and removed the same number of individual and team intramurals from Y5 to Y6, and (5) schools that primarily removed team or individuals from Y5 to Y6 (reference). These groups were then coded into the following categories: (1) primarily added team, (2) primarily added individual, (3) added team and individual, (4) no net change and (5) removed intramurals (reference). Schools classified as: (4) no net change described schools that removed an intramural for every intramural they added (e.g., added one team, removed one team and added one individual and removed one individual).

Study 3:

Changes in gender-specific and co-ed intramurals from Y5 to Y6: Changes in gender-specific and co-ed intramurals from Y5 to Y6 were determined by asking school contacts to "Please select the intramural programs/club activities involving physical activity that were offered to students at your school during the past 12 months." School administrators were also asked to indicate whether the intramural offerings were for females only, males only, or co-ed. (See

figures 4 and 5). Changes in gender-specific and co-ed intramurals from Y5 to Y6 were then determined by comparing intramural data between these years. Schools made many changes to intramurals from Y5 to Y6, and these changes were classified into one of the following four groups based on the quantity of gender-specific and co-ed intramurals: (1) schools that primarily added co-ed intramurals from Y5 to Y6, (2) schools that added gender specific intramurals from Y5 to Y6, (3) schools that added and removed the same number of female-only, male-only or co-ed intramurals from Y5 to Y6, and (4) schools that primarily removed female-only, male-only or co-ed intramurals from Y5 to Y6 (reference). These groups were coded and simplified into the following four categories: (1) primarily added co-ed, (2) added gender-specific, (3) no net change, and (4) removed intramurals (reference). Schools classified as: (2) added gender-specific, are schools that either: (i) primarily added the same number of male- and female-only intramurals from Y5 to Y6, (ii) primarily added female-only intramurals from Y5 to Y6, or (iii) primarily added male-only intramurals from Y5 to Y6. Schools classified as: (3) no net change, are schools that removed a gender-specific or co-ed intramural for every one they added (e.g., added one co-ed, removed one co-ed).

Figure 4. Y5 measure of intramural programs from COMPASS SPP.

14. **Please select the <u>intramural programs/club activities</u> involving physical activity that were offered to students at your school during the <u>past 12 months</u>.**

Sport/Club	Girls Only	Boys Only	Co-ed
Yoga	○	○	○
Dance	○	○	○
Outdoors/Outers/Hiking	○	○	○
Mountain Biking	○	○	○
Skiing	○	○	○
soccer	○	○	○
Weight training club	○	○	○
Rock climbing	○	○	○

Fitness club (e.g., CrossFit, Zumba)	○	○	○
cheerleading	○	○	○
ball hockey	○	○	○
Badminton	○	○	○
running club	○	○	○
basketball	○	○	○
Walking club	○	○	○
volleyball	○	○	○
baseball/softball	○	○	○
Other _____	○	○	○
Other _____	○	○	○
Other _____	○	○	○
Other _____	○	○	○
Other _____	○	○	○

Figure 5. Y6 measure of intramural programs from COMPASS SPP.

14. Please select the intramural programs/club activities involving physical activity that were offered to students at your school during the past 12 months.

Sport/Club	Girls Only	Boys Only	Co-ed
Yoga	○	○	○
Dance	○	○	○
Outdoors/Outers/Hiking	○	○	○
Mountain Biking	○	○	○
Skiing	○	○	○
soccer	○	○	○
Weight training club	○	○	○
Rock climbing	○	○	○
Fitness club (e.g., CrossFit, Zumba)	○	○	○
cheerleading	○	○	○
ball hockey	○	○	○
Badminton	○	○	○
running club	○	○	○
basketball	○	○	○
Walking club	○	○	○
volleyball	○	○	○
baseball/softball	○	○	○
Dodgeball	○	○	○
Ultimate Frisbee	○	○	○
Other _____	○	○	○
Other _____	○	○	○

3.5.3 Student-Level Correlates

Based on the background research, there are many student-level sociodemographic and sport participation variables that are associated with the predictor and/or the outcome. Many of these variables are measured by the Cq and were included in the models for Study 1, 2 and 3 as correlates. The sociodemographic characteristics were measured at baseline (Y5), while sport participation correlates were measured at baseline (Y5), intervention (Y6), and post-intervention (Y7).

Baseline Sociodemographic Correlates

Gender in Y5: Data on gender were measured by the Cq and asks students "Are you male or female?" The responses are coded into two categories as follows: 0=female (reference group), 1=male.

Grade in Y5: Data on the baseline grade of students was measured by the Cq by asking students "What grade are you in?" The responses are coded into two categories as follows: 9=grade 9 (reference group), 10=grade 10. Note that students in grade 11 and 12 at baseline were not able to be linked for all three years, and were therefore not included in the study.

Ethnicity in Y5: Data on the ethnicity of students are measured by the Cq and asks students "How would you describe yourself? (Mark all that apply)", and is followed by the options of White (coded as 0, reference group), Black (coded as 1), Asian (coded as 2), Aboriginal (First Nations, Metis, Inuit) (coded as 3), Latin American/Hispanic (coded as 4) and other (coded as 5). These categories were collapsed into white (coded as 0, reference group) and other (coded as 1) to ensure adequate cell counts.

Weekly spending money in Y5: Weekly spending money is proxy measure of socioeconomic status on the Cq and was measured by asking "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 babysitting, delivering papers, etc.)", and is followed by the options of "Zero" (coded as 0, reference group) "$1 to $5" (coded as 1), "$6 to $10" (coded as 2), "$11 to $20" (coded as 3), "$21 to $40" (coded as 4), "$41 to $100" (coded as 5), "more than $100" (coded as 6) and "I do not know how much money I get each week" (coded as 7). These categories were recoded as Zero (reference), $1-$20, $21-$100 and $100+ to ensure adequate cell counts.

Time-Varying Sport Participation Correlates

Intramural sport participation at Y5, Y6 and Y7: Intramural sport participation was reported on the Cq by asking: "Do you participate in before-school, noon hour, or after school physical activities organized by your school? (e.g., intramurals, non-competitive clubs)", followed by the response options of "No", "Yes" and "None offered at my school", and were recoded as "No (reference)" and "Yes" to ensure adequate cell counts.

Varsity sport participation at Y5, Y6 and Y7: Varsity sport participation was assessed on the Cq by asking "Do you participate in competitive school sports teams that compete against other schools? (e.g., junior varsity or varsity sports)", followed by the options of "No" (coded as 0, reference group) "Yes" (coded as 1), or "None offered at my school" (coded as 2), and were recoded as "No (reference)" and "Yes" to ensure adequate cell counts.

Community Sport Participation at Y5, Y6 and Y7: Community sport participation was measured on the Cq by asking "Do you participate in league or team sports outside of school?" and is followed by the options of "No" (coded as 0, reference group) "Yes" (coded as 1), or "There are

none available where I live" (coded as 2) and were recoded as "No (reference)" and "Yes" to ensure adequate cell counts.

3.5.4 School-Level Correlates

School-level correlates that were known to associate with the predictor and/or outcome were measured at baseline (Y5) and included in the analyses for Study 1, 2 and 3.

Number of intramural programs in Y5: The continuous measure of the number of intramurals a school offered in Y5 and was derived by the response on the SPP.

School size in Y5: Data on the size of each school are based on the number of students attending the school. This continuous variable was determined by the response on the SPP.

Changes in other physical activity programs from Y5 to Y6: School-level SPP data were used to assess whether schools made any other relevant changes to programs that may affect MVPA and intramural participation. Data on these programs were coded as 0=no changes in physical activity programs, 1=added physical activity programs and 2=removed physical activity programs.

School neighbourhood median income in Y5: Data on the median income of school are based on the median income of the area surrounding the school. This continuous variable was determined using school postal code and household income data from the latest Canadian Census data.(118)

Chapter 4: Analyses

The three studies in this dissertation used the same student- and school-level data. The longitudinal mixed models in the three studies included relevant student- and school-level correlates, with different sets of predictors pertinent to each study. Specifically, Study 1 models included the main predictor: *changes in intramurals from Y5 to Y6*, Study 2 models included the main predictor: of *type of intramural changes from Y5 to Y6*, and Study 3 models included the main predictor: *changes in gender-specific and co-ed intramurals from Y5 to Y6*, and all studies examined the effect of these intramural changes on MVPA.

4.1 School- and Student-Level Sample

The three studies of this dissertation used linked longitudinal school- and student-level data from 55 Ontario schools that participated in Year 5 (Y5: 2016-2017), Year 6 (Y6: 2017-2018) and Year 7 (Y7: 2018-2019) of COMPASS. Schools in Alberta, British Columbia and Quebec were excluded from these studies because of small sample sizes and differences in provincial physical activity programs and policies. There were 91 Ontario schools that participated in COMPASS in Y5, however, 36 Ontario schools were excluded because these schools did not participate across all three years, for a total of 55 schools in the sample. Students who were in grade 9 (13-14 years old) and grade 10 (14-15 years old) at baseline (Y5) with linked data across all three years were included in our studies. The main reasons for non-linkage were students transferring schools, students not providing data on grade in Y5 or Y6, students who were absent or had a spare period during the time of Y5 or Y6 data collection, those who left secondary school early, or provided inaccurate data to link measures on the Cq. A total of 5,514 students from the 55 Ontario schools were successfully linked for all three years, however only students with: i) complete data on all covariates and ii) complete data or monotone missingness in MVPA were included in our analyses, yielding a final sample size of 4,417

students for all three studies. Our studies employ traditional hierarchical mixed models, which provide reliable inference for monotone pattern of missingness (under the missing at random assumption) in the outcome. This guided the aforementioned subject exclusion criteria.(119)

4.2 Descriptive Analyses

Descriptive analyses were performed on school and student-level characteristics for the sample of 55 schools and 4,417 students. Frequency and percentage were used to describe categorical student- and school-level variables, and the mean and standard deviation were used to describe continuous and discrete student- and school-level variables. Baseline and time-varying student-level variables were summarized separately for: (i) all students, (ii) female students and (iii) male students. Chi-Square was used to examine exploratory differences between female and male students on student-level characteristics at baseline.

4.3 Longitudinal Mixed Models

All analyses were performed in SAS 9.4 and were stratified by gender. For all three studies, the ICC was estimated via the null model (i.e., a linear mixed model that only contains a random intercept) to assess the proportion of observed variance in MVPA that is attributed to school heterogeneity.(120)

For each study, linear mixed models were used to estimate how changes in intramurals in Y5 to Y6 are associated with longitudinal MVPA. These models were hierarchical to account for clustering of students within schools and students over time, and were built in six stages: (i) the unconditional means model with a random intercept and no predictors, (ii) adding the main predictor (intramural change) to the models, (iii) adding student-level demographic variables (grade, ethnicity) to the models, (iv) adding student-level social variables (weekly spending money) to the models, (v) adding student-level sport participation variables (intramural, varsity

and league sport participation) to the models, and (vi) adding school-level variables (changes in physical activity programs, number of intramurals in Y5, school size, and school neighbourhood median income) to the models. The goodness of fit of each model was assessed via Akaike's Information Criterion (AIC) and Bayesian Information Criterion (BIC).(121) The final models controlled for relevant student (grade, ethnicity, weekly spending money, intramural sport participation, varsity sport participation, community sport participation) and school (changes in physical activity programs, number of intramurals in Y5, school size, and school neighbourhood median income) factors.

A novel modeling approach to program evaluation was employed to create two indicator variables representing the main predictor of changes in intramurals from Y5 to Y6 for each study. These indictor variables allowed for the evaluation of changes in intramurals (the intervention) at two timepoints: (i) intervention year (Y6) and (ii) post-intervention year (Y7). This novel modeling method has been utilized in previous research to assess changes in provincial policies on health outcomes (122), and to assess how changes in the environment affect alcohol use (123), tobacco and cannabis use (124) over time.

4.3.1 Indicator Variables

Two indicator variables were created for each study to represent changes in intramurals. In Study 1, these indicator variables were: (i) intramural change in year Y6 and (ii) intramural change in Y7. In Study 2, these indicator variables were: (i) type of intramural changes in Y6 and (ii) type of intramural changes in Y7. In Study 3, these indicator variables were: (i) changes in gender-specific and co-ed intramurals in Y6 and (ii) changes in gender-specific and co-ed intramurals in Y7. These indicator variables in the models/studies allowed for the assessment of the effect of intramural changes from Y5 to Y6 on MVPA at those respective years. Specifically,

these indicator variables in Y6 allowed for the examination of the effect of intramural change on MVPA in that year, and in Y7, these indicator variables allowed for the examination of effect of intramural change on MVPA under the supposition that changes from Y5 to Y6 would continue (in a similar manner) into Y7. We explain the nuances of these indicator variable via a hypothetical example of a school and its intramural changes. Suppose this school for Study 1 was classified as "added intramurals", and in Y5 (pre-intervention), and this intramural change was coded as "no change" to reflect that the intervention has not yet been implemented. In Y6 (intervention), this intramural change was coded as "added intramurals", to reflect that the intervention had been implemented this year. In Y7 (post-intervention), this intramural change was coded as "added intramurals", to examine the effect of this change if it were to be continued into Y7. See Table 1 for a representation of these study 1 indicator variables for this hypothetical school.

Table 1. Indicator variables used in Study 1 for a school that added intramurals from Y5 to Y6

Year	Intramural Change from Y5 to Y6	Indicator variable for intramural change in Y6	Indicator variable for intramural change in Y7
Y5	Added	No Change	No Change
Y6	Added	Added	No Change
Y7	Added	No Change	Added

For Study 2, this school was classified as "added individual and team intramurals" and in Y5 (pre-intervention), this type of intramural change was coded as "no change", to reflect that the intervention has not yet been implemented. In Y6 (intervention), this type of intramural

change was coded as “added individual and team intramurals”, to reflect that the intervention had been implemented this year. In Y7 (post-intervention), this type of intramural change was coded as “added individual and team intramurals”, to examine the effect of this change if it were to be continued into Y7. See Table 2 for a representation of these indicator variables for this school.

Table 2. Indicator variables used in Study 2 for a school that added individual and team intramurals from Y5 to Y6

Year	Type of Intramural Change	Indicator variable for type of intramural change in Y6	Indicator variable for type of intramural change in Y7
Y5	Added Individual and Team	No Change	No Change
Y6	Added Individual and Team	Added Individual and Team	No Change
Y7	Added Individual and Team	No Change	Added Individual and Team

In Study 3, this school was classified as “added co-ed intramurals”, and in Y5 (pre-intervention), this type of intramural change was coded as “no change”, to reflect that the intervention has not yet been implemented. In Y6 (intervention), this type of intramural change was coded as “added co-ed intramurals”, to reflect that the intervention had been implemented this year. In Y7 (post-intervention), this intramural change was coded as “added co-ed intramurals”, to examine the effect of this change if it were to be continued into Y7. See Table 3 below for a representation of these indicator variables for this school.

Table 3. Indicator variables used in Study 3 for a school that added co-ed intramurals from Y5 to Y6

Year	Change in gender-specific and co-ed intramurals	Indicator variable for gender-specific and co-ed intramural change in Y6	Indicator variable for gender-specific and co-ed intramural change in Y7
Y5	Added Co-ed	No Change	No Change
Y6	Added Co-ed	Added Co-ed	No Change
Y7	Added Co-ed	No Change	Added Co-ed

Chapter 5.0 Study 1

A quasi-experimental examination of how changes in school-level intramurals are associated with physical activity among a sample of Canadian secondary school students from the COMPASS Study

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5.1 Abstract

Introduction: Intramurals in schools may encourage physical activity among youth. Schools are continuously making changes to these intramurals, yet it is not well understood how these changes impact youth physical activity. The main objective of this research was to examine if changes in the number of intramurals were associated with youth physical activity over time with a secondary objective to explore the association between sport participation and physical activity among youth over time.

Methods: This study used three years of linked longitudinal school- and student-level data from Ontario schools in year 5 (Y5: 2016-2017), year 6 (Y6: 2017-2018) and year 7 (Y7: 2018-2019) of the COMPASS study. Data on intramurals from 55 schools were collected from the School Programs and Policies questionnaire to determine intramural changes that were made from Y5 to Y6. Using the COMPASS Student Questionnaire, baseline demographics were collected and data on physical activity and sport participation were measured at Y5, Y6 and Y7 on 4417 students. Hierarchical linear mixed regression models were used to estimate how changes in intramurals were associated with youth physical activity over time.

Results: Changes in school-specific intramurals were not significantly associated with physical activity over time. Intramural, varsity and community sport participation were all positively and significantly associated with youth physical activity among female and males.

Conclusions: Intramural, varsity and community sport participation are important opportunities for youth physical activity. Schools should offer a variety of intramural and varsity sports to encourage physical activity. Although adding intramurals may not be effective at increasing youth physical activity, they may be effective when used in combination with other strategies to increase physical activity.

5.2 Introduction

Moderate-to vigorous-intensity physical activity (MVPA) is associated with numerous short- and long-term physical and mental health benefits for youth. Specific to physical benefits, MVPA is positively associated with healthy development by promoting healthy musculoskeletal and cardiovascular development among youth (7,8) and helps reduce the risk of future diseases such as heart disease, cancer and type 2 diabetes.(8,9) Relating to mental health, among youth, MVPA is associated with higher academic performance (13,14) and social development,(7) and may reduce symptoms of anxiety and depression.(8,9) Higher intensity physical activities are more strongly associated with these health benefits compared to lower intensity activities,(15) however all physical activity of various intensities, durations and patterns (sporadic and continuous) are associated with health benefits.(15) This highlights that modest changes in physical activity behaviours among youth could result in the short- and long-term physical and mental health benefits.

The Canadian 24-Hour Movement Guidelines for Children and Youth recommend that youth aged 5-17 accumulate at least 60 minutes of MVPA per day, however only about one-third of Canadian youth are meeting these MVPA recommendations.(12,19–21) This may be explained by the general decline in physical activity levels and increases in sedentary behaviour that are often observed in adolescence.(26,27)

Youth are an important target population for physical activity programs because the majority are not meeting the physical activity guidelines (12,19–21) and their physical activity levels tend to decrease as they age.(26,27) Additionally, in adolescence, habitual health behaviours such as physical activity and sedentary behaviour are developed and formed (16,22,24,25) presenting the opportunity for programs to help establish physical activity habits

that can be maintained into adulthood.(31,40) Schools are an ideal setting to offer physical activity programming because the majority of Canadian children and youth are enrolled in elementary or secondary school (44) and they spend 6-7 hours per weekday in school.(45) School-based physical activity programs provide youth an opportunity to be physically active while reducing potential barriers (e.g., socioeconomic status and athletic ability) that may prevent some youth from participating in extracurricular physical activities such as community sports.(49) Intramural (intra-scholastic) sports are an inclusive example of school-based physical activity programming because they are generally less competitive and are more accessible compared to varsity (inter-scholastic) sports because they are available to all students regardless of skill level and typically do not require a fee to participate.(68) Participation in intramural sports is positively associated with MVPA (69,72,73) and is associated with lower screen time and sedentary behaviour.(81) Lastly, participating in sports in adolescence is positively associated with physical activity in adulthood,(31,77,78) highlighting the potential longitudinal health benefits of youth intramural sport participation.

With ongoing changes to the funding provided to schools for physical activity programs,(125) there are continuous changes made to school-level physical activity programming. These continuous changes can be considered as *natural experiments*, as they are interventions that are implemented with no manipulation by the researcher.(102,103) It is important to evaluate these natural experiments to determine how these changes in school physical activity programs affect youth physical activity, and to ultimately provide schools with evidence to inform their offering of these programs. With the inclusive and accessible nature of intramurals, their positive association with physical activity and the low cost to offer these programs, it is important to evaluate how changes in intramurals are associated with youth

physical activity. To our knowledge, there is limited research examining how changes in school-level intramurals are associated with youth physical activity.(45) Therefore, the main purpose of this study was to examine if changes in the number of intramurals offered were associated with MVPA over time. A secondary objective of this research was to explore the association between sport participation and physical activity among youth over time. This study aims to fill this research gap and to provide a longitudinal quasi-experimental evaluation of how changes in intramurals are associated with youth physical activity in Canadian secondary schools. This research will provide schools with practice-based evidence to inform their offerings of intramurals to maximize participation and physical activity among students.(106)

5.3 Materials and Methods

5.3.1 Design

The COMPASS study is a school-based prospective cohort study that collects longitudinal student- and school-level data from a convenience sample of students (grade 9-12) and the secondary schools they attend in Alberta, British Columbia, Ontario and Quebec.(109) Students within schools were recruited using an active-permission passive consent procedure as this approach limits self-selection and response biases.(109,113) The COMPASS study collects student-level data on a variety of health behaviours and collects school-level data on the programs, policies and built environment over time through annual school data collections.(109) Data from the COMPASS study are used to evaluate how changes in school programs, policies, and/or the built environment are related to changes in youth health behaviours over time.(109)

Changes in intramurals are considered a natural experiment, and a longitudinal quasi-experimental design was used to evaluate how these changes associate with youth MVPA over time. The longitudinal quasi-experimental design involves pre- and post-intervention measures

from non-randomized intervention and control groups.(102) In this study, student-level data on the outcome were collected from the COMPASS host study at pre-intervention (Year 5), intervention (Year 6) and post-intervention (Year 7) time points and were compared between non-randomized intervention and control groups, that were classified by their changes to intramurals. The longitudinal quasi-experimental design is considered the gold standard research methodology in natural experimental studies.(102) Important school- and student-level covariates were measured and controlled for through both stratification and adjustment to mitigate bias due to confounding from lack of randomization.(102)

A full description of the COMPASS study methods can be found in print (109) or online (www.compass.uwaterloo.ca). All procedures were approved by the University of Waterloo Office of Research Ethics (reference number 30118) and appropriate school board committees.

5.3.2 Participants

This study used three years of linked longitudinal school- and student-level data from Ontario schools in year 5 (2016-2017), year 6 (2017-2018) and year 7 (2018-2019) of the COMPASS study. Schools in Alberta, British Columbia and Quebec were excluded from this study because of differences in provincial physical activity policies and programs and small school-level sample sizes at baseline. Schools were only included in the sample if they participated in data collection in year 5 (Y5), year 6 (Y6) and year 7 (Y7) and had complete data on intramurals for these years. Students from these schools who were in grade 9 and 10 at Y5 with linked data across all three of the time points were included in the study, as students who were in grade 11 or 12 in Y5 or students in grade 9 that were newly admitted into the study in Y6 or Y7 were not able to be successfully linked for all 3 years, and were therefore not included in the sample.

A total of 5514 students were linked over the three-year study period (Y5, Y6 and Y7). The main reasons for non-linkage were students transferring schools, students not providing data for grade in Y5 or Y6, students who were absent or had a scheduled spare during the time of Y5 or Y6 data collection, those who left secondary school early, or inaccurate data provided to link measures on the Cq. Details on the methods of COMPASS data linkage are available elsewhere.(126) Only students with: (1) complete data on all covariates and (2) complete data or monotone missingness on the outcome were included in the analysis (n=4417). The response rate for our study's inclusion criteria among the 55 schools was 76% in Y5, 79% in Y6 and 78% in Y7.

5.3.3 Data Collection

5.3.3.1 School-Level Data (SPP Questionnaire and Statistics Canada Data)

School-level data were collected using the COMPAS School Policies and Practices Questionnaires (SPP). The SPP is an online survey completed by a school administrator (e.g., principal, guidance councillor, or teacher) that is most knowledgeable about the programs and policies within the school. School-level demographic data were collected from the from the 2016 Census. All school-level covariates were measured at baseline (Y5).

5.3.3.1.1 Predictor:

Changes in intramurals from Y5 to Y6 was determined by asking school contacts to "Please select the intramural programs/club activities involving physical activity that were offered to students at your school during the past 12 months." The intramural program selections include a variety of activities including team sports (e.g., soccer, basketball) and individual activities (e.g., yoga, running club). School contacts were also asked to indicate whether the intramural offerings

were for females only, males only, or co-ed and there was space to indicate any activities not listed. *Changes in intramurals from Y5 to Y6* were determined by comparing intramural data from in Y5 to Y6. Schools made many changes from Y5 to Y6, and to ensure cell counts were large enough, these changes were categorized into three main groups (1) schools that added and removed the same number of intramural programs, (2) schools that added more programs than removed, or added programs only and (3) schools that removed more programs than added, or removed programs only. These groups were then coded into the following categories: (1) no net change, (2) primarily added programs and (3) primarily removed programs (reference).

5.3.3.1.2 Covariates:

Changes in physical activity programs: School-level SPP data were used to assess whether schools made any other relevant changes to programs that may affect MVPA and/or intramural participation. Data on these programs were compared between Y5 and Y6 and the variable was categorized as either: “no changes in physical activity programs”, “added physical activity programs” or “removed physical activity programs”.

School neighbourhood median income in Y5: Data on the median income of school are based on the median income of the area surrounding the school. This variable is continuous and was determined using school postal code and household income data from the 2016 Canadian Census data.(118)

School size in Y5: Data on the size of each school are based on the number of students attending the school. This was determined by the response on the SPP and is a continuous variable.

Number of intramurals in Y5: The number of intramurals offered in the 2016-2017 year is a continuous variable calculated by examining the intramural data on Y5 of the SPP.

5.3.3.2 Student-Level Data (COMPASS Questionnaire)

The student-level data were self-reported using the COMPASS questionnaire (Cq) that is administered during class time. Based on previous research, there are many sociodemographic and behavioural characteristics that are associated with the outcome of MVPA. Many of these characteristics are measured by the Cq and were included in the model as covariates. MVPA, varsity, community and intramural sport participation were measured at all three time points (Y5, Y6 and Y7) while the remaining covariates were measured at baseline (Y5).

5.3.3.2.1 Outcome:

MVPA in Y5, Y6 and Y7: The Cq asks students to record their daily time (hours and/or minutes) spent engaging in hard and moderate physical activity each day for the last 7 days (e.g., Monday-Sunday) and includes all physical activity during physical education class, lunch, after school, evenings and spare time. The average combined moderate and vigorous activity per day is a variable derived by summing the total time in minutes of moderate physical activity for each day (Monday-Sunday) and the total time in minutes of hard (vigorous) physical activity for each day (Monday-Sunday) and dividing this sum by 7 days. The result is a continuous variable for MVPA.

5.3.3.2.2 Covariates:

Gender in Y5: Data on gender are measured by asking "Are you male or female?" The responses were coded into two categories: Female (Reference) and Male.

Grade in Y5: Data on the age of students are measured by asking "What grade are you in?" The responses were coded as Grade 9 (Reference) and Grade 10.

Ethnicity in Y5: Data on the ethnicity of students are measured by the question "How would you describe yourself?". To ensure adequate cell counts ethnicity was coded as White (reference) and Other.

Weekly spending money in Y5: Weekly spending money is proxy measure of socioeconomic status and is measured by asking "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 babysitting, delivering papers, etc.)", and was coded as "Zero" (Reference), "$1-$20", "$21-$100" and "$100+".

Varsity sport participation in Y5, Y6 and Y7: Varsity sport participation is measured each year by the question "Do you participate in competitive school sports teams that compete against other schools? (e.g., junior varsity or varsity sports)", followed by the options of "No" (Reference) and "Yes".

Community Sport Participation in Y5, Y6 and Y7: Community sport participation is measured each year by asking "Do you participate in league or team sports outside of school?" and is followed by the options of "No" (Reference) and "Yes".

Intramural Participation in Y5, Y6 and Y7: Intramural participation is measured each year by asking students "Do you participate in before-school, noon hour, or after school physical activities organized by your school? (e.g., intramurals, non-competitive clubs)", and is followed by the options of "No" (Reference) and "Yes".

5.3.4 Data Analysis

All analyses were performed in SAS 9.4 (SAS Institute, Cary, NC). Descriptive school-level (N=55) and student-level characteristics (N=4417) were calculated. Chi-Square was used to

examine exploratory differences between female and male students on the student-level characteristics at baseline.

An empty linear mixed regression model was used to estimate the intraclass correction (ICC) to determine the variability in MVPA among schools. Linear mixed regression models were used via PROC MIXED to model whether changes in intramurals in Y5 to Y6 were associated with longitudinal MVPA and were stratified by sex. These models were hierarchical to account for clustering of students within schools and students over time. These models also controlled for the following relevant student-level factors: grade, ethnicity, weekly spending money, intramural participation, varsity sport participation, community sport participation, and the following school-level factors: changes in physical activity programs, number of intramurals in Y5, school size, and school neighbourhood median income. A novel modeling approach to program evaluation was utilized to create indicator variables representing the yearly intramural change: (i) intramural change in year 6 and (ii) intramural change in year 7. These indicator variables were included in the model and allowed for the assessment of their effect at those respective years. For year 7, the effect of intramural change was assessed under the supposition that changes from year 6 could continue (in a similar manner) onto year 7. This research intended to evaluate how changes in schools' intramural offerings from Y5 to Y6 were associated with youth MVPA over time, so supposing the changes from Y5 to Y6 onto Y7 was reasonable to meet this objective. This novel modeling approach has been used in other research to assess changes in provincial policies on health outcomes (122) and to assess changes in the environment on alcohol use, (123) tobacco and cannabis use (124) over time. The non-randomized intervention groups included schools classified as: (1) no net change and (2)

primarily added programs, and the non-randomized comparison group included schools classified as (3) primarily removed programs (reference).

5.4 Theory

The socio-ecological model (SEM) is a theoretical framework used to understand how multidimensional factors interact to influence behaviour.(127) This model highlights how proximal (e.g., individual, interpersonal) and distal (e.g., environmental and organizational) factors interact to influence physical activity.(127) There are many integrated factors determining youth physical activity behaviours,(95) however, an important environmental factor associated with youth physical activity continues to be the school environment.(51) As a modifiable factor, it is important to study the effect of the school environment (e.g., intramural changes) on youth physical activity.

5.5 Results

5.5.1 School-Level Descriptive Statistics

The characteristics of the school-level sample are presented in Table 4. Most schools in the sample reported primarily adding intramurals from Y5 to Y6 (n=35), while 17 schools reported primarily removing programs and 3 schools reported no net change. Only 5 schools reported changes in physical activity programs from Y5 to Y6, and all 5 reported adding programs, as opposed to removing them. The mean school median income was $69,804 (SD=$15,404.29) and the mean school size was 670 students (SD=289). The mean number of intramurals offered in Y5 was 5.38 (SD=4.12).

Table 4: Descriptive Statistics for School-Level Characteristics for the sample (n=55) from Year 5 (2016-2017) of the COMPASS study

Variable	Freq/Mean	%/SD

Changes in Intramurals	Primarily Removed (Ref)	17	30.9
	No Net Change	3	5.5
	Primarily Added	35	63.6
Changes in Other Physical Activity Programs	No Change (Ref)	50	90.9
	Added Programs	5	9.1
School Neighbourhood Median Income		$69, 804	$15,404.3
School Size		669.2	288.1
Number of Intramurals Offered in Y5		5.4	4.12

5.5.2 Student-Level Descriptive Statistics

The characteristics of this sample can be found in Table 5 and 6. As shown, 54% (n=2402) of the sample was female and 73% (n=3210) were white. Most students (43%, n=1875) reported $1-$20 in weekly spending money at baseline. Intramural participation among female students was 38% in Y5, 36% in Y6 and 33% in Y7. Among male students, intramural participation was 39% in Y5, 37% in Y6 and 36% in Y7. Both male and female students participated in less average daily MVPA over time, with females accumulating 105 minutes (SD=66) in Y5, 97 minutes (SD=64) in Y6 and 89 minutes (SD=61) in Y7 while males accumulated an average of 117 minutes (SD=68) in Y5, 109 minutes (SD=68) in Y6 and 102 minutes (SD=65) in Y7.

Table 5: Descriptive Statistics for Baseline Student-Level Characteristics for the sample (n=4417) from Year 5 (2016-2017) of the COMPASS study

Variable		Total n=4417	Female (Ref) n=2402 (54%)	Male n=2015 (46%)			
		Counts (%)	Counts (%)	Counts (%)	DF	Chi-Square	P-Value
Grade	Grade 9 (Ref)	2434 (55.1)	1335 (55.6)	1099 (54.5)	1	1.431	0.232
	Grade 10	1983 (44.9)	1067 (44.4)	916 (45.5)			
Ethnicity	White (Ref)	3210 (72.7)	1744 (72.6)	1466 (72.8)	1	0.036	0.849
	Other	1207 (27.3)	658 (27.4)	549 (27.2)			
Weekly Spending Money	Zero (Ref)	1130 (25.6)	541 (22.5)	589 (29.2)	3	107.4002	<.0001
	$1-$20	1875 (42.5)	1062 (44.2)	813 (40.3)			
	$21-$100	1065 (24.1)	628 (26.1)	437 (21.7)			
	$100+	347 (7.9)	171 (7.1)	176 (8.7)			

Percent values may not equal 100 due to rounding.

Table 6: Descriptive Statistics for Time-Varying Student-Level Characteristics for the sample (n=4417) from Year 5 (2016-2017), Y6 (2017-2018) and Y7 (2018-2019) of the COMPASS study

Variable		Total n=4417			Female (Ref) n=2402			Male n=2015		
		Year 5 Counts (%)	Year 6 Counts (%)	Year 7 Counts (%)	Year 5 Counts (%)	Year 6 Counts (%)	Year 7 Counts (%)	Year 5 Counts (%)	Year 6 Counts (%)	Year 7 Counts (%)
Intramurals	No	2733	2813	2903	1494	1542	1616	1239	1271	1287
	(Ref)	(61.9)	(63.7)	(65.7)	(62.2)	(64.2)	(67.3)	(61.5)	(63.1)	(63.9)
	Yes	1684	1604	1514	908	860	786	776	744	728
		(38.1)	(36.3)	(34.3)	(37.8)	(35.8)38	(32.7)	(38.5)	(36.9)	(36.1)
Varsity	No	2568	2529	2688	1464	1447	1558	1104	1082	1130
	(Ref)	(58.1)	(57.3)	(60.9)	(60.9)	(60.2)	(64.9)	(54.8)	(53.7)	(56.1)
	Yes	1849	1888	1729	938	955	844	911	933	885
		(41.9)	(42.7)	(39.1)	(39.1)	(39.8)	(35.1)	(45.2)	(46.3)	(43.9)
Community	No	2109	2394	2781	1218	1377	1599	891	1017	1182
	(Ref)	(47.7)	(54.2)	(63.0)	(50.7)	(57.3)	(66.6)	(44.2)	(50.5)	(58.7)
	Yes	2308	2023	1636	1184	1025	803	1124	998	833
		(52.3)	(45.8)	(37.0)	(49.3)	(42.7)	(33.4)	(55.8)	(49.5)	(41.3)
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)

MVPA (min/day)*	110 (67)	102 (66)	95 (64)	105 (66)	97 (64)	89 (61)	117 (68)	109 (68)	102 (65)
	n=4417	n=4414	n=4375	n=2402	n=2400	n=2380	n=2015	n=2014	n=1995

*Note that the sample sizes for MVPA in Y6 and Y7 are different compared to baseline as well as Y6 and Y7 of other covariates. This is because some subjects included in the model are missing MVPA data in Y6 and Y7 (i.e., monotone pattern).

5.5.3 Results from Longitudinal Mixed Models

Based on the ICC, school-level differences accounted for 1.91% of the variability in MVPA among females and 2.09% among males, suggesting modest differences between schools on MVPA. Results from the linear mixed models are presented in Table 7. Female and male students in grade 10 at baseline accumulated significantly less daily MVPA minutes on average compared to students in grade 9 at baseline (Females: $\hat{\beta}$ =-8.391, p<0.001, Males: $\hat{\beta}$ = -7.307, p<0.001). Year was negatively associated with MVPA for both females and males, although this relationship was only significant for females (Females $\hat{\beta} = -7.255$, p=0.004, Males $\hat{\beta} = -1.080$, p=0.698). Females participating in intramurals accumulated an average of 4.987 more daily minutes of MVPA (p=0.003) and males accumulated an average of 9.709 more daily minutes of MVPA (p<0.001) compared to females and males not participating in intramurals respectively. Female and male students reporting varsity sport participation accumulated significantly more average daily MVPA minutes compared to their non-participating counterparts (Females: $\hat{\beta} = 16.128$ p<0.001, Males: $\hat{\beta} = 18.020$, p<0.001). Females participating in community sports achieved an average of 26.060 more minutes of MVPA per day (p<0.001) and males accumulated an average of 20.267 more minutes of MVPA per day (p<0.001) compared to females and males not participating in community sports respectively.

Primarily adding intramurals had a positive but non-significant association with female MVPA in Y6 and a non-significant negative association with male MVPA in Y6 regardless of whether youth participated in intramurals, compared to schools that primarily removed intramurals (Females: $\hat{\beta} = 4.810$ p=0.065, Males: $\hat{\beta} = -2.087$, p=0.480). Schools that made no net changes to intramurals were positively, but non-significantly associated with both female and male MVPA in Y6 regardless of whether youth participated in intramurals, both compared to

schools that primarily removed intramurals (Females: $\hat{\beta} = 2.248$ p=0.484, Males: $\hat{\beta} = 5.133$, p=0.147).

Next, assuming the intramural changes in Y6 were maintained in Y7, their effect on MVPA in Y7 was estimated for female and male students. If the schools that primarily added intramurals maintained these changes in Y7, it was estimated to have a positive yet non-significant effect on MVPA among females in Y7 ($\hat{\beta}$=3.135, p=0.230) and a negative and non-significant effect on MVPA among males in Y7 ($\hat{\beta}$= -0.666, p=0.822). If schools that made no net changes to intramurals maintained this change into Y7, it was estimated to have a negative and non-significant effect on MVPA among females in Y7 ($\hat{\beta}$= -1.489, p=0.783) and a positive and non-significant effect on MVPA among males in Y7 ($\hat{\beta}$= 8.758, p=0.138).

Table 7: Linear Mixed Models examining the association between changes in intramurals in Y6 on MVPA in Y6 and Y7 of the COMPASS Study stratified by gender

Variable		Female n=2402			Male n=2015		
		Estimate	95% CI	p-value	Estimate	95% CI	p-value
Effect of Intramural Change on MVPA in Y6	Primarily Removed (Ref)	—	—	—	—	—	—
	Primarily Added	4.810	-0.289-9.909	0.065	-2.087	-7.876-3.702	0.480
	No Net Change	2.248	-4.044-8.540	0.484	5.133	-1.800-12.066	0.147
Effect of Intramural Change on MVPA in Y7	Primarily Removed (Ref)	—	—	—	—	—	—
	Primarily Added	3.135	-1.979-8.248	0.230	-0.666	-6.468-5.135	0.822
	No Net Change	-1.489	-12.056-9.079	0.783	8.758	-2.817-20.333	0.138
Grade	Grade 9 (Ref)	—	—	—	—	—	—
	Grade 10	-8.391	-12.093- -4.689	**<.001**	-7.307	-11.431- -3.183	**<0.001**
Year		-7.255	-12.244- -2.266	**0.004**	-1.080	-6.538-4.378	0.698
Intramural Sport Participation	No (Ref)	—	—	—	—	—	—
	Yes	4.987	1.753-8.221	**0.003**	9.709	6.031-13.386	**<.001**
Varsity Sport Participation	No (Ref)	—	—	—	—	—	—
	Yes	16.128	12.474-19.782	**<.001**	18.020	13.919-22.120	**<.001**

Community Sport	No (Ref)	—	—	—	—	—	—
Participation	Yes	26.060	22.760-29.360	**<.001**	20.267	16.477-24.057	**<.001**

Models controlled for changes in physical activity programs in Y6, median school neighbourhood income in Y5, school enrolment in Y5, number of intramurals in Y5, ethnicity and weekly spending money. Values significant at $\alpha = 0.05$ *are bolded.*

5.6 Discussion

To our knowledge, this was the first study to evaluate how changes in intramurals were associated with MVPA over time. We explored this association using a large sample of linked longitudinal data, and employed an innovative methodology that allowed us to examine how the effect of changes in intramurals affected MVPA in Y6 and into Y7, under the assumption these changes were maintained from Y6. Our results suggest that youth MVPA declines over time and changes in intramurals did not significantly protect youth against this negative trend in MVPA. Despite these results, this study contributes to our understanding of how real-world changes in intramurals affect MVPA over time.

Female and male students in grade 10 at baseline accumulated significantly less daily MVPA minutes compared to those in grade 9 at baseline. Cross-sectional research using objective measures of physical activity have found similar results, as younger youth accumulated significantly more MVPA compared to older youth.(19,20) Additionally, our findings are consistent with other studies that have observed decreases in MVPA as youth progress from grade 9 to grade 10 (128) and throughout the rest of high school.(129) Year was negatively associated with MVPA for both female and male students, however this association was only significant among females. This general decrease in MVPA over time is consistent with longitudinal research using self-report (28–32) and objective (26,27) measures of physical activity. This association was only significant in female students which may be explained by the greater decline in physical activity that is generally observed in females compared to males over time.(35,36)

Participation in intramural, varsity and community sports were all significantly and positively associated with MVPA for both males and females. These associations have been

observed in other research as intramural,(70,72,73) varsity (72,73) and community (72,77,96,97) sport participation are all positively associated with youth MVPA. These sports are all opportunities for youth to be physically active which is an important predictor of youth physical activity.(71,95,97)

The innovative modeling method used in this study allowed us to examine how intramural change impacts students' MVPA over time. The associations between intramural change and MVPA were non-significant for both female and male youth, regardless of whether students reported participating in these programs. These results suggest that changes in school-level intramurals do not have an effect on MVPA and that perhaps adding intramurals is not an effective method to increase MVPA among students. Previous research has echoed this and suggests that school-based physical activity programs are most effective at increasing student MVPA when they are multifaceted. For example, physical activity programs that integrate a combination of curriculum, policy, environmental, community and parental strategies have shown most effective in improving youth physical activity.(48,52) Although not effective at increasing MVPA on their own, policies to increase intramural programming could be an important part of a more comprehensive school-based physical activity strategy.(130,131) Changes in intramurals were not associated with MVPA, however it is important to highlight that these changes may impact intramural participation, which we did not examine in this research. Intramural participation is associated with a multitude of health benefits including improved mental health,(8,9) improved academic performance,(13,14) increased socialization,(7) reduced substance use,(132) and sport sampling,(31,74–80) and research examining how school-based intramurals associate with intramural participation is warranted.

It is also important to note that this study did not consider additional details about the intramural changes that may be important for youth MVPA. For example, past research examining MVPA and sport participation has shown that some intramurals generate more MVPA compared to others, and that team sports are generally associated with more MVPA compared to individual activities.(87,110) Perhaps the positive intramural changes in our study were primarily to lower-intensity or individual-based sports, and/or the negative intramural changes were primarily made to higher-intensity or team-based sports, potentially explaining our non-significant findings. Recent research found that adding team and individual intramurals were positively associated with female MVPA, regardless of intramural participation,(133) which underscores the importance of examining types of intramural changes on youth MVPA. These results suggest an indirect effect between changes in intramurals and MVPA, and may be explained by the fact that adding team and individual intramurals fosters a supportive physical activity environment and addresses important proximal factors associated with female MVPA.(88,89,134–138) Additionally, we did not consider whether the intramural changes were to female-only, male-only or co-ed intramurals. Classifying intramurals by gender-offering is important in physical activity research, as it has been shown to influence intramural participation and potentially MVPA. For example, females attending schools with female-only intramurals were more likely to participate in intramurals compared to females attending schools without such programs,(94) therefore female-only intramurals may generate higher levels of physical activity among females compared to co-ed programs.(69,70,72,73)

Future studies should aim to further classify intramural changes by intensity and gender-offering to account for the potential differentiating effects of these on MVPA. This research future would enhance our understanding of how changes in intramural programs are associated

with MVPA, and would better aid in school-level decision making. Additionally, future research should seek to understand how intramural programs affect intramural participation over time to account for the numerous benefits of participation apart from physical activity.

5.6.1 Limitations

Firstly, schools were recruited using convenience sampling which may limit the generalizability of the results. However, the COMPASS study has a large sample size and utilizes active-information, passive-consent protocol to encourage participation and honest response.(113) This recruitment method has been shown to limit self-selection and response biases and generate more robust results.(109) Secondly, we did not examine changes in the type of intramural programs (e.g., team and individual) and gender-offering (e.g., female-only, male-only and co-ed) in our analysis. Team and individual intramurals are differentially associated with MVPA, as team sports typically generate more MVPA among youth compared to individual sports. Also, the gender-offering of intramural programs should be considered, as this affects participation and potentially physical activity. Thirdly, because schools make many intramural changes each year, the intervention groups may have been diluted (e.g., primarily added versus added only), making the association between these changes and MVPA difficult to measure. Lastly, it is possible that this study was under-powered at the school-level to detect associations between changes in intramural programs on MVPA over time.

5.7 Conclusion

The results of this study highlight the important effect that intramural, varsity and community sport participation have on youth MVPA, as participation in these sports were positively associated with youth MVPA. Schools should consider offering a variety of varsity and intramural sports to encourage physical activity among their student population. Although

not effective at increasing MVPA on their own, intramurals could be an important part of a more comprehensive school-based physical activity strategy. When considering changes to intramural programs, schools should consider participation rates and offer intramurals that will engage a large proportion of students, including those at high risk for physical inactivity. Sport participation in youth is a predictor for physical activity later in life, therefore it is important for schools to offer a variety of sports at the intramural and varsity levels to accommodate students with a wide range of interests and athletic abilities.

Chapter 6.0 Study 2

Examining if Changes in The Type of School-Based Intramural Programs Affect Youth Physical Activity Over Time: A Natural Experiment Evaluation

Status: This study has been published in the *International Journal of Environmental Research and Public Health* and can be accessed by using the following link: https://doi.org/10.3390/ijerph18052752

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6.1 Abstract

(1) School-based physical activity programs such as intramurals provide youth with inclusive opportunities to be physically active, yet we know little about how types of intramurals (e.g., team and individual sports) may contribute to youth MVPA. This research aims to evaluate how real-world changes in types of intramurals available in schools impact youth physical activity over time. (2) This study used three years of longitudinal school- and student-level data from Ontario schools participating in year 5 (2016–2017), year 6 (2017–2018) and year 7 (2018–2019) of the COMPASS study. Data on types of intramural programs from 55 schools were obtained, baseline demographic characteristics were measured and data on physical activity and sport participation were collected on a sample of 4417 students. Hierarchical linear mixed regression models were used to estimate how changes in the type of intramurals associate with youth MVPA over time. (3) Regardless of participation, adding individual and team intramurals was significantly and positively associated with female MVPA in Y6. (4) The indirect, but positive relationship between adding individual and team intramurals and female MVPA may be explained by other characteristics of the school environment that are conducive to female MVPA.

Keywords: intramurals, school physical activity, team intramurals, individual intramurals, adolescence, youth, students

6.2 Introduction

Moderate-to-vigorous physical activity (MVPA) is positively associated with physical and mental health among youth and is important in healthy development and disease prevention.(8,9) Despite these benefits, only one-third of Canadian youth are meeting the Canadian guidelines of at least 60 minutes of MVPA per day,(19–21) and MVPA tends to decrease in youth as they age.(26,27) Physical inactivity is a major modifiable behavioural risk factor for premature mortality and lost life expectancy,(41–43) and small increases in physical activity can have a positive impact on current health and the future risk of disease.(15) As a leading modifiable risk factor for disease and mortality, interventions targeting physical inactivity should be a public health priority to reduce the population-level health burden in future years.

Youth are an important target for physical activity interventions, because health behaviours (e.g., physical activity, sedentary behaviour and diet) continue to shape and form during this time.(16,22,24,25) As highlighted in the social ecological model, the environment is an important factor influencing health behaviour.(127) Of particular interest is the school-environment because school-level programs, policies and the built environment all interrelate to influence youth physical activity behaviour.(70,139,140) School-based physical activity programs can effectively target physical inactivity,(48,131) especially if these programs are inclusive and accessible to a large proportion of the youth population.(55) Intramurals (e.g., intra-scholastic sports) are played or participated in by students within the same school, and are an example of such inclusive programs, as these activities typically do not involve a fee or a high level of skill to partake in.(68)

Participation in intramurals is positively associated with youth physical activity,(69,70,72,73) however there is limited knowledge on how these programs affect MVPA over

time. Not only is the longitudinal effect of intramurals on youth MVPA not well understood, but there are different types of intramurals, including individual activities (e.g., yoga, running club) and team activities (e.g., soccer, tennis), which may differentially affect youth physical activity. Previous research suggests that individual and team sports have different effects on female and male sport participation, as female youth are more likely to participate in individual sports, while males are more likely to participate in team sports.(85,110) Additionally, participation in team sports is generally associated with more physical activity compared to individual sports,(87,110) highlighting that types of intramurals may have differential effects on physical activity.

There is a paucity of literature available to help inform schools on which intramural options provide an effective impact on improving student physical activity levels. However, in real-world practice, schools continue to add and remove a variety of different intramural programs regardless of the lack of scientific evidence guiding those decisions. This creates a unique opportunity to generate practice-based evidence by evaluating the impact that these ongoing real-world changes to intramurals have on student physical activity within the context of a natural experiment.(102) As such, this research aims to use a natural experimental study design to evaluate how ongoing changes in school-level individual and team intramurals impact female and male youth MVPA over time. The results from this study will provide practice-based evidence that can be used by schools to help inform the offering of intramurals, to ultimately increase participation and physical activity among the youth population.

6.3 Materials and Methods

6.3.1 Study Design

The COMPASS study is a 9-year prospective cohort study (2012–2021) collecting hierarchical and longitudinal data from a convenience sample of secondary school students and

the schools they attend in Alberta, British Columbia, Ontario and Quebec.(109) This study used COMPASS host study data from the 55 Ontario schools that participated in Year 5 (Y5 2016–2017), Year 6 (Y6 2017–2018) and Year 7 (Y7 2018–2019) of the COMPASS study. Schools in Alberta, British Columbia and Quebec were excluded from this study because of differences in provincial physical activity programs and policies. Ontario schools (n = 36) were excluded if they did not participate across all three years. The COMPASS study used active-information, passive-consent parent/guardian permission protocols, and active student assent, where students could refuse to participate at any time. Participating students completed the COMPASS student questionnaire (Cq), which is a paper-based, self-administered, anonymous survey, in class time annually. Senior administration at each participating school completed the School Policies and Practice (SPP) questionnaire online annually. Details on the COMPASS host study, including sampling and the Cq and SPP data collection tools, are available online (www.compass.uwaterloo.ca (accessed on 8 March 2021)). The COMPASS study was approved by the Human Research Ethics Board at the University of Waterloo (ORE 30118) and appropriate school board and school committees.

Only students who were in grade 9 (13–14 years old) and 10 (14–15 years old) at baseline (Y5) with linked data across all three years were included in the study. A total of 5514 students were linked for the three-year study period from the 55 Ontario schools. Main reasons for non-linkage were students transferring schools, students not providing data on grade in Y5 or Y6, students who were absent or had a spare period during the time of Y5 or Y6 data collection, those who left secondary school early, or inaccurate data provided to link measures on the Cq. Details on the methods of COMPASS data linkage are available elsewhere.(126,141) Only

students with: i) complete data on all covariates and ii) complete data or monotone missingness on the outcome were included in the analysis for a final sample size of 4,417 students.

This study utilized a longitudinal quasi-experimental study design, meaning that data on the outcome were measured at pre-intervention (Y5), intervention (Y6) and post-intervention (Y7) time points and were compared between non-randomized intervention and control groups.(102) This design is considered the gold standard research methodology in natural experimental studies, and important school- and student-level covariates were measured and controlled for through stratification and adjustment to mitigate bias due to confounding from lack of randomization.(102)

6.3.2 Measures

6.3.2.1 Outcome

Average daily MVPA was measured for students in Y5, Y6 and Y7 using the Cq. The Cq asks students to record their daily time (hours and/or minutes) spent engaging in hard and moderate physical activity each day for the last 7 days (e.g., Monday-Sunday) by the following two prompts: (1) “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 (2) “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”. The Cq also provides students with descriptions of moderate and vigorous activities to aid with recall. Moderate physical activities are described as “physical activities include lower intensity activities such as walking, biking to school, and recreational swimming”,

and vigorous physical activities are described as “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”. These descriptions align with definitions given by Canadian Society for Exercise Physiology (CSEP) that are used in physical activity research among youth.(2) Average daily MVPA is derived by summing the total time in minutes of moderate physical activity for each day (Monday–Sunday) and the total time in minutes of hard (vigorous) physical activity for each day (Monday–Sunday) and dividing this sum by 7 days. This self-reported measure of MVPA on the Cq has demonstrated satisfactory reliability and validity, making it an acceptable measure of MVPA in research involving school-age youth.(117,142)

6.3.2.2 School-Level Predictor: Type of Intramural Change

Type of intramural change was measured in the Ontario schools by comparing intramural data from year 5 (Y5) to year 6 (Y6). The offering of intramurals is distinctly separate from physical education and varsity sports. School administrators were asked in Y5 and Y6 to “Please select the intramural programs/club activities involving physical activity that were offered to students at your school during the past 12 months.” The intramural program selections include a variety of activities (e.g., soccer, basketball, yoga, running club) and include spaces for unlisted activities. School administrators were also asked to indicate whether the intramural offerings were for females only, males only, or co-ed. The intramurals were classified as team or individual sports based on the classifications found in Appendix C. Changes in team and individual intramurals from Y5 to Y6 were then determined by comparing the number of intramural programs offered between these years. Schools made many changes in team and individual intramurals from Y5 to Y6 (e.g., added and removed programs), and to ensure cell counts were large enough, these changes were categorized into five groups based on the quantity

of types of intramural changes: (1) schools that primarily added individual intramurals from Y5 to Y6, (2) schools that primarily added team intramurals from Y5 to Y6, (3) schools that added the same number of individual and team intramurals from Y5 to Y6, (4) schools that added and removed the same number of individual and team intramurals from Y5 to Y6, and (5) schools that primarily removed team or individuals from Y5 to Y6 (reference). These groups were then coded into the following categories: (1) primarily added team, (2) primarily added individual, (3) added team and individual, (4) no net change and (5) removed intramurals (reference). Schools classified as: (4) no net change, are schools that removed an intramural for every intramural they added (e.g., added one team, removed one team and added on individual and removed one individual).

6.3.3.3 Student-Level Correlates

Student-level sport participation and sociodemographic data that were known to associate with the predictor and/or outcome were measured by the Cq and included in the analyses. Data on intramural sport participation, varsity sport participation and community sport participation were measured at Y5, Y6 and Y7. Intramural sport participation is measured by asking "Do you participate in before-school, noon hour, or after school physical activities organized by your school? (e.g., intramurals, non-competitive clubs)", followed by the response options of "No", "Yes" and "None offered at my school". Varsity sports are competitive sports played between students from different schools and typically involve a higher level of skill compared to intramurals. Varsity sport participation is measured by asking "Do you participate in competitive school sports teams that compete against other schools? (e.g., junior varsity or varsity sports)", followed by the response options of "No", "Yes" and "None offered at my school". Community sports are competitive and non-competitive sports played by students outside of school.

Community sport participation is measured by asking “Do you participate in league or team sports outside of school?”, followed by the response options of “No”, “Yes” and “None offered where I live”. Responses to all sport participation questions were recoded as “No (reference)” and “Yes” to ensure adequate cell counts. Demographic data were measured at baseline using the Cq and for the following variables with the corresponding response options in brackets: gender [female (ref), male], ethnicity [White, Black, Asian, Indigenous (First Nations, Métis, Inuit) Latin American/Hispanic, and Other)] and weekly spending money [0 CAD, 1 CAD to 5 CAD, 6 CAD to 10 CAD, 11 CAD to 20 CAD, 21 CAD to 40 CAD, 41 CAD to 100 CAD, more than 100 CAD, I do not know. Ethnicity and weekly spending money were collapsed into the following categories to ensure adequate cell count: ethnicity [white (ref), other], weekly spending money [Zero (ref), 1–20 CAD, 21–100 CAD and 100+ CAD].

6.3.3.4 School-Level Correlates

School-level covariates that were known to associate with the predictor and/or outcome were measured and included in the analyses. The number of intramural programs and school size are both continuous variables measured at baseline using the SPP. Data on other school-level physical activity programs that may affect MVPA and/or intramural participation were obtained from the SPP and compared between Y5 and Y6 to derive the variable changes in physical activity programs which was categorized as either: “no changes in physical activity programs”, “added physical activity programs” or “removed physical activity programs”. School neighbourhood median income was obtained from the 2016 Canadian Census and are based on the median income of the area surrounding the school at baseline.(118)

6.4 Analyses

All analyses were performed in SAS 9.4. Descriptive analyses were performed on school- (n = 55) and student-level characteristics (n = 4417). Chi-Square was used to examine exploratory differences between female and male students on student-level characteristics at baseline. An empty linear mixed regression model (i.e., intercept-only model) was used estimate the intraclass correlation (ICC) to determine the variability of MVPA between schools. Linear mixed models stratified by gender were used to estimate how changes in team and individual intramurals in Y5 to Y6 were associated with longitudinal MVPA. These models were hierarchical to account for clustering of students within schools and students over time and controlled for relevant student (grade, ethnicity, weekly spending money, intramural sport participation, varsity sport participation, community sport participation) and school (changes in physical activity programs, number of intramurals in Y5, school size, and school neighbourhood median income) factors. A novel modeling approach to program evaluation was employed to create an indicator variable representing the yearly change in type of intramurals: (i) type of intramural change in Y6 and (ii) type of intramural change in Y7. These indicator variables were included in the model and allowed for the assessment of their effect on MVPA at the intervention year (Y6) and post-intervention year (Y7). For Y7, the effect of type of intramural change was assessed under the assumption that changes from Y6 would continue into Y7. This novel modeling method has been utilized in previous research to assess changes in provincial policies on health outcomes,(122) and to assess how changes in the environment affect alcohol use,(123) tobacco and cannabis use (124) over time.

6.5 Results

6.5.1 School-Level Descriptive Statistics

The characteristics of the school-level sample are presented in Table 8. Specific to the change in types of intramurals from Y5 to Y6, 13 schools primarily added individual intramurals, 17 schools primarily added team intramurals, 5 schools added individual and team intramurals, 3 schools made no net change to intramurals and 17 schools removed intramurals. Five schools reported adding physical activity programs from Y5 to Y6 and no schools reported removing programs during this time. The mean school neighbourhood median income was 69,804 CAD (SD = 15,404 CAD) and the mean school size in Y5 was 669 students (SD = 288). Schools offered an average of 5.4 (SD = 4.1) intramural programs in Y5.

Table 8: Descriptive Statistics for School-Level Characteristics for the sample (n=55) from Year 5 and 6 (2016-2017) of the COMPASS Study

Variable		Frequency	%
Changes in Types of Intramurals from Y5 to Y6	Primarily Added Individual	13	23.7
	Primarily Added Team	17	30.9
	Added Individual and Team	5	9.1
	No Change	3	5.5
	Removed Programs (Reference)	17	30.9

Changes in Other Physical Activity Programs from Y5 to Y6	No Change (Ref)	50	90.9
	Added Programs	5	9.1
	Removed Programs	0	0
Variable		Mean	Standard Deviation
School Neighbourhood Median Income in Y5		$69, 804	$15,404 Min: $31,763 Max: $107, 702
School Size In Y5		669	288 Min: 136 Max: 1550
Number of Intramurals Offered in Y5		5.4	4.1 Min: 0 Max: 14

6.5.2 Student-Level Descriptive Statistics

The baseline demographic characteristics of the student-level sample are presented in Table 9 and the time-varying characteristics of the student-level sample are presented in Table 10. The purpose of these descriptive tables is to empirically observe the student-level categorical and continuous variables by presenting the frequency and percent for categorical variables and the mean and standard deviation for continuous variables. As shown in Table 11, 54% (n = 2402) of the sample were female, 73% (n = 3210) were white and $1-$20 was most frequently (43%, n

= 1875) reported amount of weekly spending money. There were significant differences between males and females at baseline on weekly spending money ($p < 0.0001$). Referring to Table 10, intramural participation among female students was 38% in Y5, 36% in Y6 and 33% in Y7 and 39% in Y5, 37% in Y6 and 36% in Y7 among male students. Both female and male students participated in lower average daily MVPA over time, with females reporting 105 min (SD = 66) in Y5, 97 min (SD = 64) in Y6 and 89 min (SD = 61) in Y7 and males reporting an average of 117 min (SD = 68) in Y5, 109 min (SD = 68) in Y6 and 102 min (SD = 65) in Y7.

Table 9: Descriptive Statistics for Baseline Student-Level Characteristics for the sample (n=4417) from Year 5 (2016-2017) of the COMPASS study

Variable		Total n=4417	Female (Ref) n=2402 (54%)	Male n=2015 (46%)			
		Frequency (%)	Frequency %	Frequency %	DF	Chi-Square	P-Value
Grade	Grade 9 (Ref)	2434 (55.1)	1335 (55.6)	1099 (54.5)	1	1.431	0.232
	Grade 10	1983 (44.9)	1067 (44.4)	916 (45.5)			
Ethnicity	White (Ref)	3210 (72.7)	1744 (72.6)	1466 (72.8)	1	0.036	0.849
	Other	1207 (27.3)	658 (27.4)	549 (27.2)			

Weekly Spending Money	Zero (Ref)	1130 (25.6)	541 (22.5)	589 (29.2)	3	107.400	<.0001
	$1-$20	1875 (42.5)	1062 (44.2)	813 (40.3)			
	$21-$100	1065 (24.1)	628 (26.1)	437 (21.7)			
	$100+	347 (7.9)	171 (7.1)	176 (8.7)			

Percent values may not equal 100 due to rounding.

Table 10: Descriptive Statistics for Time-Varying Student-Level Characteristics for the sample (n=4417) from Year 5 (2016-2017), Y6 (2017-2018) and Y7 (2018-2019) of the COMPASS study

Variable		Total n=4417			Female (Ref) n=2402			Male n=2015		
		Year 5	Year 6	Year 7	Year 5	Year 6	Year 7	Year 5	Year 6	Year 7
		Frequency (%)	Frequency (%)	Frequency (%)/)	Frequency (%)/	Frequency (%)/	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)
Intramurals	No (Ref)	2733 (61.9)	2813 (63.7)	2903 (65.7)	1494 (62.2)	1542 (64.2)	1616 (67.3)	1239 (61.5)	1271 (63.1)	1287 (63.9)
	Yes	1684 (38.1)	1604 (36.3)	1514 (34.3)	908 (37.8)	860 (35.8)	786 (32.7)	776 (38.5)	744 (36.9)	728 (36.1)
Varsity	No (Ref)	2568 (58.1)	2529 (57.3)	2688 (60.9)	1464 (60.9)	1447 (60.2)	1558 (64.9)	1104 (54.8)	1082 (53.7)	1130 (56.1)
	Yes	1849 (41.9)	1888 (42.7)	1729 (39.1)	938 (39.1)	955 (39.8)	844 (35.1)	911 (45.2)	933 (46.3)	885 (43.9)
Community	No (Ref)	2109 (47.7)	2394 (54.2)	2781 (63.0)	1218 (50.7)	1377 (57.3)	1599 (66.6)	891 (44.2)	1017 (50.5)	1182 (58.7)
	Yes	2308 (52.3)	2023 (45.8)	1636 (37.0)	1184 (49.3)	1025 (42.7)	803 (33.4)	1124 (55.8)	998 (49.5)	833 (41.3)
Variable		Mean (Standard Deviation)	Mean (Standard Deviation)	Mean (Standard Deviation)	Mean (Standard Deviation)	Mean (Standard Deviation)	Mean (Standard Deviation)	Mean (Standard Deviation)	Mean (Standard Deviation)	Mean (Standard Deviation)
MVPA (min/day)*		110 (67) n=4417	102 (66) n=4414	95 (64) n=4375	105 (66) n=2402	97 (64) n=2400	89 (61) n=2380	117 (68) n=2015	109 (68) n=2014	102 (65) n=1995

MVPA=Moderate-to-Vigorous Physical Activity

*Note that the sample sizes for MVPA in Y6 and Y7 are different compared to baseline as well as Y6 and Y7 of other covariates. This is because some subjects included in the model are missing MVPA data in Y6 and Y7 (i.e., monotone pattern)

6.5.3 Results from Longitudinal Mixed Models

The ICC was calculated to estimate the amount of variation in MVPA that can be attributed to school-level differences for both female and male students. School-level differences accounted for 1.91% of the variability in MVPA among females and 2.09% among males, suggesting modest differences between schools on MVPA. Results from the linear mixed models are presented in Table 11. At baseline, female and male students in grade 10 reported significantly less average daily MVPA minutes compared to students in grade 9 (females: $\widehat{\boldsymbol{\beta}}$ =-8.383, p<0.0001, males: $\widehat{\boldsymbol{\beta}}$ =-7.310, p=0.001). Year was negatively associated with MVPA among females and males, although this relationship was only significant for females (females: $\widehat{\boldsymbol{\beta}}$ =-7.226, p=0.005, males $\widehat{\boldsymbol{\beta}}$ =-1.070, p=0.701). Participation in school and community sports were all positively associated with MVPA for both females and males. More specifically, students participating in intramurals (females: $\widehat{\boldsymbol{\beta}}$ =5.040, p=0.002, males: $\widehat{\boldsymbol{\beta}}$ =9.722, p<0.0001), varsity sports (females: $\widehat{\boldsymbol{\beta}}$ =16.904, p<0.0001, males: $\widehat{\boldsymbol{\beta}}$ =18.045, p<0.0001) and community sports (females: $\widehat{\boldsymbol{\beta}}$ = 26.105, p<0.0001, males: $\widehat{\boldsymbol{\beta}}$ =20.287, p<0.0001) accumulated more daily MVPA on average compared to those who did not participate.

After controlling for intramural participation, adding individual and team intramurals was positively and significantly associated with female MVPA in Y6. In schools that added individual and team intramurals (n=5), female students accumulated an average of 9.577 daily minutes of MVPA (p=0.034) compared to female students attending schools that removed individual and team intramurals. The most frequent individual intramurals added among these 5 schools were rock climbing (n=3), weight training (n=2), yoga (n=2) and outdoor club (n=2). The most common team intramurals added among these 5 schools were dodgeball (n=3), volleyball (n=2) and soccer (n=2). Primarily adding individual intramurals, primarily adding

team intramurals, and no change in intramurals were all positively, but non-significantly associated with female MVPA in Y6. If these intramural changes in Y6 were maintained in Y7, primarily adding individual intramurals, primarily adding team intramurals and adding both individual and team intramurals were estimated to be positively, but non-significantly associated with MVPA in Y7. If schools that made no changes to individual and team intramurals in Y6 maintained this in Y7, it was estimated to have a negative, but non-significant effect on female MVPA.

Primarily adding individual and primarily adding team intramurals were both negatively, but non-significantly associated with male MVPA in Y6, after controlling for intramural participation. Adding individual and team intramurals and making no changes to intramurals were both positively and non-significantly associated with male MVPA in Y6, regardless of intramural participation. If these changes were to be maintained into Y7, primarily adding individual intramurals was estimated to be negatively and non-significantly associated with male MVPA, while primarily adding team intramurals, adding individual and team intramurals and making no changes to individual and team intramurals were all estimated to be positively, but non-significantly associated with male MVPA in Y7, independent of intramural participation.

Table 11: Linear Mixed Models examining the association between changes in intramural programming in Y6 on MVPA in Y6 and Y7 of the COMPASS Study stratified by gender

Variable	Female n=2402			Male n=2015		
	Estimate	95% CI	p-value	Estimate	95% CI	p-value

Effect of Type of Intramural Change on MVPA in Y6	Removed Intramurals (Reference)	—		—	—	—	—
	Primarily Added Individual	5.545	-1.054 - 12.144	0.100	-2.238	-9.884- 5.407	0.566
	Primarily Added Team	2.929	-3.054 - 8.912	0.337	-3.172	-10.048 -3.704	0.366
	Added Individual and Team	9.577	0.726- 18.429	**0.034**	1.539	-8.320- 11.397	0.760
	No Net Change	2.272	-4.010 - 8.553	0.478	5.149	-1.784 - 12.082	0.145
Effect of Type of Intramural Change on MVPA in Y7	Removed Intramurals (Reference)	—	—	—	—	—	—
	Primarily Added Individual	1.169	-5.469 - 7.807	0.730	-2.962	-10.603 -4.680	0.448
	Primarily Added Team	4.874	-1.125 - 10.873	0.111	0.241	-6.650 - 7.132	0.945
	Added Individual and Team	1.527	-7.369- 10.423	0.737	1.300	-8.667- 11.267	0.798
	No Net Change	-1.441	- 11.989- 9.107	0.789	8.782	-2.793- 20.357	0.137

Grade	Grade 9 (Ref)	—	—	—	—	—	—
	Grade 10	-8.383	-12.086 - -4.681	**<.0001**	-7.310	-11.434 - -3.186	**0.001**
Year		-7.226	-12.207--2.246	**0.005**	-1.070	-6.527-4.388	0.701
Intramural Sport Participation	No (Ref)	—	—	—	—	—	—
	Yes	5.040	1.806 - 8.274	**0.002**	9.722	6.044-13.401	**<.0001**
Varsity Sport Participation	No (Ref)	—	—	—	—	—	—
	Yes	16.094	12.400-19.747	**<.0001**	18.045	13.944-22.147	**<.0001**
Community Sport Participation	No (Ref)	—	—	—	—	—	—
	Yes	26.105	22.804-29.405	**<.0001**	20.287	16.496-24.078	**<.0001**

Models controlled for changes in physical activity programs in Y6, median school neighbourhood income in Y5, school enrolment in Y5, number of intramurals in Y5, ethnicity and weekly spending money. Values significant at $\alpha = 0.05$ are bolded.

6.6 Discussion

Using a large linked sample of longitudinal data, we believe that this was the first study to evaluate how changes in the type of intramurals were associated with youth MVPA over time. We explored this association using an innovative new methodology that allowed us to examine

how the effect of changes in type of intramurals affected MVPA in Y6 and into Y7 under the supposition these changes were maintained from Y6. Our results suggest that youth MVPA declines over time and adding team and individual intramurals positively impacts female MVPA in the year they were added, regardless of participation. Although other changes in type of intramurals did not provide a significant protective effect on this decline over time, these results nonetheless contribute to our understanding of how real-world changes in intramurals affect MVPA over time.

At baseline, youth in this sample achieved an average of 110 daily minutes of MVPA per day, which declined over time to 102 minutes in Y6 and 95 minutes in Y7. Additionally, female and male youth in grade 10 at baseline achieved significantly less daily average minutes of MVPA compared to youth in grade 9 at baseline. These findings are supported by other research, as younger youth typically accumulate significantly more daily MVPA minutes compared to older youth,(19,20) and MVPA tends to decrease from grade 9 to grade 10 (128) and throughout high school.(129) MVPA declined over time for both male and female students, although the decline was only significant among female students. Decreases in youth physical activity over time have been well-documented (26–32) and may be attributed to decreases in sport participation,(32,33) reduced physical education,(67,143) and increased screen time and sedentary behaviour,(24,26–28) that are typical among youth during this time. Decreased sport participation in youth over time may be explained by many intrapersonal factors such as lack of enjoyment and lack of time.(137,144) Additionally, female youth generally have a larger decline in physical activity over time compared to males,(35,36) which may explain why this relationship was only significant among females.

Intramural, varsity and community sport participation were all positively associated with MVPA among female and male youth. These findings are supported by previous research which suggests that intramural, varsity and community sport participation are all positively associated with youth MVPA.(70,72,73,77,96,97) Participation in community sports provided youth with more MVPA compared to intramural and varsity sports, which may be explained by the higher demand of community sports which typically includes frequent training and practice sessions in addition to competition.(145) It is important to note that intramurals and varsity are important opportunities for youth physical activity, especially for students who do not participate in community sports.(146) Additionally, community sports are less-inclusive than school-based intramural and varsity sports because they require transportation and are typically more time-consuming and more expensive compared to school-based sports.(68) Although community sports provided the most physical activity, all types of sport participation provided youth with daily MVPA, helping them achieve the recommended 60 minutes per day and providing other benefits associated with physical activity such as improved academic performance (13,14) and improved mental health.(8,9)

The indictor variables included in the linear mixed models allowed for us to examine the associations between type of intramural change and MVPA in Y6 and Y7. After controlling for intramural participation, adding individual and team intramurals positively impacted female MVPA in the year they were implemented, but not if these changes were continued into Y7. This suggests adding individual and team intramurals is effective in the immediate year for females, but not over time, regardless of whether students participated in these intramurals or not. To keep youth involved over time, schools should consider ongoing engagement and in-school promotion of intramurals. This is not the first study to highlight that school-level intramurals indirectly and

positively impact student MVPA. Other research has found that regardless of intramural participation, adolescents attending high schools with more intramurals engaged in more physical activity compared to those attending schools with less intramurals.(69) Perhaps schools that implemented team and individual intramurals have other characteristics of the school environment that positively associate with MVPA, especially among females. For example, these schools may provide students with access to equipment and facilities that support participation in non-competitive (e.g., aerobics, weight classes, yoga) and nonorganized physical activity (e.g., walking, running, rock climbing), both of which positively associate with physical activity among females in early high school.(147) Female students may have the opportunity to participate in these activities outside of intramurals if schools have implemented physical activity policies such as providing open access to equipment and facilities before-school, after-school and during lunch. Although the effect of the school environment on youth MVPA over time was not examined in this study, future research should explore how policies and facilities associate with youth MVPA especially among females, considering they consistently achieve less MVPA compared to their male counterparts.

The lack of other significant findings suggests that changes in types of intramurals are not associated with MVPA over time. Multifaceted physical activity programs are most effective at increasing physical activity among youth, so perhaps intramurals, though not effective on their own, they may be effective as part of a more comprehensive physical activity programs that include changes to school-level curriculum, policy and environment.(130,131) Although changes in types of intramurals were not associated with MVPA it is important highlight that these changes may impact other beneficial outcomes students may receive from intramural participation. These include improved mental health,(8,9) improved academic performance,

(13,14) reduced substance use (82) and more sport sampling.(31,74–80) Considering the multitude of benefits associated with youth intramural participation, future research should examine the effect of type of intramurals on intramural participation among youth.

Finally, it is important to note that intramurals are offered as into female-only, male-only and co-ed, which impact intramural participation and MVPA. For example, gender offering of intramurals appears to be especially important for female students, as females attending schools that offered female-only intramurals were more likely to participate in intramurals compared to those attending schools without such programs.(94) Additionally, female-only intramurals may generate higher levels of physical activity among females compared to co-ed programs.(69,70,72,73) The gender-offering of intramurals was beyond the scope of this study, however a direction for future research could be to examine how gender-offering of intramurals is associated with intramural participation and MVPA over time.

6.6.1 Limitations

Firstly, schools were recruited using convenience sampling, which may limit the generalizability of the results. However, the COMPASS study has a large sample size and utilizes as active-information, passive-consent protocol to encourage participation and honest response.(113) This recruitment method has been shown to limit self-selection and response biases and generate more robust results.(109) Secondly, we did not examine how changes in gender-offering (e.g., female-only, male-only and co-ed) in our analysis. The gender-offering of intramural programs should be considered, as this may affect participation and physical activity, especially among females. Thirdly, because schools make many changes to the types of intramurals each year, the intervention groups may have been diluted (e.g., primarily added team, versus added team only), making the association between these changes and MVPA difficult to

detect. Lastly, it is possible that this study was under-powered at the school-level to detect associations between changes in types of intramural programs and MVPA over time.

6.7 Conclusion

This study found that females attending schools that added individual and team intramurals achieved significantly more average MVPA per day the year intramurals were added, compared to females attending schools that removed programs, regardless of intramural participation. This suggests that there are school-level characteristics that are positively associated with female physical activity beyond intramurals, such as access to physical activity facilities or equipment. Although other associations between changes in types of intramurals and MVPA were not significant, intramurals can be an important aspect of comprehensive school-based physical activity strategies. Intramurals and varsity sport participation were all positively associated with youth physical activity and schools should consider offering a variety of intramural and varsity sports to maximize participation and physical activity among students. Sport participation in youth is positively associated with physical activity later in life,(31,77,78) therefore school-based sports present an important investment in youth health that should be a priority for stakeholders.

Chapter 7.0 Study 3

Examining if changes in gender-specific and co-ed intramural programs affect youth physical activity over time: a natural experiment evaluation using school- and student-level data from the COMPASS Study

Status: This study is under review in *BMC Public Health*.

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7.1 Abstract

Introduction: Despite the benefits of physical activity, the majority of Canadian youth are falling short of the recommended 60 minutes of moderate-to-vigorous physical activity (MVPA) per day. School-based physical activity programs such as intramurals, are important opportunities for youth to be physically active. There is limited evidence available on the impact of gender-specific (e.g., female-only, male-only) and co-ed intramurals on youth physical activity over time, however evidence suggests female-only intramurals may be important for female MVPA. This research aims to capitalize on a natural experiment to generate practice-based evidence on the impact of changes in gender-specific and co-ed intramurals on youth MVPA over time.

Methods: This This study used linked longitudinal school- and student-level data from Ontario secondary schools in year 5 (2016-2017), year 6 (2017-2018) and year 7 (2018-2019) of the COMPASS study. Data on intramurals from 55 schools were used to determine the changes to gender-specific and co-ed intramurals that occurred from Y5 to Y6. Baseline demographic characteristics were measured and data on physical activity and sport participation were collected in Y5, Y6 and Y7 on a sample of 4417 students. Hierarchical linear mixed regression models were used to estimate how changes in gender-specific and co-ed intramurals were associated with youth MVPA over time.

Results: Participation in intramural, varsity and community sport were all positively and significantly associated with youth MVPA. Changes in gender-specific and co-ed intramurals were not significantly associated with youth MVPA in Y6 or Y7. However, the positive association between maintaining the addition of gender-specific intramurals on female MVPA in Y7 was on par with the significance level of $\alpha = 0.05$, suggesting that adding gender-specific intramurals may be important for female MVPA.

Conclusions: Adding gender-specific and co-ed intramurals may not be sufficient strategies to increase physical activity among youth. Further research should explore the effect of gender-specific intramurals on youth physical activity, as this study may have been underpowered at the school-level. Gender-specific intramurals may promote a supportive physical activity environment that promotes physical activity, especially among females. These intramurals may be an important component of more comprehensive strategies to increase youth MVPA.

Keywords: Intramurals, co-ed, gender-specific, physical activity, youth, natural experiment

7.2 Introduction

Moderate-to-vigorous physical activity (MVPA) is important for physical and mental health among youth and is critical for healthy development and disease prevention.(8,9) Despite the multitude of benefits, approximately two thirds of Canadian youth are falling short of the recommended 60 minutes of MVPA per day.(19–21) Youth physical activity also tends to decrease with age, (26,27) with large declines observed during secondary school when sedentary behaviours typically increase (24,26–28) and the participation in physical education (67,143) and sports (32,33) typically decreases. These trends in youth physical activity are alarming because physical inactivity is a leading modifiable risk factor for premature death.(41–43) Youth are an important target population for physical activity interventions because health behaviours, such as physical activity, continue to develop during this time.(16,22,24,25) Modest increases in physical activity can have a positive impact on health and risk of disease,(15) and school-level physical activity interventions can encourage these modest increases and effectively target physical inactivity among youth. (70,139,140)

School-based physical activity programs are effective strategies to increase physical activity among youth,(48,131) especially when these programs are perceived as inclusive and accessible by students.(55) Intramurals are examples of such inclusive and accessible programs, as they generally do not require a high-level of skill or a fee to participate in, especially compared to other school-based programs (e.g., varsity sports).(68) The positive association between participation in intramurals and physical activity among youth has been well-documented, (69,70,72,73) and their impact on youth MVPA over time has been previously explored (133,148) Specifically, previous studies have explored how real-world changes in intramurals affect youth MVPA over time, and although general changes in intramurals were not

associated with youth MVPA over time, (148) adding a combination of individual (e.g., running) and team (e.g., soccer) intramurals was positively associated with female MVPA.(133) Our earlier evidence suggested that adding a variety of intramurals had a positive effect on female MVPA regardless of intramural participation, highlighting the positive and indirect relationship between changes in intramurals and MVPA.(133) In addition to individual and team intramurals, intramurals are further categorized by gender-specific (e.g., female-only, male-only) and co-ed, which may have differential effects on the physical activity of female and male youth. Limited research has been done to examine how gender-specific and co-ed intramurals associate with physical activity; however, previous research suggests that gender-specific intramurals may be an important factor for intramural participation, particularly among female students. For example, a previous study found that female students attending schools with female-only intramurals were more likely to participate in intramurals compared to females attending schools without these female-only intramurals, and no such association was observed for males.(94) Female youth consistently achieve less physical activity compared to their male counterparts,(19–21) suggesting that gender-specific sports may be an important opportunity for female physical activity.

There is limited research available on the impact of gender-specific and co-ed intramurals on youth MVPA over time. Given the previous positive relationship observed between adding individual and team intramurals and female MVPA,(133) a practical next step would be to examine how gender-specific and co-ed intramurals affect youth MVPA. Schools continue to make changes to these intramurals each year, creating the opportunity to evaluate a natural experiment and generate practice-based evidence.(107) The objective of this study is to use a

natural experimental study design to evaluate how changes in school-based gender-specific and co-ed intramurals are associated with female and male youth MVPA over time.

7.3 Materials and Methods

7.3.1 Study Design

The COMPASS study is a 9-year prospective cohort study (2012-2021) collecting hierarchical and longitudinal data from a convenience sample of secondary school students and the schools they attend in Alberta, British Columbia, Ontario and Quebec.(109) This study utilized COMPASS host study data from 55 Ontario schools that participated in Year 5 (Y5 2016-2017), Year 6 (Y6 2017-2018) and Year 7 (Y7 2018-2019) of the COMPASS study. Schools in other provinces were excluded from this study because of small sample sizes at baseline (Y5) and provincial differences in physical activity programs and policies. Ontario schools (n=36) were excluded if they did not participate across all three years. The COMPASS study used active-information, passive-consent parent/guardian permission protocols, and active student assent, where students could refuse to participate at any time. Participating students completed the COMPASS student questionnaire (Cq), which is a paper-based, self-administered, anonymous survey administered annually during class time. Each year, senior administration at each participating school completed the School Policies and Practice (SPP) questionnaire online. Details on the COMPASS host study, including sampling and the Cq and SPP data collection tools, are available online (www.compass.uwaterloo.ca). The COMPASS study was approved by the Human Research Ethics Board at the University of Waterloo (ORE 30118) and appropriate school board and school committees.

This study builds on our previous research examining intramural changes and youth MVPA.(148,149) Students who were in grade 9 (13-14 years old) and 10 (14-15 years old) at the

baseline time point for this study (Y5) with linked data across all three years were included in the study. A total of 5,514 students from the 55 Ontario schools were linked over the three-year study period. Main reasons for non-linkage were students transferring schools, students not providing data on grade in Y5 or Y6, students who were absent or had a spare period during the time of Y5 or Y6 data collection, those who left secondary school early, or inaccurate data provided to link measures on the Cq. Details on the methods of COMPASS data linkage are available elsewhere.(126,141) Only students with: i) complete data on all covariates and ii) complete data or monotone missingness on the outcome were included in the analysis for a final sample size of 4,417 students.

This study used a longitudinal quasi-experimental study design, where data on the outcome were measured at pre-intervention (Y5), intervention (Y6) and post-intervention (Y7) time points and were compared between non-randomized intervention and control groups.(107) In natural experimental studies, this design is considered the gold standard research methodology, and important school- and student-level covariates were measured and controlled for through stratification and adjustment to mitigate bias due to confounding from lack of randomization.(107)

7.3.2 Measures

7.3.2.1 Outcome

The Cq was used to measure average daily MVPA for students in Y5, Y6 and Y7. The Cq asks students to record their daily time (hours and/or minutes) spent engaging in hard and moderate physical activity each day for the last 7 days (e.g., Monday-Sunday) by the following two prompts: (1) “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 (2) "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". To aid with recall, the Cq provides students with descriptions of moderate and vigorous activities. Moderate physical activities are described as "lower intensity activities such as walking, biking to school, and recreational swimming", and vigorous physical activities are described as "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". These descriptions align with CSEP definitions that are used in physical activity research among youth.(4) Average daily MVPA is derived by summing the total time in minutes of moderate physical activity for each day (Monday-Sunday) and the total time in minutes of hard (vigorous) physical activity for each day (Monday-Sunday) and dividing this sum by 7 days. This self-reported measure of MVPA on the Cq has demonstrated satisfactory reliability and validity, making it an acceptable measure of MVPA in school-based research.(117,142)

7.3.2.2 School-Level Predictor: Changes in Gender-Specific and Co-ed Intramurals

In line with our previous research,(148,149) changes in gender-specific and co-ed intramurals were measured in the Ontario schools by comparing intramural data from year 5 (Y5) to year 6 (Y6). School administrators were asked in Y5 and Y6 to "Please select the intramural programs/club activities involving physical activity that were offered to students at your school during the past 12 months." The intramural selections include a variety of activities (e.g., fitness club, rock climbing, soccer, baseball) and include spaces for unlisted activities. School administrators were also asked to indicate whether the intramural offerings were for

females only, males only, or co-ed. Changes in gender-specific and co-ed intramurals from Y5 to Y6 were then determined by comparing intramural data between these years. Schools made many changes to intramurals from Y5 to Y6, and these changes were classified into one of the following four groups based on the quantity of gender-specific and co-ed intramurals: (1) schools that primarily added co-ed intramurals from Y5 to Y6, (2) schools that added gender specific intramurals from Y5 to Y6, (3) schools that added and removed the same number of female-only, male-only or co-ed intramurals from Y5 to Y6, and (4) schools that primarily removed female-only, male-only or co-ed intramurals from Y5 to Y6 (reference). These groups were coded and simplified into the following four categories: (1) primarily added co-ed, (2) added gender-specific, (3) no net change, and (4) removed intramurals (reference). Schools classified as: (2) added gender-specific, are schools that either: (i) added the same number of male- and female-only intramurals from Y5 to Y6, (ii) schools that primarily added female-only intramurals from Y5 to Y6, or (iii) schools that primarily added male-only intramurals from Y5 to Y6. Schools classified as: (3) no net change, are schools that removed a gender-specific or co-ed intramural for every one they added (e.g., added one co-ed, removed one co-ed).

7.3.2.3 Student-Level Correlates

Consistent with our previous research,(148,149) data on student-level sport participation and sociodemographic factors that were known to associate with the predictor and/or outcome were measured by the Cq and included in the analyses. Intramural sport participation, varsity sport participation and community sport participation were measured at Y5, Y6 and Y7. *Intramural sport participation* is measured by asking “Do you participate in before-school, noon hour, or after school physical activities organized by your school? (e.g., intramurals, non-competitive clubs)”, with the response options of “No” (Reference) and “Yes”. *Varsity sport*

participation is measured by asking "Do you participate in competitive school sports teams that compete against other schools? (e.g., junior varsity or varsity sports)", with the response options of "No" (Reference) and "Yes". *Community sport participation* is measured by asking "Do you participate in league or team sports outside of school?", followed by the response options of "No" (Reference) and "Yes". Demographic data were measured at baseline using the Cq and for the following variables with the corresponding response options in brackets: *gender* [female (ref), male], *ethnicity* [White, Black, Asian, Indigenous (First Nations, Métis, Inuit) Latin American/Hispanic, and Other)] and *weekly spending money* [$0, $1 to $5, $6 to $10, $11 to $20, $21 to $40, $41 to $100, more than $100, I do not know]. *Ethnicity* and *weekly spending money* were collapsed into the following categories to ensure adequate cell count: *ethnicity* [white (ref), other], *weekly spending money* [Zero (ref), $1-$20, $21-$100 and $100+].

7.3.3.4 School-Level Correlates

Important school-level correlates associated with the predictor and/or outcome were measured and included in the analyses.(148,149) The *number of intramural programs in Y5* and *school size* are both continuous variables measured at baseline using the SPP. Data on other school-based physical activity programs that may affect student MVPA and/or intramural participation were obtained from the SPP and compared between Y5 and Y6 to derive the variable *changes in physical activity programs from Y5 to Y6* which were categorized as either: "no change in physical activity programs", "added physical activity programs" or "removed physical activity programs". *School neighbourhood median income* was obtained from the 2016 Canadian Census and are based on the median income of the area surrounding the school at baseline.(118)

7.3.3 Analyses

The analytical methods employed in this research are consistent with our previous studies that examined how changes in intramurals associate with youth MVPA over time.(148,149) All analyses were performed in SAS 9.4. Descriptive analyses were conducted on school- (N=55) and student-level characteristics (N=4417). Summary statistics of individual variables were reported by frequency and percentage for class/categorical variables, while means and standard deviation were used for continuous/discrete variables. Exploratory differences between female and male students on student-level characteristics at baseline were examined using Chi-Square. The unconditional means model (i.e., linear mixed model with only a random intercept and not predictors) stratified by gender was used estimate the intraclass correlation (ICC) to determine the within-school variation in MVPA. Linear mixed models stratified by gender were used to estimate how changes in gender-specific and co-ed intramurals in Y5 to Y6 were associated with MVPA over time. These models were hierarchical to account for clustering of students within schools and students over time and controlled for relevant student (grade, ethnicity, weekly spending money, intramural sport participation, varsity sport participation, community sport participation) and school (changes in physical activity programs, number of intramurals in Y5, school size, and school neighbourhood median income) factors. Two indicator variables were created to represent the yearly change in gender-specific and co-ed intramurals: (i) gender-specific and co-ed intramural change in Y6 and (ii) gender-specific and co-ed intramural change in Y7. These indicator variables were included in the models and allowed for the assessment of their effect on MVPA at the intervention year (Y6) and post-intervention year (Y7). For Y7, the effect of changes in gender-specific and co-ed intramurals was assessed under the assumption that changes from Y6 would continue into Y7.

7.4 Results

7.4.1 School-Level Descriptive Characteristics

Statistics describing the characteristics of the school-level sample are presented in Table 12. Specific to the changes in gender-specific and co-ed intramurals from Y5 to Y6, 27 schools primarily added co-ed intramurals, 8 added gender-specific intramurals, 3 schools made no net change to intramurals, and 17 school removed intramurals. Five schools added physical activity programs from Y5 to Y6. In Y5, the school neighbourhood median income was $69,804 (SD=$15,404) and the mean school size was 669 students (SD=288) in Y5. An average of 5.4 (SD=4.1) intramural programs were offered at the schools in Y5.

Table 12: Descriptive Statistics for School-Level Characteristics for the sample (n=55) from Year 5 and 6 (2016-2017) of the COMPASS Study

Variable		Freq	%
Changes in Types of Intramurals from Y5 to Y6	Primarily Added Co-ed Intramurals	27	49.1
	Added Gender-Specific Intramurals	8	14.6
	No Net Change in Intramurals	3	5.5
	Removed Intramurals (Reference)	17	30.9
Changes in Other Physical Activity Programs from Y5 to Y6	No Change (Ref)	50	90.9
	Added Programs	5	9.1
	Removed Programs	0	0
Variable		Mean	SD
School Neighbourhood Median Income in Y5		$69, 804	$15,404 Min: $31,763

		Max: $107, 702
School Size In Y5	669	288 Min: 136 Max: 1550
Number of Intramurals Offered in Y5	5.4	4.1 Min: 0 Max: 14

Percent values may not sum to 100 due to rounding.

7.4.2 Student-Level Descriptive Characteristics

Baseline and time-varying characteristics of the students included in the sample are presented in Table 13 and 14 respectively. The majority of the sample were female (54%, n=2402) and white (73%, n=3210), and the most frequent amount of weekly spending money reported by students was $1-$20 (43%, n=1875). Intramural participation (females: Y5: 38%, Y6:36% Y7:33%; males: Y5:39%, Y6:37%, Y7:36%) and average daily MVPA (females: Y5:105 min (SD=66), Y6:97 min (SD=64), Y7:89 min (SD=61); males: Y5:117 min (SD=68), Y6:109 min (SD=68), Y7:102 minutes (SD=65)) decreased among female and male students over the study period.

Table 13: Descriptive Statistics for Baseline Student-Level Characteristics for the sample (n=4417) from Year 5 (2016-2017) of the COMPASS study

Variable		Total n=4417	Female (Ref) n=2402 (54%)	Male n=2015 (46%)			
		Freq (%)	Freq (%)	Freq (%)	DF	Chi-Square	P-Value
Grade	Grade 9 (Ref)	2434 (55.1)	1335 (55.6)	1099 (54.5)	1	1.431	0.232
	Grade 10	1983 (44.9)	1067 (44.4)	916 (45.5)			
Ethnicity	White (Ref)	3210 (72.7)	1744 (72.6)	1466 (72.8)	1	0.036	0.849
	Other	1207 (27.3)	658 (27.4)	549 (27.2)			
Weekly Spending Money	Zero (Ref)	1130 (25.6)	541 (22.5)	589 (29.2)	3	107.400	<.0001
	$1-$20	1875 (42.5)	1062 (44.2)	813 (40.3)			
	$21-$100	1065 (24.1)	628 (26.1)	437 (21.7)			
	$100+	347 (7.9)	171 (7.1)	176 (8.7)			

Percent values may not sum to 100 due to rounding.

Table 14: Descriptive Statistics for Time-Varying Student-Level Characteristics for the sample (n=4417) from Year 5 (2016-2017), Y6 (2017-2018) and Y7 (2018-2019) of the COMPASS study

Variable		Total n=4417			Female (Ref) n=2402			Male n=2015		
		Year 5	Year 6	Year 7	Year 5	Year 6	Year 7	Year 5	Year 6	Year 7
		Freq (%)/Mean (SD)	Freq (%)/Mean (SD)	Freq (%)/Mean (SD)	Freq (%)/Mean (SD)	Freq (%)/Mean (SD)	Freq (%)/Mean (SD)	Freq (%)/Mean (SD)	Freq (%)/Mean (SD)	Freq (%)/Mean (SD)
Intramurals	No (Ref)	2733 (61.9)	2813 (63.7)	2903 (65.7)	1494 (62.2)	1542 (64.2)	1616 (67.3)	1239 (61.5)	1271 (63.1)	1287 (63.9)
	Yes	1684 (38.1)	1604 (36.3)	1514 (34.3)	908 (37.8)	860 (35.8)	786 (32.7)	776 (38.5)	744 (36.9)	728 (36.1)
Varsity	No (Ref)	2568 (58.1)	2529 (57.3)	2688 (60.9)	1464 (60.9)	1447 (60.2)	1558 (64.9)	1104 (54.8)	1082 (53.7)	1130 (56.1)
	Yes	1849 (41.9)	1888 (42.7)	1729 (39.1)	938 (39.1)	955 (39.8)	844 (35.1)	911 (45.2)	933 (46.3)	885 (43.9)
Community	No (Ref)	2109 (47.7)	2394 (54.2)	2781 (63.0)	1218 (50.7)	1377 (57.3)	1599 (66.6)	891 (44.2)	1017 (50.5)	1182 (58.7)
	Yes	2308 (52.3)	2023 (45.8)	1636 (37.0)	1184 (49.3)	1025 (42.7)	803 (33.4)	1124 (55.8)	998 (49.5)	833 (41.3)

Variable	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
MVPA (min/day)*	110 (67) n=4417	102 (66) n=4414	95 (64) n=4375	105 (66) n=2402	97 (64) n=2400	89 (61) n=2380	117 (68) n=2015	109 (68) n=2014	102 (65) n=1995

*Note that the sample sizes for MVPA in Y6 and Y7 are different compared to baseline as well as Y6 and Y7 of other covariates. This is because some subjects included in the model are missing MVPA data in Y6 and Y7 (i.e., monotone pattern).

7.4.3 Results from Linear Mixed Models

The ICC was used to estimate the variability in MVPA among female and male students that were attributed to between-school differences. Between-school differences accounted for 1.91% of the variability in female MVPA and 2.09% in male MVPA, which suggests that the characteristics of the school a female or male student attends, are modestly associated with their MVPA. Results from the linear mixed models are presented in Table 15. Female and male students in grade 10 at baseline accumulated significantly less average MVPA minutes per day compared to those in grade 9 (females: $\hat{\beta}$ =-8.428, p<0.0001, males: $\hat{\beta}$ =-7.298, p=0.001). MVPA decreased over time for both females and males, although this was only significant for female students (females: $\hat{\beta} = -7.253$, p=0.004, males $\hat{\beta}$ =-1.100, p=0.692). Sport participation was positively associated with female and male MVPA, as students participating in school-based intramurals (female: $\hat{\beta}$ =4.998, p=0.003, male: $\hat{\beta}$ =9.728, p<0.0001), school-based varsity sports (female: $\hat{\beta}$ =16.161, p<0.0001, male: $\hat{\beta}$ =18.003, p<0.0001) and community sports (female: $\hat{\beta}$ = 26.084, p<0.0001, male: $\hat{\beta}$ =20.310, p<0.0001) achieved significantly more average MVPA minutes per day, all compared to those who reported no participation.

The associations between changes in gender-specific and co-ed intramurals and MVPA were non-significant for both female and male youth, regardless of whether students reported participating in these programs. Specifically, primarily adding co-ed intramurals, adding gender-specific intramurals and making no net changes to intramurals in Y6 were all positively, but non-significantly associated with female MVPA in Y6. If these changes were to continue into Y7, primarily adding co-ed intramurals and gender-specific intramurals were both positively, but non-significantly associated with female MVPA one year later, into Y7. This significance of the association between maintaining the addition of gender-specific intramurals on female MVPA in

Y7 was on par with significance level of $\alpha = 0.05$; and hence was inconclusive. If schools that added gender-specific intramurals in Y6 maintained these changes into Y7, female students accumulated an average of 7.507 more daily minutes of MVPA compared to female students attending schools that removed intramurals. Lastly, if schools maintained no net changes from Y6 into Y7, this was negatively and non-significantly associated with female MVPA in Y7.

Primarily adding co-ed intramurals and gender specific intramurals in Y6 was negatively and non-significantly associated with male MVPA in Y6. If these changes were to continue into Y7, primarily adding co-ed intramurals was positively but non-significantly associated with male MVPA into Y7, while adding gender-specific intramurals was negatively and non-significantly associated with male MVPA in Y7. No net changes in intramurals in Y6 was positively and non-significantly associated with male MVPA in Y6. If these changes were maintained in Y7, the direction of this association was consistent, as no net changes was positively and non-significantly associated with male MVPA in Y7 as well.

Table 15: Linear Mixed Models examining the association between changes in intramural programming in Y6 on MVPA in Y6 and Y7 of the COMPASS Study stratified by gender

Variable		Female n=2402			Male n=2015		
		Estimate	95% CI	p-value	Estimate	95% CI	p-value
Effect of Intramural Change on MVPA in Y6	Removed Intramurals (Reference)	—		—	—	—	—
	Primarily Added Co-ed Intramurals	4.695	-0.699-10.089	0.088	-1.163	-7.32-4.998	0.711
	Added Gender-Specific Intramurals	5.098	-2.382-12.578	0.182	-4.703	-13.194-3.787	0.278
	No Net Change in Intramurals	2.236	-4.060-8.534	0.486	5.148	-1.780-12.075	0.145
Effect of Intramural Change on MVPA in Y7	Removed Intramurals (Reference)	—	—	—	—	—	—
	Primarily Added Co-ed Intramurals	1.749	-3.66-7.159	0.526	0.411	-5.764-6.587	0.896
	Added Gender-Specific Intramurals	7.507	-0.0126-15.027	0.050	-3.764	-12.276-4.748	0.692
	No Net Change in Intramurals	-1.502	-12.079-9.075	0.781	8.747	-2.818-20.312	0.138

Grade	Grade 9 (Ref)	—	—	—	—	—	—
	Grade 10	-8.428	-12.131--4.724	**<.0001**	-7.298	-11.421--3.175	**<.0001**
Year		-7.253	-12.391--2.348	**0.004**	-1.100	-6.554-4.353	0.692
Intramural Sport Participation	No (Ref)	—	—	—	—	—	—
	Yes	4.998	1.7647-8.2318	**0.003**	9.728	6.051-13.406	**<.0001**
Varsity Sport Participation	No (Ref)	—		—			—
	Yes	16.161	12.506-19.815	**<.0001**	18.003	13.902-22.104	**<.0001**
Community Sport Participation	No (Ref)	—		—			—
	Yes	26.084	22.784-29.384	**<.0001**	20.310	16.520-24.101	**<.0001**

Models controlled for changes in physical activity programs in Y6, median school neighbourhood income in Y5, school enrolment in Y5, number of intramurals in Y5, ethnicity and weekly spending money. Values significant at $\alpha = 0.05$ are bolded.

7.5 Discussion

To our knowledge, this was the first study to evaluate how changes in gender-specific and co-ed intramurals were associated with MVPA over time. This study builds on previous research (133,148) using COMPASS data which found that although general changes to intramurals were unrelated to youth MVPA, adding a combination of individual and team intramurals had a positive impact on female MVPA. Considering that intramurals are also divided into gender-specific and co-ed intramurals, exploring the association between these specific intramurals and MVPA among youth was a logical progression of this previous research. This association was examined using a large, linked longitudinal school- and student-level dataset, and employed an innovative methodology that allowed for the examination of the effect of changes in gender-specific and co-ed intramurals on MVPA in Y6 and into Y7, under the assumption that these changes were continued from Y6. The results of this study suggest that youth MVPA generally decreases over time, and although no statistically significant associations were observed, the effect of gender-specific intramurals on female MVPA may be important, and should be further explored. Future research should explore the associations between gender-specific intramurals and youth MVPA over time using a larger school sample to ensure adequate power at the school-level.

As expected (19,20,128,129) average daily MVPA decreased among female and male students over time, and female and male students in grade 10 at baseline achieved significantly less daily MVPA minutes per day compared to youth in grade 9 at baseline. The decreasing trends in MVPA over time among youth may be attributed to many social, behavioural and environmental factors typically observed during this time which may include perceived lack of time,(137) decreases in sport participation, (32,33) and increased screen time and sedentary

behaviour. (24,26–28) Although MVPA declined over time for both females and males, this association was only significant for females, which may be explained by the greater decrease in MVPA over time typically observed in females compared to males.(35,36) Sport participation was positively associated with MVPA among female and male youth. Other research supports these findings, as intramural (70,72,73), varsity (72,73) and community (72,77,96,97) sport participation all positively associate with MVPA among female and male youth. These school- and community-based sports provide opportunities for physical activity, which is an important correlate of youth MVPA. (71,95,97)

Primarily adding co-ed intramurals and no net change in intramurals were not associated with female or male MVPA in Y6 or Y7. Although no research was found directly on intramural change, other research on intramurals supports this finding, as the availability of intramurals was not directly associated with student MVPA.(69,140) Although the environmental context can influence youth MVPA, intrapersonal and interpersonal characteristics may be more important predictors of MVPA, (150) which may help explain these nonsignificant findings. For example, intrapersonal factors such as self-efficacy and enjoyment, and interpersonal factors such as peer support for physical activity are all positively associated with youth MVPA, (150–153) and aspects of school-physical activity environment, such as the availability of school programs,(150) may not be as important for youth MVPA. Therefore, changes in the school environment, such as adding co-ed intramurals, or making no net changes to intramurals, may not be sufficient approaches to increasing physical activity among youth. More comprehensive strategies to address the physical inactivity among youth are warranted. For example, physical activity programs that include a combination of changes to the school environment (e.g., school curriculum, school-based policies), community engagement and parental involvement have

proven effective in improving youth physical activity(48,52,53) and warrant further investigation and evaluation.

There were no significant associations between adding gender-specific intramurals and MVPA among female or male students. However, there may not have been adequate power at the school-level to detect a significant association, as only 8 schools reported adding gender-specific intramurals in our sample. Although this association may be underpowered at the school-level, it is important to note that adding gender-specific intramurals was positively associated with female MVPA in Y7, and the p-value of this association warrants further exploration using a larger school-level sample. Past research has suggested that gender-specific intramurals are more important for female youth participation, compared to males.(94) Females may face more barriers to sport participation and physical activity compared to males, and these barriers range from intrapersonal to environmental factors, as described by the social-ecological model.(127,136) More specifically, females may face intrapersonal barriers (e.g., low self-efficacy), interpersonal barriers (e.g., time-restraints and lack of social support from peers), and environmental barriers (e.g., lack of choice and limited female-only opportunities in physical activity programs).(136) To address these barriers, strategies to increase self-efficacy, provide accessible physical activity programs and create a supportive physical activity environment are warranted.(136) Gender-specific intramurals may provide females with this environment by offering supportive and accessible opportunities to be physically active, and reducing some of these barriers to physical activity. For example, female-only intramurals may increase confidence and self-efficacy by providing a safe space to participate in physical activity, that is free of intimidation or excessive competition that may be present in a co-ed environment.(70,136) These female-only programs may also address time-restraints by providing

access to physical activity during school-time and may promote positive interactions with peers and encourage peer support for physical activity.(150–153) Finally, gender-specific intramurals address programming barriers, by providing a variety of female-only opportunities to be physically active.(136)

7.5.1 Limitations

Firstly, the generalizability of these results may be limited, as COMPASS uses convenience sampling to recruit schools. However, the COMPASS study has a large sample size and employs an active-information, passive-consent procedure to promote participation and honest responses from students.(113) Additionally, this procedure may produce more robust results by limiting self-selection and response biases.(109) Secondly, because schools made many changes to their gender-specific and co-ed intramurals, the intervention groups may have been diluted. For example, the intervention groups consisted of schools that: (i) "primarily" added co-ed intramurals, (ii) "primarily" added gender-specific and (iii) no net changes to intramurals, as opposed to schools that: (i) "only" added co-ed intramurals, (ii) "only" added gender-specific intramurals and (iii) no changes to intramurals. These diluted intervention groups may have made associations difficult to detect, which highlights the complexity of evaluating physical activity programs using a natural experiment. Thirdly, this study may have been under-powered at the school-level, possibly limiting the ability to detect associations between changes in gender-specific intramurals on youth MVPA over time. However, this study provides insight into the potential role of gender-specific and co-ed intramurals on youth MVPA, and future research should explore these associations using a larger school-level sample to ensure adequate power.

7.6 Conclusions

This study found that intramural and varsity sports are important school-based opportunities for youth physical activity, as participation in these sports were positively associated with MVPA. To encourage sport participation and physical activity among students, schools should continue to offer a variety of intramural and varsity sports. Changes in gender-specific and co-ed intramurals were not associated with female or male MVPA over time. Changes in the school environment, such as adding gender-specific and co-ed intramurals may not be sufficient strategies to increase physical activity among youth, although further research should explore the effect of gender-specific intramurals on youth physical activity, as this study may have been underpowered at the school-level. Gender-specific intramurals may promote a supportive physical activity environment by fostering self-efficacy, enjoyment and peer support, especially among females. These intramurals may be an important component of more comprehensive strategies to increase youth physical activity.

Chapter 8: Overall Discussion

8.1 Overview

Using a large linked sample of longitudinal school- and student-level data, this dissertation was the first to examine how changes in school-based intramurals were associated with student MVPA over time. More specifically, this dissertation comprehensively evaluated changes in intramurals using a robust study design and methodology to examine: (i) how general changes in intramurals were associated with students' MVPA over time, (ii) how changes in the type of intramurals were associated with students' MVPA over time, and (iii) how changes in gender-specific and co-ed intramurals were associated with students' MVPA over time. These associations were explored using a novel analytical methodology to program evaluation, which allowed for the examination of these changes in intramurals on MVPA in Y6 and into Y7 under the assumption that these changes were maintained from Y6. The results of the three studies suggest that MVPA among students declines over time and: (i) general changes in school-based intramurals (added, removed and no change) were not significantly associated with student MVPA in those schools over time, regardless of participation; (ii) adding team and individual intramurals at a school positively impacted female MVPA in those schools in the year they were added, regardless of participation in intramurals; and, (iii) changes in gender-specific (female-only, male-only) and co-ed intramurals within schools were not significantly associated with student MVPA in those schools over time. These findings address important gaps in the literature on intramurals and physical activity, and contribute to our understanding of how real-world changes in school-level intramurals impact students' MVPA over time. Overall, our results suggest that offering a variety of team and individual intramurals in schools is important for physical activity among females within these schools. Additionally, gender-specific intramurals may be important for female physical activity,(89,94) as the p-value of this association was at the

level of significance ($\alpha = 0.05$). This association warrants further exploration using a larger school sample to ensure adequate power to detect significant findings. There were no other associations between changes in intramurals and the MVPA of female students within these schools over time.

There were no significant associations between changes in intramurals and male MVPA over time, suggesting that changes to intramurals is not an effective strategy to improve MVPA among male students within these schools. Despite the general lack of association with MVPA among males, and the limited association with MVPA among females, intramurals are associated with several other important outcomes among youth not examined in this dissertation, such as sport sampling, physical literacy, socialization and reduced substance use. Therefore, schools should offer intramurals as inclusive physical activity programs, in addition to other physical activity programs and policies, to encourage equitable access to sport and physical activity and to foster healthy behaviours among youth.

8.2 Discussion of Overall Findings

The novel results of Study 1 and 3 of this dissertation found that general changes in intramurals were not significantly associated with students' MVPA over time, and that changes in gender-specific and co-ed intramurals were not significantly associated with MVPA among students over time, both regardless of intramural participation. These null findings between intramurals and student MVPA may not be surprising, because although intramurals are inclusive and important physical activity programs, they are only one program within the larger school physical activity environment, and schools likely have other programs and policies that interrelate with intramurals to influence student physical activity.(70,139,140,154) For example, offering access to school physical activity facilities,(55) providing access to after-school

supervised activity,(155) creating community partnerships to improve access to community health facilities,(140,149) and the presence of fitness ambassadors (individuals that promote physical activities among students),(149) are all positively associated with student physical activity, and these aspects of the school environment were beyond the scope of this dissertation, and were therefore not examined. It is also important to note that as a natural experiment evaluation, we examined changes in intramurals from Y5 to Y6, and did not examine the presence or absence of school-level programs policies, or facilities within the school environment, many of which are positively associated with student MVPA.(55,70,139,140,149,154,155) Although we found that changes in intramurals were mostly unassociated with youth MVPA over time, it is likely that existing school physical activity programs, including established intramural and varsity sports, have a positive impact on student physical activity.(69,93,149) We observed a positive association between participation in intramurals and varsity sports on students' MVPA over time, which may be reflective of the positive effect that existing school-based physical activity programs have on student MVPA.

In addition to school-level environmental factors, youth physical activity is shaped by the interrelation of several other factors, ranging from proximal (e.g., individual and interpersonal) to distal (e.g., community and organizational).(127,150,156,157) This complex interrelation of factors to influence youth physical activity is often described by the socio-ecological model, where individual, interpersonal, community, organizational and high-level policy collectively influence youth physical activity.(127,150,156,157) Past research suggests that proximal factors (e.g., self-efficacy, peer support) may have a larger influence on youth physical activity compared to distal factors (e.g., school physical activity policies, facilities and programs),(150) which may explain our null findings. For example, individual factors such as knowledge,

attitudes and behaviours, and interpersonal factors such as family, friends and social networks may be more influential on youth physical activity behaviours, compared to organizational factors such as the school-environment.(134,135,138,150,156,158–160) This concept was reflected in our findings, as student physical activity behaviours, specifically participation in intramural, varsity and community sports, were all positively associated with MVPA over time, while changes in the school environment, including intramurals and other physical activity programs, were mostly unassociated with students' MVPA. However, in line with the socio-ecological model, we can best explain physical activity behaviours when considering multiple factors across all levels,(127,150,156,157) and future research should examine how the proximal and distal factors interrelate to influence youth MVPA.

In Study 2, we found that adding team and individual intramurals was positively and significantly associated with female students' MVPA in Y6, regardless of participation. This result suggests that there is an indirect association between changes in intramurals at the school-level and individual female student MVPA in those schools. Other research has found this positive and indirect association, as regardless of participation, students attending schools with a more intramurals engaged in more physical activity compared to those attending schools with a fewer intramurals.(69) Perhaps schools that added team and individual intramurals had a mandate to create and support an inclusive physical activity environment.(136) Through this mandate, schools may have addressed key individual and interpersonal factors that are especially important for female physical activity, including: (i) autonomy, by providing females with a variety of physical activity opportunities, (ii) self-efficacy, by providing opportunities for female students to develop physical literacy, be active role models and improve their fitness levels, and (iii) social attachment, by providing opportunities for females to socialize with peers in a

comfortable and safe space for physical activity.(88,89,134–138) Future research should explore the association between aspects of the school environment (e.g., physical activity programs and policies) and these individual and interpersonal factors related to female MVPA, considering that females are an at-risk group for physical inactivity, and the school environment is an important modifiable factor that may positively influence MVPA.

Previous research has shown the that the effect of the school physical activity environment on MVPA may be different between male and female students.(72,93,161) This was reflected in our findings, as the positive association between adding team and individual intramurals on female MVPA was not observed among males. This is likely explained by the differences in motivations for physical activity and barriers to physical activity between male and female youth. Specifically, promoting an inclusive and supportive physical activity environment by adding intramurals may not target male motivations for physical activity, which include competition, strength and winning, and more likely targeted female motivations for physical activity which include peer socialization, inclusion and keeping fit.(88,134,135) Additionally, males may face less barriers to physical activity compared to females (e.g., on self-efficacy, physical literacy, self-esteem, access to opportunities, and lack of time),(127,136) so the effect of a supportive and inclusive environment on MVPA may not be as evident among males compared to females.

Although there were no significant associations between gender-specific and co-ed intramurals on youth MVPA in Study 3, the positive association between adding gender-specific intramurals on female MVPA in Y7 had a p-value of 0.05, warranting further examination with a larger school sample. This positive association was observed regardless of intramural participation, suggesting there may be an indirect association between adding gender-specific

intramurals and female MVPA over time. This is a noteworthy finding, as previous research has suggested that gender-specific intramurals are important to female participation (94) and physical activity,(89) and may promote equal opportunities for physical activity and address important barriers that female youth face to physical activity and sport participation.(89,110,136) It is likely that the addition of gender-specific intramurals in Study 3 is capturing the schools' ongoing commitment to promote physical activity among females, and their mandate to support a diverse, inclusive and positive physical activity environment that appeals to female motivations for physical activity, while reducing barriers.(88,89,134–137) Moreover, adding gender-specific intramurals may promote social norms for female physical activity and cause a contagion effect among female students, leading to increases in physical activity.(162) Motivations for female physical activity include peer socialization and inclusion,(88,134,135) so the contagion effect of physical activity may be especially important for females, and help to explain these findings among this group. Future research should examine the association between female-only intramurals and female MVPA over time with a larger school-level sample, to better understand this important association and inform programs, to increase physical activity among female youth.

The indirect and positive association between changes in intramurals and female MVPA that were observed in Study 2 and 3, were not observed in Study 1. Study 1 examined general changes to intramurals (added, removed and no change) without considering other aspects of these changes, such as type (team and individual), gender-specific and co-ed intramurals. Based on Study 2 and 3, adding team, individual and gender-specific intramurals may be reflective of the schools' mandates to promote supportive and inclusive school physical activity environment, which is important for female MVPA.(88,89,134–137). It is possible that the schools'

commitments to a supportive and inclusive physical activity environment was not captured in the general changes to intramurals, and these changes needed to be further categorized (e.g., into team, individual, gender-specific and co-ed) to more accurately examine the association between changes in intramurals on female MVPA over time.

Although the impact of intramurals on student MVPA over time may be limited on their own, intramurals may be an important part of more comprehensive school-based strategies to improve youth physical inactivity.(130,131) Previous research suggests that multi-faceted physical activity interventions are most effective, and successful interventions often integrate changes to the school curriculum and the school environment while encouraging community engagement and parental involvement.(48,52,53) Additionally, intramurals may be important for female physical activity, which is important, given they are at-risk group for physical inactivity.

8.3 Implications for Practice

This dissertation comprehensively examined how changes in intramurals associated with student MVPA over time, and highlights many important implications for school stakeholders. Based on the limited impact intramurals had on student MVPA in our studies, intramurals are likely not an effective strategy on their own to address student physical inactivity within schools. However, schools should continue to offer a variety of intramurals, as these programs offer many benefits to students, above and beyond physical activity, with very limited disadvantages. In our studies, intramural, varsity and community sport participation were all positively and significantly associated with youth MVPA. Although the amount of MVPA accumulated from intramural participation was lesser compared to varsity and community sport participation, intramurals provide youth with inclusive school-based opportunities for physical activity and are modestly and positively associated with youth MVPA.(69,72,73) Intramurals may reduce

barriers such as time-constraints, cost, lack of skill/ability and accessibility, that are commonly associated with youth sport participation,(163) and are especially important for youth who do not participate in varsity and community sports.(146) Additionally, community sports may be exclusive to youth of high socioeconomic status, which potentially limits these physical activity opportunities among youth in low and middle socioeconomic groups.(164) This highlights that schools should continue to offer a variety of intramurals, as these programs provide students with an inclusive sports opportunities that address common barriers to sport participation.

Intramurals may also provide students with opportunities to participate in a wide variety of activities throughout the school year, which is a concept known as sport sampling.(74,75) Sport sampling may help youth find a sport/activity they enjoy participating in, which can promote confidence and physical activity participation that may continue into adulthood.(31,74–80) Finding an enjoyable sport/activity in youthhood may promote the competence, confidence and knowledge to be physically active for life, a concept known as physical literacy.(136,165) Recent research suggests that physical literacy in youth may positively influence physical activity behaviours and health outcomes later in life.(136,165) Additionally, intramurals may provide students with the opportunity for a "first try" at sports, which helps develop physical literacy among students who were not able to participate in sports or other physical activities at a younger age.(136,165) This underscores the importance of intramurals as school-based physical activity programs, considering they provide students with opportunities to engage in sport sampling and develop physical literacy, which is especially important for youth that do not participate in community sports (146) and for those that did not participate in sports at a younger age.

Previous research suggests that changes in the school physical activity environment may have different effects on youth MVPA between schools,(139) which may have been reflected in our study results, as changes in intramurals within schools were mainly not associated with student MVPA over time. This suggests that a uniform approach to intramurals may not be appropriate across COMPASS schools, as not all changes to the school physical activity environment will have the same effect on student MVPA across schools.(139) This may be explained by differences in the available resources and existing school programs, policies, and facilities between schools that may interrelate to influence student MVPA.(70,139,140,154) Schools should consider changes to intramurals based on the unique needs of their students, while considering other aspects of the school environment (e.g., established physical activity programs and policies).(70,136,139,140,154) Student engagement is important for the implementation of physical activity programming and schools may consider surveying students on their intramural preferences or conducting informal evaluations of intramurals based on demand, which could be measured by participation rates. Perhaps schools can re-evaluate their intramural offerings on a seasonal or annual basis, to address the changing needs of their students as they progress throughout secondary school. For example, sport participation tends to decrease throughout secondary school,(166) and this may be attributed to changes in intrapersonal factors associated with sport participation, such as lack of enjoyment and lack of time.(137,144) Regularly reassessing and implementing changes to intramural offerings may address some of these factors, and keep students continuously engaged in intramurals over time.

Lastly, in addition to physical activity, participation in intramurals are associated with several positive outcomes, including improved mental health,(8,9,167) academic performance,(13,14) socialization,(7) self-esteem, social interaction,(167) and reduced substance

use.(82) Additionally, recent research found that consistent participation in intramurals throughout secondary school was protective of cigarette and cannabis use over time,(132) highlighting that intramurals may be an equitable and cost-effective method to address substance use in youth. Considering the multitude of health benefits associated with intramurals participation, schools should consider implementing and promoting intramurals as viable strategies to encourage healthy psychological, social, and academic development among their students.(7–9,13,14,82,167)

8.4 Implications for Research

This dissertation creates a strong foundation for future studies and highlights many directions for future research on intramurals and student MVPA. Firstly, this study may have been underpowered at the school-level, therefore future research should examine changes in intramurals on youth MVPA over time using a larger school sample. For example, the novel methods employed in this dissertation can be replicated using more recent COMPASS data, as there is a substantially larger sample of schools and students in later years of the study. Additionally, based on the important findings from Study 3, gender-specific intramurals may be important for female MVPA, and other research has highlighted the positive effect of female-only intramurals for female participation.(94) It is likely that female-only intramurals are positively associated with female MVPA as well,(89) and the examination of this association with a larger school-level sample would enable the detection of a significant effect if one were to exist, and would provide a more comprehensive examination of how changes in intramurals associate with MVPA over time. This is an important association to examine, considering female youth are an at-risk group for physical inactivity.

Secondly, future research should examine how changes in intramurals associate with youth intramural participation over time, as previous research suggests that intramural offerings are associated with youth participation cross-sectionally.(94) Examining how intramurals are associated with youth participation longitudinally, would determine whether these programs are protective against the declining trajectory of sport participation among this group.(32,33) Additionally, mixed methods approaches could be used to further examine youth intramural participation, and more specifically, to understand why youth participate in intramurals. Past research suggests that youth MVPA and sport participation decreases over time,(32,33) which may be explained by an increase in time constraints, reduced enjoyment, increased social pressures and decreased perceived competence that youth experience over time.(137,144,168) Although overall sport participation may decrease, there is research to suggest this decrease may be specific to team sports,(166,169) and participation in non-competitive forms of physical activity may increase, especially among females.(169) This suggests that as non-competitive activities, such as intramurals, although perhaps not effective at increasing MVPA among students, could be a viable activity to prevent further decreases in physical activity among older youth. Although these data are not available in COMPASS, understanding the reasons that youth participate in intramurals and why they participate in some activities (e.g., individual, team, gender-specific, co-ed) compared to others, would provide evidence to inform and tailor the offerings of these programs. This would help to maximize participation and prevent further declines in MVPA among students as they age, which is critical given the declining physical activity levels and sport participation among this population. Future research may also consider replicating or conducting similar studies to examine how changes in intramurals associate with MVPA over time, and stratifying the analyses by intramural participation. In our studies, we did

not stratify the analyses by intramural participation, which had practical and methodological rationales. Practically, when schools implement intramurals, they are supporting a whole school approach to physical inactivity, and these programs would be available to all students, not just those students that reported participating at the time of data collection. Methodologically, the analyses were already stratified by gender, and stratifying the data again by intramural participation was not feasible, as the cell counts were too small to run reliable models. It is likely that the effect of changes in intramurals on youth MVPA is affected by intramural participation, and future research with larger sample sizes may consider examining this association by student intramural participation.

Thirdly, it is important to examine how the offering of intramurals in schools are associated with MVPA among students from different socioeconomic groups. Previous research suggests that youth of higher socioeconomic status are more likely to participate in sports (170) and achieve more physical activity,(95–97) compared to those of lower socioeconomic status. This may be especially true for community sports,(146) which are typically exclusive to youth of higher socioeconomic status.(164) Considering intramurals require no cost or transportation to participate,(68) these activities may be especially important for students of lower socioeconomic status,(170,171) and may provide this group with inclusive opportunities for sport participation and physical activity. Although measures of student-level weekly spending money and school neighbourhood median income were included in this research, weekly spending money is a proxy of socioeconomic status, and school neighbourhood median income may not be representative of individual socioeconomic status. Future studies may consider including individual measures of individual socioeconomic status in their analyses through stratification, to examine if the effect of intramurals on participation and MVPA differs between socioeconomic

groups. This may provide evidence to support intramurals as a strategy to increase sport participation and physical activity among this at-risk group.

Lastly, we hypothesized that fostering a supportive physical activity environment is a plausible explanation for the positive and indirect association that was observed between changes in intramurals and female physical activity.(69,150–153) This supportive school environment for physical activity is likely associated with school connectedness,(70,172) which is the belief held by students that adults and peers within their school care about their learning and well-being.(173) Future research should examine the association between intramurals and school connectedness, as creating a supportive physical activity environment by offering intramurals, may improve school connectedness among students.(98,174,175) If intramurals are positively associated with school connectedness, schools should consider intramurals and other physical activity programs to promote school connectedness among their students, as it is associated with positive health behaviours, including increased physical activity and reduced substance use behaviours among students.(98,175)

8.5 Strengths and Limitations

8.5.1 Strengths

This research comprehensively examined how changes in intramurals were associated with youth MVPA over time through the robust evaluation of a natural experiment. To our knowledge, this was the first set of studies to examine how general changes, changes in team and individual and changes in gender-specific and co-ed intramurals associate with youth MVPA over time. This research addressed important gaps in the intramural and youth physical activity literature. Firstly, there was a lack of experimental research evaluating the effectiveness of intramural programs on students' physical activity outcomes. This research addressed this gap

through the evaluation of a natural experiment using a robust quasi-experimental design and a large linked sample of longitudinal data. This design has high internal and external validity because of its pre-intervention and post-intervention (longitudinal) measures an intervention and control group.(107) To address potential bias due to confounding, relevant student sociodemographic and behavioural characteristics and school-level factors were measured and included in the analyses. Additionally, the student-level sample included those with complete data and monotone missingness on MVPA, providing a more robust evaluation compared to complete case analysis. Secondly, this dissertation systematically examined how intramurals associate with physical activity over time, as we considered the quantity of intramurals and the categories of these programs, including the type (team and individual) and gender-offering (e.g., gender-specific and co-ed) when deriving the intramural change variables. This provided a very comprehensive examination of how intramurals were associated with students' MVPA over time, and highlights important directions for future research on type and gender-offering of intramurals.

This dissertation also employed an innovative and robust approach to program evaluation through the use of indicator variables. These indicator variables allowed for the examination of how changes in intramurals were associated with youth MVPA in Y6 and into Y7, under the assumption these changes were maintained into this year. Typical linear mixed models used in longitudinal program evaluation would include an interaction term between the main exposure (program implementation) and time, to examine the impact of program change on an outcome over time. These hierarchical models often prove difficult to converge, and a two-way interaction term between program change and time is difficult to interpret, complicating the dissemination of the results of a program evaluation to stakeholders. The indicator method employed in this

dissertation is a practical approach to program evaluation, as it evaluates how a program will impact an outcome in the year it was implemented, and into subsequent years, given that the circumstances of the program remain constant in those years. The results from this method are easily interpreted and conveyed, and stakeholders can use these evaluation data to easily inform program development and implementation into subsequent years. Future research involving the evaluation of school physical activity programs may consider employing this method to generate practice-based evidence that be used by stakeholders to make evidence-based decisions about school-based physical activity programs.

8.5.2 Limitations

COMPASS collects data from a convenience sample of students and the schools they attend,(109) which may limit the generalizability of the results.(111) However, the COMPASS study has a large sample size and utilizes as active-information, passive-consent protocol to encourage participation and honest response.(113).This recruitment method has been shown to limit self-selection and response biases and generate more robust results.(109) Despite the large student-level sample, this study may have been under-powered at the school-level. This potentially limits the ability to detect significant associations between changes in intramurals on youth MVPA over time. Future research should consider examining changes in intramurals on youth MVPA with larger school samples that can be successfully linked longitudinally.

This research evaluated a natural experiment (changes in intramural programs) which introduced the potential of bias due to confounding.(105,107) Bias due to confounding can be addressed by randomization in experimental research, however considering the nature of natural experimental studies (e.g., the researcher does not assign the intervention) this was not possible.(105,107) Other methods to address bias due to confounding in observational research

include the use of a comparison group and measuring and controlling for important contextual factors through stratification or adjustment.(105–107) To mitigate bias due to confounding, comparison groups were used in the analyses and several known important contextual factors were measured by the SPP and Cq and were included in the models. Residual confounding is the distortion between the intervention and the outcome that remains after controlling for confounding variables. This is a potential limitation of natural experimental studies because of the lack of randomization of the intervention to experimental units. To mitigate this limitation, data collected on important confounding variables (by the Cq and the SPP) were controlled for in the analyses.

There are some limitations related to the measurement of the intramural participation and MVPA. Firstly, intramural participation is limited by its dichotomous nature, as the frequency, duration, type or extent of participation in intramural programs is not measured. Secondly, this measure of intramural participation does not capture students who may have initiated participation. It would be interesting to examine if changes in intramurals are associated with initiation of participation in intramurals, and future research may consider examining how changes in intramurals associate with different patterns of intramural participation (e.g., initiated, consistent or quit participation) over time.(132) Thirdly, the Cq relies on self-report data, introducing the potential for social desirability and recall biases, which affect the validity of the measure.(176) However, the students are assured that their responses will remain anonymous on the Cq which may be helpful in reducing social desirability bias and encouraging honest responses.(177) Additionally, if there is misreporting on physical activity outcomes, it was likely consistent over time, limiting its impact on this longitudinal research.(117) Specific to the MVPA outcome, the Cq provides definitions and examples of moderate and hard physical

activity which has been shown to aid in recall and reduce recall bias.(178,179) Research examining the reliability and validity of the physical activity measure on the Cq found it to be an acceptable measure of MVPA for school-level research of health behaviours among youth.(117)

8.6 Conclusions

This dissertation comprehensively evaluated how changes in intramurals associate with youth MVPA over time using a robust quasi-experimental design. Intramural participation was significantly associated with youth MVPA over time and adding individual and team intramurals were positively associated with female MVPA, regardless of intramural participation. General changes in intramurals and changes in gender-specific and co-ed intramurals were not associated with female or male MVPA over time. However, the association between adding gender-specific intramurals and female MVPA should be further explored, as this analysis may have been under-powered at the school-level. The indirect and positive association between adding individual and team intramurals were positively associated with female MVPA may have reflected a supportive school environment that targeted important intrapersonal and interpersonal factors associated with female physical activity. Additionally, gender-specific intramurals may promote a supportive physical activity environment by fostering self-efficacy, enjoyment and peer support, especially among females, and this association should be examined with a larger school sample.

Based on Study 1, 2 and 3, changes in intramurals were not significantly associated with male MVPA over time. This suggests that changes in intramurals are not effective at increasing MVPA among males, and may be explained by the fact that the inclusive and supportive nature of intramurals generally do not target male motivations for physical activity, which include competition, strength and winning.

Although changes in intramurals were generally not associated with youth MVPA, intramurals are associated with several other important outcomes among youth, such as sport sampling, physical literacy, socialization, school connectedness and reduced substance use. Schools should offer intramurals as inclusive physical activity programs, in addition to other physical activity programs and policies, to encourage equitable access to sport and physical activity and to foster healthy behaviours among youth.

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Appendices

Appendix A: Canadian 24-Hour Movement Guidelines (5)

CANADIAN 24-HOUR MOVEMENT GUIDELINES FOR CHILDREN AND YOUTH:

An Integration of Physical Activity, Sedentary Behaviour, and Sleep

PREAMBLE

These guidelines are relevant to apparently healthy children and youth (aged 5–17 years) irrespective of gender, race, ethnicity, or the socio-economic status of the family. Children and youth are encouraged to live an active lifestyle with a daily balance of sleep, sedentary behaviours, and physical activities that supports their healthy development.

Children and youth should practice healthy sleep hygiene (habits and practices that are conducive to sleeping well), limit sedentary behaviours (especially screen time), and participate in a range of physical activities in a variety of environments (e.g., home/school/community; indoors/outdoors; land/water; summer/winter) and contexts (e.g., play, recreation, sport, active transportation, hobbies, and chores).

For those not currently meeting these 24-hour movement guidelines, a progressive adjustment toward them is recommended. Following these guidelines is associated with better body composition, cardiorespiratory and musculoskeletal fitness, academic achievement and cognition, emotional regulation, pro-social behaviours, cardiovascular and metabolic health, and overall quality of life. The benefits of following these guidelines far exceed potential risks.

These guidelines may be appropriate for children and youth with a disability or medical condition; however, a health professional should be consulted for additional guidance.

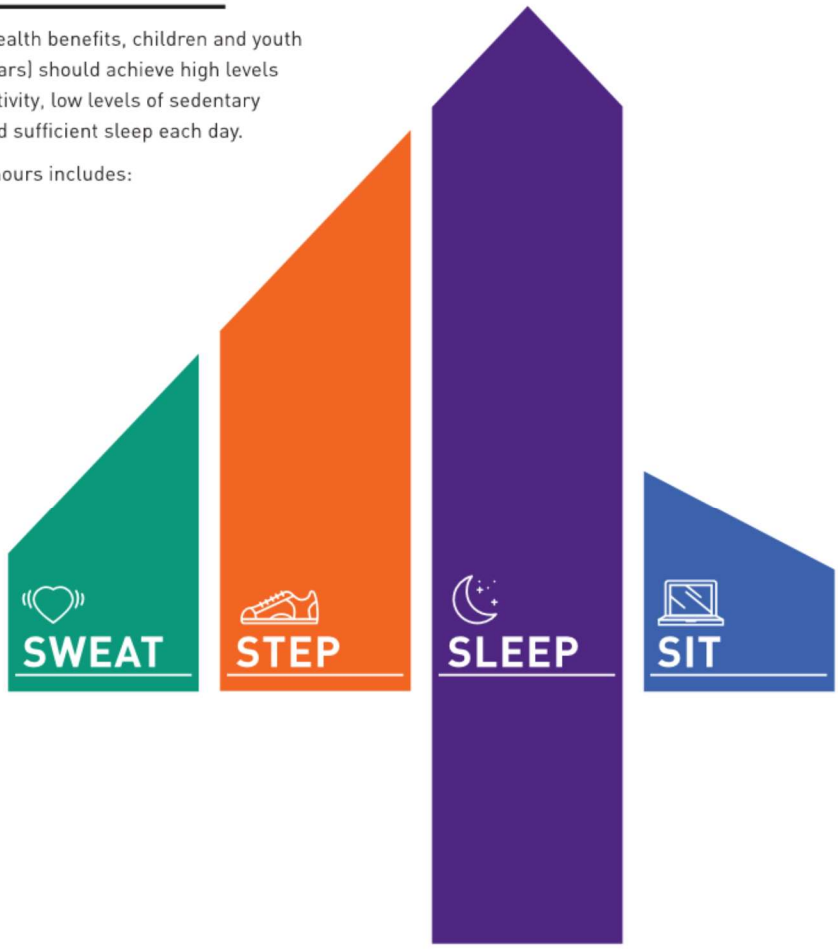
The specific guidelines and more details on the background research informing them, their interpretation, guidance on how to achieve them, and recommendations for research and surveillance are available at www.csep.ca/guidelines.

CHEO Research Institute Institut de recherche | The Conference Board of Canada Le Conference Board du Canada | CSEP SCPE | Public Health Agency of Canada Agence de la santé publique du Canada | PARTICIPACTION

GUIDELINES

For optimal health benefits, children and youth (aged 5–17 years) should achieve high levels of physical activity, low levels of sedentary behaviour, and sufficient sleep each day.

A healthy 24 hours includes:



SWEAT

MODERATE TO VIGOROUS PHYSICAL ACTIVITY

An accumulation of at least 60 minutes per day of moderate to vigorous physical activity involving a variety of aerobic activities. Vigorous physical activities, and muscle and bone strengthening activities should each be incorporated at least 3 days per week;

STEP

LIGHT PHYSICAL ACTIVITY

Several hours of a variety of structured and unstructured light physical activities;

SLEEP

SLEEP

Uninterrupted 9 to 11 hours of sleep per night for those aged 5–13 years and 8 to 10 hours per night for those aged 14–17 years, with consistent bed and wake-up times;

SIT

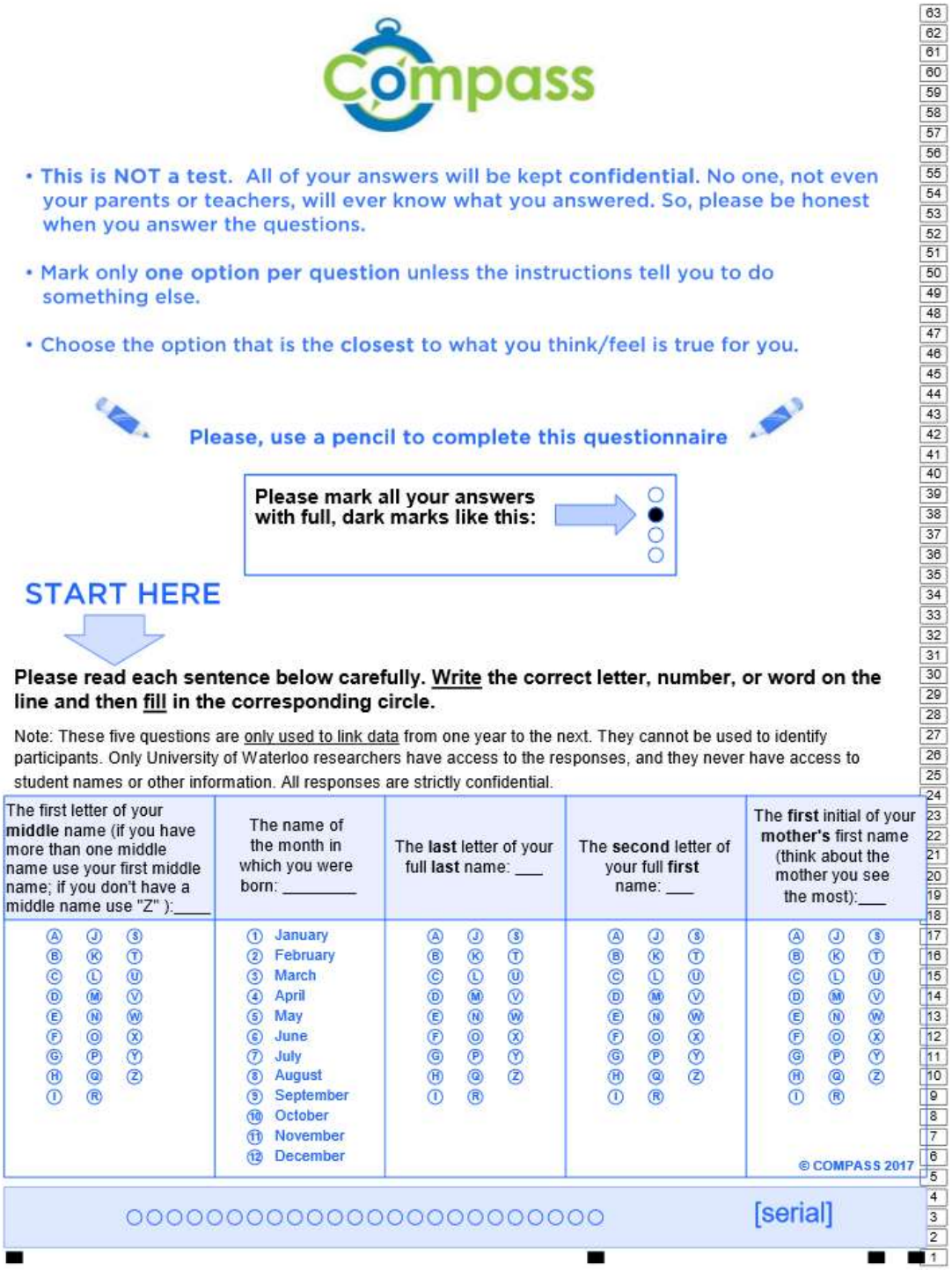
SEDENTARY BEHAVIOUR

No more than 2 hours per day of recreational screen time;

Limited sitting for extended periods.

Preserving sufficient sleep, trading indoor time for outdoor time, and replacing sedentary behaviours and light physical activity with additional moderate to vigorous physical activity can provide greater health benefits.

Appendix B: Compass Questionnaire (Cq)



Compass

- 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.

Note: These five questions are only used to link data from one year to the next. They cannot be used to identify participants. Only University of Waterloo researchers have access to the responses, and they never have access to student names or other information. All responses are strictly confidential.

The first letter of your **middle** 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 **last** letter of your full **last** name: ___	The **second** letter of your full **first** name: ___	The **first** initial of your **mother's** 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

Quebec students only

- ○ Secondary I
- ○ Secondary II
- ○ Secondary III
- ○ Secondary IV
- ○ Secondary V
- ○ Other

2. How old are you today?

- ○ 12 years or younger
- ○ 13 years
- ○ 14 years
- ○ 15 years
- ○ 16 years
- ○ 17 years
- ○ 18 years
- ○ 19 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 <u>each week</u> 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	From school
○ By car (as a passenger)	○ By car (as a passenger)
○ By car (as a driver)	○ By car (as a driver)
○ By school bus	○ By school bus
○ By public bus, subway, or streetcar	○ By public bus, subway, or streetcar
○ By walking	○ By walking
○ By bicycling	○ By bicycling
○ Other	○ 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

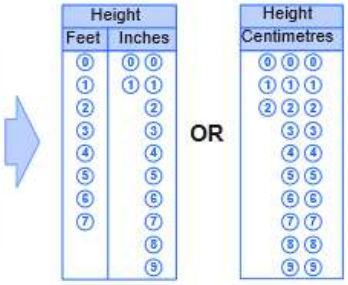
8. How tall are you without your shoes on? (Please write your height in feet and inches **OR** in centimetres, and then fill in the appropriate numbers for your height.)

○ **I do not know how tall I am**

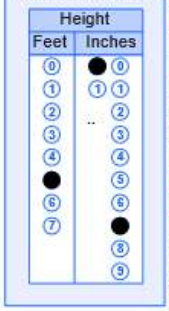
"My height is ____feet, _____inches"

OR

"My height is _____ centimetres"



Example:
My height is 5 ft 7 in



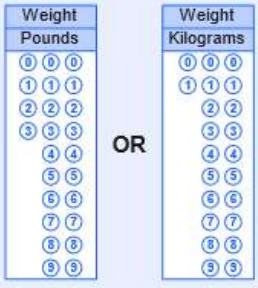
9. How much do you weigh without your shoes on? (Please write your weight in pounds **OR** in kilograms, and then fill in the appropriate numbers for your weight.)

○ **I do not know how much I weigh**

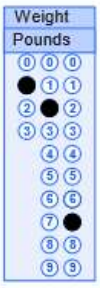
"My weight is _____ pounds"

OR

"My weight is _____ kilograms"



Example:
My weight is 127 lbs



[serial]

10. How do you describe your weight?

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

11. 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

12. How much time per day do you *usually* spend doing the following activities?

For example: If you spend about 3 hours watching TV each day, you will need to fill in the 3 hour circle, and the 0 minute circle as shown below:

a) Watching/streaming TV shows or movies — Hours: 0 1 2 ● 4 5 6 7 8 9 — Minutes: ● 15 30 45

	Hours										Minutes			
a) Watching/streaming TV shows or movies	0	1	2	3	4	5	6	7	8	9	0	15	30	45
b) Playing video/computer games	0	1	2	3	4	5	6	7	8	9	0	15	30	45
c) Doing homework	0	1	2	3	4	5	6	7	8	9	0	15	30	45
d) Talking on the phone	0	1	2	3	4	5	6	7	8	9	0	15	30	45
e) Surfing the internet	0	1	2	3	4	5	6	7	8	9	0	15	30	45
f) Texting, messaging, emailing **(note: 50 texts = 30 minutes)**	0	1	2	3	4	5	6	7	8	9	0	15	30	45
g) Sleeping	0	1	2	3	4	5	6	7	8	9	0	15	30	45

13. In the last 30 days, did you gamble online for money?

- ○ Yes
- ○ No

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.

14. 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	○	○	○	○	○	○	○	○	○	○
Tuesday	○	○	○	○	○	○	○	○	○	○
Wednesday	○	○	○	○	○	○	○	○	○	○
Thursday	○	○	○	○	○	○	○	○	○	○
Friday	○	○	○	○	○	○	○	○	○	○
Saturday	○	○	○	○	○	○	○	○	○	○
Sunday	○	○	○	○	○	○	○	○	○	○

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	●	○	○	○	○	○	○	○	●	

15. 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	○	○	○	○	○	○	○	○	○	○
Tuesday	○	○	○	○	○	○	○	○	○	○
Wednesday	○	○	○	○	○	○	○	○	○	○
Thursday	○	○	○	○	○	○	○	○	○	○
Friday	○	○	○	○	○	○	○	○	○	○
Saturday	○	○	○	○	○	○	○	○	○	○
Sunday	○	○	○	○	○	○	○	○	○	○

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	○	●	○	○	○	○	○	●	○	

16. 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

○○○○○○○○○○○○○○○○○○○○○○○○○ [serial]

17. 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

18. 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

19. 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

20. 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

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

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

22. 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

Healthy Eating

23. 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

24. 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	○	○	○	○	○	○
b) Eat breakfast provided to you **as part of a school program**	○	○	○	○	○	○
c) Eat lunch at school - lunch packed and brought from home	○	○	○	○	○	○
d) Eat lunch at school - lunch purchased in the cafeteria	○	○	○	○	○	○
e) Eat lunch purchased at a fast food place or restaurant	○	○	○	○	○	○
f) Eat snacks purchased from a vending machine **in your school**	○	○	○	○	○	○
g) Eat snacks purchased from a vending machine, corner store, snack bar, or canteen **off school property**	○	○	○	○	○	○
h) Drink sugar-sweetened beverages (soda pop, Kool-Aid, Gatorade, etc.) Do not include diet/sugar-free drinks	○	○	○	○	○	○
i) Drink high-energy drinks (Red Bull, Monster, Rock Star, etc.)	○	○	○	○	○	○
j) Drink coffee or tea **with sugar** (include cappuccino, frappuccino, iced-tea, iced-coffees, etc.)	○	○	○	○	○	○
k) Drink coffee or tea **without sugar**	○	○	○	○	○	○

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

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

○○○○○○○○○○○○○○○○○○○○○○○○○○ [serial]

26. 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**

27. 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**

28. 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**

29. 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

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

- ○ Yes
- ○ No

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

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

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

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

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

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

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

- ○ Yes
- ○ No

35. 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)*

36. 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

37. 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

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

- ○ Yes
- ○ No

39. 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

40. 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

41. 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)*

○○○○○○○○○○○○○○○○○○○○○○○○ [serial]

Alcohol and Drug 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, whisky, etc); or 1 mixed drink (1 shot of liquor with pop, juice, energy drink).

42. 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

43. 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

44. 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

45. 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

46. 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

47. If you have used marijuana or cannabis in the last 12 months, how did you use it? *(Mark all that apply)*

- ○ I have used it by smoking it (e.g., in a joint, a pipe, a bong)
- ○ I have used it by vaping it
- ○ I have used it by eating or drinking it (e.g., in brownies, cookies, candies, tea)
- ○ I have not used marijuana or cannabis in the last 12 months

48. 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

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

- ○ Difficult
- ○ Easy
- ○ I do not know

50. Have you used or tried any of the following medications TO GET HIGH?

	No, I have never done this	**Yes**, I have done this in the last 12 months	**Yes**, I have done this, but NOT in the last 12 months
a) Oxycodone (oxy, OC, APO, OxyContin®, percs, roxies, OxyNEO®)	○	○	○
b) Fentanyl (china white, synthetic heroin, china girl)	○	○	○
c) Other prescription pain relievers (codeine, morphine, Tylenol 3)	○	○	○

51. Do you think it would be difficult or easy to get pain relievers (Oxycodone, Fentanyl, codeine, etc.) if you wanted some?

- ○ Difficult
- ○ Easy
- ○ I do not know

○○○○○○○○○○○○○○○○○○○○○○○○ [serial]

Mental Health

52. How much do you agree or disagree with the following statements?

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
a) I have a happy home life	○	○	○	○	○
b) My parents/guardians expect too much of me	○	○	○	○	○
c) I can talk about my problems with my family	○	○	○	○	○
d) I can talk about my problems with my friends	○	○	○	○	○

53. How much do you agree or disagree with the following statements?

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
a) I lead a purposeful and meaningful life	○	○	○	○	○
b) My social relationships are supportive and rewarding	○	○	○	○	○
c) I am engaged and interested in my daily activities	○	○	○	○	○
d) I actively contribute to the happiness and well-being of others	○	○	○	○	○
e) I am competent and capable in the activities that are important to me	○	○	○	○	○
f) I am a good person and live a good life	○	○	○	○	○
g) I am optimistic about my future	○	○	○	○	○
h) People respect me	○	○	○	○	○
i) I generally recover from setbacks quickly	○	○	○	○	○

54. Choose the answer that best describes how you feel.

	True	Mostly true	Sometimes true, sometimes false	Mostly false	False
a) In general, I like the way I am	○	○	○	○	○
b) Overall, I have a lot to be proud of	○	○	○	○	○
c) A lot of things about me are good	○	○	○	○	○
d) When I do something, I do it well	○	○	○	○	○
e) I like the way I look	○	○	○	○	○

55. If you had concerns regarding your mental health, are there any reasons why you would not talk to an adult at school (e.g., a school social worker, child and youth worker, counsellor, psychologist, nurse, teacher, or other staff person)? *(Mark all that apply)*

- ○ I would have no problem talking to an adult at school about my mental health

- ○ Worried about what others would think of me (e.g., I'd be too embarrassed)
- ○ Lack of trust in these people - word would get out
- ○ Prefer to handle problems myself
- ○ Do not think these people would be able to help
- ○ Would not know who to approach
- ○ There is no one I feel comfortable talking to

56. Over the last 2 weeks, how often have you been bothered by the following problems?

	Not at all	Several days	Over half the days	Nearly every day
a) Feeling nervous, anxious, or on edge	○	○	○	○
b) Not being able to stop or control worrying	○	○	○	○
c) Worrying too much about different things	○	○	○	○
d) Trouble relaxing	○	○	○	○
e) Being so restless that it is hard to sit still	○	○	○	○
f) Becoming easily annoyed or irritable	○	○	○	○
g) Feeling afraid as if something awful might happen	○	○	○	○

57. Please indicate how often the following statements apply to you:

	Almost never	Sometimes	About half the time	Most of the time	Almost always
a) I have difficulty making sense out of my feelings	○	○	○	○	○
b) I pay attention to how I feel	○	○	○	○	○
c) When I'm upset, I have difficulty concentrating	○	○	○	○	○
d) When I'm upset, I believe there is nothing I can do to make myself feel better	○	○	○	○	○
e) When I'm upset, I lose control over my behaviour	○	○	○	○	○
f) When I'm upset, I feel ashamed for feeling that way	○	○	○	○	○

58. On how many of the last 7 days did you feel the following ways?

	None or less than 1 day	1-2 days	3-4 days	5-7 days
a) I was bothered by things that usually don't bother me	○	○	○	○
b) I had trouble keeping my mind on what I was doing	○	○	○	○
c) I felt depressed	○	○	○	○
d) I felt that everything I did was an effort	○	○	○	○
e) I felt hopeful about the future	○	○	○	○
f) I felt fearful	○	○	○	○
g) My sleep was restless	○	○	○	○
h) I was happy	○	○	○	○
i) I felt lonely	○	○	○	○
j) I could not get "going"	○	○	○	○

59. In general, how would you rate your mental health?

- ○ Excellent
- ○ Very good
- ○ Good
- ○ Fair
- ○ Poor

If you are a young person in Canada who needs support, you can reach out to Kids Help Phone's professional counsellors by calling 1-800-668-6868 or visiting kidshelpphone.ca. Their service is free, anonymous, confidential, and available 24/7/365.

Kids Help Phone

1-800-668-6868

○○○○○○○○○○○○○○○○○○○○○○○○○ [serial]

Your School and You

60. 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	○	○	○	○
b) I feel I am part of my school	○	○	○	○
c) I am happy to be at my school	○	○	○	○
d) I feel the teachers at my school treat me fairly	○	○	○	○
e) I feel safe in my school	○	○	○	○
f) Getting good grades is important to me	○	○	○	○

61. 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

62. 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

63. 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

64. 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

65. 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	○	○	○	○
b) Making sure students have access to healthy foods and drinks	○	○	○	○
c) Making sure no one is bullied at school	○	○	○	○
d) Giving students the support they need to resist or quit tobacco	○	○	○	○
e) Giving students the support they need to resist or quit drugs and/or alcohol	○	○	○	○

66. In your current or most recent Math course, what is your approximate overall mark?
(Think about last year if you have not taken math this year)

- ○ 90% - 100%
- ○ 80% - 89%
- ○ 70% - 79%
- ○ 60% - 69%
- ○ 55% - 59%
- ○ 50% - 54%
- ○ Less than 50%

67. In your current or most recent English course, what is your approximate overall mark?
(Think about last year if you have not taken English this year)

- ○ 90% - 100%
- ○ 80% - 89%
- ○ 70% - 79%
- ○ 60% - 69%
- ○ 55% - 59%
- ○ 50% - 54%
- ○ Less than 50%

68. What is the highest level of education you would like to get? *(Choose only one)*

- ○ Some high school or less
- ○ High school diploma or graduation equivalency
- ○ College/trade/vocational certificate
- ○ University Bachelor's degree
- ○ University Master's / PhD / law school / medical school / teachers' college degree
- ○ I don't know

69. What is the highest level of education you think you will get? *(Choose only one)*

- ○ Some high school or less
- ○ High school diploma or graduation equivalency
- ○ College/trade/vocational certificate
- ○ University Bachelor's degree
- ○ University Master's / PhD / law school / medical school / teachers' college degree
- ○ I don't know

70. In the last 4 weeks, how many days of school did you miss because of your health?

- ○ 0 days
- ○ 1 or 2 days
- ○ 3 to 5 days
- ○ 6 to 10 days
- ○ 11 or more days

71. In the last 4 weeks, how many classes did you skip when you were not supposed to?

- ○ 0 classes
- ○ 1 or 2 classes
- ○ 3 to 5 classes
- ○ 6 to 10 classes
- ○ 11 to 20 classes
- ○ More than 20 classes

72. How often do you go to class without your homework complete?

- ○ Never
- ○ Seldom
- ○ Often
- ○ Usually

○○○○○○○○○○○○○○○○○○○○○○○○ [serial]

Appendix C: Classification of Intramurals into Team and Individual

Team	Individual
Soccer	Yoga
Cheerleading	Dance
Ball Hockey	Outdoor Club
Badminton	Mountain Biking
Basketball	Skiing
Volleyball	Weight Training Club
Baseball/Softball	Rock Climbing
Dodgeball	Fitness Club (e.g., CrossFit, Zumba)
Ultimate Frisbee	Running Club
Hockey	Walking Club

Glossary

Youth: There are several definitions of youth, however it is generally agreed upon that it is a period time when one transitions from childhood to adulthood.(180) Although there is not a consensus as to which age group youth include, the United Nations defined youth as those aged 15-24, which is consistent with the definition used in other research.(180) This research focuses on youth in Ontario secondary schools, aged 13-18 years.

Intramural programs: School-sponsored physical/recreational/club activities that occur outside of instructional time, are available to all students, are focused on maximizing participation, and are limited to individuals/groups/teams of the school population.

Varsity sports: School-level competitive sports played between students from different schools and typically involve a higher level of skill compared to intramurals.

Community sports: Community sports are competitive and non-competitive sports played by students outside of school.

Moderate-vigorous physical activity: Activities that are either of moderate or vigorous intensity and are commonly used in physical activity guidelines. For youth moderate activities are equivalent to 4.0-6.9 METs, while vigorous activities are ≥7.0 METs.