SCHOOL-BASED FACTORS ASSOCIATED WITH PHYSICAL EDUCATION AMOUNT AND PHYSICAL ACTIVITY LEVELS OF STUDENTS IN ONTARIO ELEMENTARY SCHOOLS.

by

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Abstract

BACKROUND: As very few Canadian children are meeting the recommended physical activity (PA) levels suggested for maximal health benefits, gaining an understanding of the role of the school-environment in PA promotion is critical. While physical education (PE) classes have the potential for increasing PA levels of students both inside and outside school, little is known about why some schools are providing more PE than others. **PURPOSE:** The purpose of this exploratory study was to 1) determine what school-level factors were associated with the number of PE classes provided to elementary school students and 2) determine how these school factors, including PE amount, were associated with the PA levels of students. **METHODS:** Multi-level regression techniques were used to explore which school-level and student-level variables were associated with the PE amount provided to students and their PA levels. Administrator (n=30) and student (n=2,447) responses from two separate surveys from the PLAY-ON study were used to answer the study questions. **RESULTS:** After adjusting for important demographic characteristics, the number of PE classes reported per week was higher in schools that had two PA facilities in addition to a gymnasium (β=1.13, p =0.048) and in schools with greater levels of parental involvement in school-based PA decisions and programs (β=2.06, p =0.001). In contrast, students in schools that provided intramural programs reported fewer PE classes than those in schools without (β=-1.97, p <0.001). Finally, the number of PE classes provided to students in the previous week was associated with greater odds of students being highly active compared to minimally active (OR=1.14, p=0.003). **CONCLUSION:** The results of this study highlight the inconsistent amount of PE that students in Ontario elementary schools are receiving. The findings also reinforce previous research showing that greater amounts of PE are associated

with increased PA levels of students. Schools that have fewer PA facilities and have more difficult communication lines with parents may be at risk of providing students with lower amounts of PE.

Preface

This thesis contains the work from a study conducted by the candidate, Daniel I. Naiman, under the supervision of Dr. Louise C. Mâsse with guidance from Dr. Scott Leatherdale and Dr. Carolyn Gotay. The study used secondary data, with the primary data having been previously collected under the supervision of Dr. Scott Leatherdale at the Propel Centre at The University of Waterloo. The study design, data analysis, and writing of a manuscript were primarily the work of the candidate.

Sections of this thesis will be submitted for publication in peer reviewed journals.

Ethics approval for this study was provided by the University of British Columbia Children's and Women's Research Ethics Board (CW11-0253 / H11 – 02319)

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List of Symbols & Abbreviations

BMI	Body Mass Index
BC	British Columbia
CATCH	Child and Adolescent Trial for Cardiovascular Health
CCHS	Canadian Community Health Survey
CFLRI	Canadian Fitness and Lifestyle Research Institute
CVD	Cardiovascular Disease
EnRG	Environmenal Research framework for weight Gain prevention
MPA	Moderate Physical Activity
MVPA	Moderate to Vigorous Physical Activity
OR	Odds Ratio
PA	Physical Activity
PAM	Physical Activity Module
PHEC	Physical and Health Education Canada
PLAY-ON	Physical Activity of Youth in Ontario Schools Study
PE	Physical Education
SHES	School Health Environment Survey
SHAPES	School Health Action, Planning, and Evaluation System
US	United States
VPA	Vigorous Physical Activity
WHO	World Health Organization
$\sigma^2_{\mu 0}$	Between school variation
σ^2_{e0}	Within school variation
π	Pi = 3.14

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Dedication

I would like to dedicate this thesis to three very important people in my life. To my parents Neil and Joanne, thank you for the support and guidance you have given me throughout my schooling. Also, to Livia, thank you for the constant moral and emotional support that you have provided me with throughout this process, I am so lucky to be with someone who has such a consistently positive outlook on life.

Chapter 1: Literature Review

1.1 Obesity in Canada

The percentage of Canadian children diagnosed as obese or overweight has increased at an alarming rate over the past three decades.[2,3,4] Between 1978/79 and 2004 the obesity prevalence in Canadian children aged 2 to 17 grew from 2% to 8%, while the prevalence of overweight increased from 12% to 18%.[4] While adult obesity is associated with a number of health complications including cardiovascular disease (CVD) and type II diabetes, evidence is also accumulating that overweight and obese children develop adverse health outcomes such as early onset risk factors for CVD,[5] type II diabetes,[6] sleep apnea, and psychological disorders.[7] Further, recent evidence suggests that more than 80% of overweight youth will maintain an unhealthy weight into adulthood.[8]

1.2 Importance of Physical Activity

Although obesity is a complex disorder with an equally complex etiology, physical activity (PA) has been shown to have an inverse relationship with excess weight gain in both adults[9,10] and children.[11] In 2004, the World Health Organization (WHO) listed lack of PA as the fourth largest risk factor for all-cause mortality in high-income countries such as Canada, as well as globally.[12] There is also a growing body of literature in adult populations indicating that lack of PA may be an independent risk factor for at least 25 chronic diseases including CVD, type II diabetes, certain cancers, and psychological disorders such as depression.[13,14] A recent debate has also developed over whether "fitness" may be more important than "fatness," [15,16] or, in other words, whether being physically active may negate

the importance of losing weight.[17] Although an in-depth examination of this debate is beyond the scope of this literature review, it is sufficient to state that, irrespective of body weight, increased fitness leads to greater health benefits.[18] For example, findings from the Look Ahead study, a large ethnically diverse cohort of obese adults with type II diabetes, found that poor fitness and obesity were both independently related to CVD risk factors.[19] Although no studies have looked at the relative importance of "fitness versus fatness" in children, it is likely that, regardless of child's body weight, PA can provide independent health benefits.

1.2.1 Physical Activity Guidelines

Evidence suggests that an effective primary public health strategy for improving lifelong health of children is the fostering of a lifestyle pattern or routine of regular PA during childhood that might carry into their adult years.[20] Thus, finding ways of encouraging children to adhere to current PA guidelines has been critically important to public health researchers over the past few decades.[21-23]

In Canada, the PA guidelines suggest that for maximum health benefits, children (aged 5 to 17) should: [1] get at least 60 minutes of moderate to vigorous physical activity (MVPA) daily; [2] perform vigorous activities at least three days per week; and [3] perform activities that strengthen muscle at least three days per week.[24] Moderate physical activity (MPA) can be defined loosely as any activity equivalent in energy expenditure to a brisk walk, or more specifically as an activity that is performed at an intensity corresponding to 64% to 76% of an individual's maximum heart rate.[25] Vigorous physical activity (VPA) can be defined as

any activity that results in an energy expenditure equal to or greater than jogging, and has an individual's heart rate at over 77% of its maximum.[25] The researchers involved in creating the guidelines maintain that even if the guidelines cannot be met, small increases in PA can have large benefits, especially in those children who are the least active.[24, 26]

1.2.2 Physical Activity Levels of Canadian Children

Accurate assessment of PA levels in Canadian children can be a complicated endeavour as there are a number of validated measures of PA, each of which have both strengths and limitations. Self-report measures of PA are most often used for population assessments of PA, although accelerometers have been used increasingly in recent years. As these techniques are inherently measuring different aspects of PA (i.e., accelerometers measure walking-based activities while self-report measures assess perceptions of PA frequency, intensity, type, or time) prevalence results based on these different measures often differ quite a bit, and there is no assessment technique that is considered the gold-standard in all situations.

Accelerometry data from the 2007 to 2009 Canadian Health Measures Survey indicate that only about 9% of boys and 4% of girls (aged 6 to 19) are getting 60 minutes of MVPA at least six days per week and only 4% of children are getting more than 20 minutes of VPA at least three days per week.[27] In the United States (US), the trends are similar, though much more promising for young children: accelerometry data from a subset of the National Health and Nutrition Examination Survey show that 48% of boys and 35% of girls aged 6-11 are getting at least 60 minutes of MVPA at least five days per week.[28] The data from American

children aged 12 to 15, however, mirror the Canadian numbers, indicating that only 12% of boys and 3% of girls are getting at least 60 minutes of MVPA at least five days per week.[28]

In contrast, when self-report measures of PA have been used in children, the findings have been quite different. The 2001-2002 Health Behaviour in School-Aged Children survey (a cross-national study conducted in 34 countries of children in grades 6-10) is the most recent study that examined prevalence of PA among children using the Canadian guidelines described above.[29] This study found that 44.9% of Canadian children reported getting more than 60 minutes of cumulative PA on five or more days per week.[29] Similarly, the Canadian Community Health Survey (CCHS; 2004) asked children (aged 6-11) to self-report their MVPA: [1] in school; [2] out of school in organized sport; and [3] out of school in free play or unorganized sport.[30] The CCHS data indicated that 83% of Canadian children were getting seven or more hours of MVPA weekly.[30] It is important to note that in the CCHS, PA was measured as an aggregate weekly amount, and was not concerned with how many days children had 60 or more minutes of PA in the past week.

To get an idea of where Canada ranks from a global perspective, a recent article comparing 13 developed countries by average step counts (a similar measurement of PA to accelerometry that does not take into account the intensity of activities) found Canada alongside the US at the bottom, more than 3,000 steps per day below countries like Australia and New Zealand.[31] It is clear that much needs to be done to increase the PA levels of Canadian children.

1.3 The School Environment

The school environment is considered an ideal target for addressing childhood obesity and promoting an active lifestyle in children.[32-34] For example, in its new report on obesity prevention, the US Institute of Medicine included 'making schools a focal point for obesity prevention' as one of their five main recommendations for sustainable obesity prevention.[34] Interventions in this environment have the ability to reach almost all children as most children attend school.[35] Furthermore, since children spend most of their waking hours at school, it is an important setting in which to encourage PA and healthy living.[32]

For public health researchers and health promotion professionals, the school environment is an enticing intervention setting as it provides not only a venue for the provision of supervised PA, but also a setting in which to educate children on the importance of being active. Unfortunately, results from reviews looking at the efficacy of school-based interventions targeted at increasing PA or decreasing Body Mass Index (BMI) have been extremely variable.[36-38] A thorough review by Dobbins and colleagues (2009) on school-based programs for promoting PA in school-aged children highlights these inconsistent findings.[38] These researchers felt that overall there was good evidence to suggest that school-based interventions can be an effective means of increasing total PA;[38] however, they also found that school-based interventions were not effective for increasing the amount of time children were physically active in their leisure time, nor were they effective at reducing BMI.[38] Dobbins and colleagues note that difficulties arose in creating consensus results in their review, as studies exploring PA in schools have used a myriad of different outcome variables (e.g., minutes of MVPA vs. defined bouts of VPA), PA measurement tools (e.g., self-report

vs. objective assessment), and intervention strategies. In addition, a large proportion of studies that met the relevance criteria were of insufficient quality to be included in this review, highlighting the need for more rigorous and methodologically sound research in this area.[38] However, Brown and Summerbell (2009) suggest that inconsistent findings are likely due, at least partially, to the variety and heterogeneity in the types of PA interventions that have been implemented in school settings.[36] For example, school-based interventions targeted at increasing student PA have included: providing educational materials to students[39] and parents;[40] altering the PE curriculum;[41,42] adding PA sessions to the school day;[43] modifying recess;[44] changing the school playground;[45,46] adding or changing after-school programs;[47] and attempting to decrease television watching.[48] Many of these interventions are multifaceted and target multiple school areas (e.g., interventions that target both curriculum and PA facilities).[38] In addition, many of these PA interventions are combined with nutrition interventions,[49,50] which further complicates comparisons across studies.

The interventions that have shown the most consistent success in changing PA behaviours have often been multifaceted and been guided by an ecological framework (those that alter environmental settings).[51] For example, the Child and Adolescent Trial for Cardiovascular Health (CATCH) that targeted PE curriculum, school PA policies, and teaching practices, resulted in increased MVPA in the intervention group.[49] Specifically, in a three-year follow up of the CATCH randomized trial, students in the intervention schools averaged 30.2 minutes of daily VPA, while students in the control schools averaged only 22.1 minutes ($p < 0.001$).[52] Similarly, Action Schools! BC utilized a social ecological model to guide their intervention, which targeted multiple levels of the school environment (school policies,

school environment, classroom activities, PE curriculum, and school community involvement) with the purpose of increasing PA opportunities in the schools.[53] Action Schools! BC proved successful in creating more opportunities for children to participate in PA at school, and students in the intervention schools participated in more PA (as measured by accelerometry), [54] had lower cardiovascular disease risk profiles[55] and had greater bone strength[56] than students in the control group.

Although the evidence from school-based interventions to promote PA has been somewhat variable,[38] the US Centers for Disease Control Community Health Guide concludes that the school environment is still a critical venue in which to promote PA to children.[57-59] As a result, in recent years much effort has gone into determining which specific aspects of the school environment are the most important for influencing PA behaviour. If these environmental factors are identified, it is thought that this knowledge will help improve future PA interventions.[60]

1.3.1 Specific School Environment Factors Associated with Physical Activity

Numerous studies have sought to discover which specific environmental factors are the strongest determinants of PA behaviour in children.[61] Unfortunately, findings from ecological studies (meaning 'studies of the environment') that explore the PA behaviour of children have been inconsistent. A recent systematic review of reviews looking at environmental correlates of PA behaviours in children found little consensus on any one environmental factor (including home environments, neighbourhoods, etc.) that showed consistent associations with PA behaviour in children.[61] Not surprisingly, then, little

consistency is seen when examining if any specific school environment factor is associated with the PA levels of students. For example, a longitudinal study in a naturally representative sample of elementary and secondary school students in Australia determined that median levels of total PA (as well as fitness and BMI) were similar across schools regardless of facilities, policies, or other environmental factors. This suggests that school environmental factors may actually have no association with student PA. The researchers concluded that current school policies around PA were lacking sufficient intensity to have an effect on student PA at the individual level.[62] In contrast, a recent review by Ferreira and colleagues determined that school-policies related to PA were in fact positively associated with PA levels in children.[60] For example, they found that studies which explored the influence of PA policies – such as the amount of free play provided to children – supported a positive association between these policies and PA behaviours.[60] Clearly, there is still debate among academics regarding the relative importance of school environment factors on PA behaviour. School environment factors that have been looked at for potential associations with PA include: [1] physical factors such as school location, school facilities; [2] social factors such as teacher/school support for PA, teacher's PA levels, and teacher's education level; and [3] policy factors such as school enrollment and school PE programming, to name a few.[60,61]

One school environment factor that has shown relatively consistent correlations with PA levels in children is the amount of PE provided to students. For example, a recent paper looking at school environment and PA in school-aged girls in Scotland found that the time schools allocated to PE was the strongest predictor of MVPA on a weekly basis.[63] Another study found that the number of days in which PE was provided per week was positively

correlated with PA levels in American high school students.[64] In addition, Hobin and colleagues (2010) found that Canadian elementary students who were offered more than two PE classes per week participated in more moderate intensity activity and high-intensity activity than those students who participated in fewer than two PE classes per week.[65]

1.4 Physical Education

It has long been thought that PE plays an important role in public health and PA promotion.[66,67] In theory, structured and supervised classes led by qualified teachers provide students with the physical skills required to pursue PA outside of the classroom, while simultaneously educating them about the importance of living an active, healthy lifestyle.[68] Furthermore, for many students, PE classes may be their only source of regular PA.[69] The evidence surrounding the importance of PE on total daily PA in school-aged children, however, has been variable. In 1998, Rowland argued that children had a biological drive to be physically active, and that children compensated for lost PA (i.e., if PE were to be removed) by being more active at a later time (e.g., after school).[70] However, a later study investigating this compensatory phenomenon determined that not only did children get less total PA on days when PE or recess was not offered, but children were actually more active in the after school period (3:30 – 7:00PM) on days when recess and PE were offered than days when they were not.[71] Although no theoretical basis was provided in this study explaining why children might have been more active after school on days they were provided PE than on days they were not, more recent literature has addressed this question. For example, Self-Determination Theory[72] predicts that students taking PE who have: [1] improved at an activity (gained competence); [2] a greater amount of choice in their PA

participation (have autonomy); or [3] built relationships with other students in the class (feel connectedness), are more likely to participate in PA outside of school than students who have not.[73] Although research in this area has been minimal, early results indicate support for these assertions.[74]

There is also still debate as to whether increasing the frequency of PE provided to students would be enough to increase PA in children, as some studies have found that students do not spend the majority of PE classes in MVPA.[75] This debate, however, seems to focus simply on how much PA students get in the PE class while ignoring the bigger picture of how PE might increase total weekly PA, outside-of-school PA, or PA behaviour tracked throughout the lifecourse. For example, a more recent study looking at PA on days PE was provided versus days PE was not provided replicated the results of the earlier study. These researchers found that on days that PE was offered – the least, moderately, and most active children accumulated 1,700, 1,100, and 2,500 more steps per day, respectively, than on days where PE was not offered. In addition, after controlling for PE time, they found the most active children were even more active on days when PE was offered.[76] Strangely, although many studies have shown PE interventions or PE frequency are positively associated with increased PA,[63,65,77] few relationships between PE and BMI have been found.[78,79] O'Malley et al suggest that a possible contributory factor to this lack of association is that there is a paucity of PE programs that are demanding enough to result in any measureable differences in BMI.[78] By "demanding," they are referring not only to the percentage of PE classes that the students are involved in MVPA, but also the amount of PE classes that are required on a weekly basis. For example, one study that increased the proportion of PE classes dedicated

to MVPA but did not increase the actual number of PE classes that were provided, found no significant changes in BMI.[80] In contrast, a recent longitudinal study found that for each additional weekday that a child participated in PE, their odds of being an overweight adult decreased by 5%.[81] Thus, having a greater number of PE classes has shown to have short term benefits for PA levels in children while also showing to have potential long term benefits on BMI.

1.4.1 Physical Education Policy

In Canada, the PE curriculum is mandated provincially, and, as such, there are no national standards outlining how much PE is required in schools. At the secondary or high school level, most provinces require students to take at least one PE course in order to graduate.[58] However, at the elementary school level there is little consistency in how the provinces mandate PE requirements. In some provinces – notably Ontario and British Columbia (BC) – there is no mandated amount of required PE for elementary school children.[58] Therefore, it is up to school administrators or individual teachers to determine how much PE they provide to their students. It is important to note that although there is no mandated PE, both Ontario and BC (among other provinces) have implemented Daily Physical Activity policies. These policies mandate that schools provide at least 20 minutes (Ontario) or 30 minutes (BC) of PA to each student daily through any means that schools or individual teachers choose, which may include: PE, recess, or supervised play.[58,82] Although no universal policies for PE provision exist in BC or Ontario, a number of relevant groups have provided suggestions for how much PE should be provided in order to provide students with maximum health benefits.[58,83] For example, Physical Health and Education Canada (PHEC; formerly the

Canadian Association for Health and Physical Education, Recreation, and Dance) released a position statement on what it calls Quality Daily Physical Education,[83] which is conceptualized as "a well-planned school program of compulsory PE provided for a minimum of 30 minutes each day to all students (kindergarten to grade 12) throughout the school year.[83] PHEC adds that this daily PE should include curricular instruction, activities for enhancing cardiovascular and muscular strength, intramurals, and an emphasis on participation, fun and fair play.[83] Active Healthy Kids Canada in its annual PA Report Card for Children and Youth (2011) recommend that daily PE be mandated in all schools for all ages, as well as the hiring of PE specialists for all ages.[58] Unfortunately, little is known on how much PE is actually being provided to elementary school students across Canada.

1.4.2 Physical Education Quantity in Canada

Results from the 2006 Canadian Fitness and Lifestyle Research Institute's (CFLRI) Survey of PA in Canadian Schools found that the average elementary school student takes at least three PE classes per week, with classes lasting 42 minutes on average.[84] This report, however, does not provide much in the way of provincial comparisons except to state that Ontario, BC, Manitoba and Nova Scotia have shorter classes than the national average. In another CFLRI survey, parents of children in all grades (K-12) reported that 9% of children do not receive any PE, 44% are getting between one and two classes per week, 25% are getting three or four classes per week, and 22% are getting daily PE.[85] A paper by Hardman and Marshall (2000) providing an international comparison of factors relating to PE found that only 57% of Canadian schools were providing the amount of PE that is statutorily mandated by the province. This can be compared with 74% in the US, 87% in European

countries, 70% in Oceania and 33% in Asia.[86] These results suggest that many Canadian schools are still finding it difficult to provide regular PE. Although there is clearly a need for more rigorous investigations into what is actually happening inside schools, most Canadian schools are apparently not providing daily PE as has been recommended by a number of researchers and health agencies.[76,87,88]

1.5 How the School Environment is Related to Physical Education Provision

To summarize, it has been established that increased MVPA in children has numerous lifelong health benefits, including the short- and long-term prevention of obesity.[89,90] There is also evidence, albeit not overwhelmingly so, that more PE is associated with more MVPA.[64,65] Moving further upstream in the causal pathway for PA, the next question to be considered is what factors influence how much PE children get. Unfortunately, very little is known about what school environment or demographic factors might influence the amount of PE elementary schools provide their students with. Results from CFLRI indicate that larger elementary schools and urban elementary schools in Canada provide fewer PE classes per week than smaller or rural elementary schools.[84] One study from the US found that schools with PE specialists (i.e., bachelor training in PE) provide more PE than schools without PE specialists,[91] while another found schools that have a low student-to-PE teacher ratio provide more PE than do schools without.[92] In addition, a recent study from the US found that elementary schools that had access to a gymnasium provided students with more PE than schools without such access.[93] Beyond these studies, however, there is very little available research on factors that are associated with PE provision at the elementary school level. There are some studies that have looked at variables relating to PE enrollment at the high

school level.[94,95] For example, Hobin et al (2010) found that students attending schools that offered daily PE were more likely to enroll in PE than students attending schools that did not offer daily PE.[94] High school PE, however, is in many ways conceptually different than elementary school PE, given that, for example, in many schools children can volitionally drop PE beginning in high school.[58]

Thus, while it is known that school environment factors such as PE are related to PA behaviour in children, there is still very little known about what school environment factors are associated with the amount of PE a school provides to its students. Better understanding the relationship between school environments, PE provision, and PA behaviour will be critical for policy makers, stakeholders, and public health researchers to better target school health promotion campaigns both currently and in the future.

1.6 Theoretical Perspectives for Examining the Influence of the School Environment on Physical Education Provision

Since few studies have explored the relationship between school environment factors and PE amount, there has been almost no development of theory with which to help frame this type of research. Therefore, any study seeking to better understand this relationship would have to combine or amend preexisting theories in order to develop research questions, determine variables of interest, and establish study hypotheses. Incorporating elements from the Environmental Research Framework for Weight Gain Prevention (EnRG),[1,96] and the Theories of Organizational Change might provide a useful framework for exploring how

school environment factors are associated with the amount of PE provided to students and their overall PA behaviours.

The EnRG developed by Kremers et al (2006),[1] is in many ways similar to Mcleroy's (1988)[97] socio-ecological model, which conceptualizes individuals as an entity that exist within different levels of environment and are influenced by these environments in different ways.[97] The EnRG, however, also takes into account the more detailed inter- and intra-personal factors associated with what are termed energy balance-related behaviours (e.g., PA and healthy eating).[1,96] In this model (depicted in Figure 1), Kremers and colleagues outline how different environmental influences (e.g. physical, political, socio-cultural) occurring at different levels (e.g. micro vs macro) could influence energy balance-related behaviours either directly or indirectly (e.g., when mediated through cognitive factors such as intention).

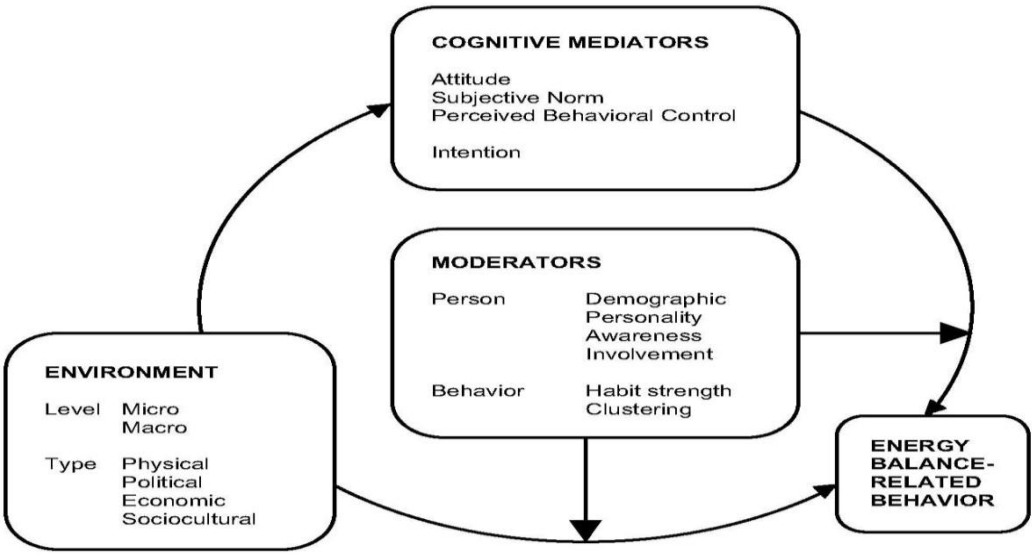


Figure 1. Kremers' Research framework for weight Gain prevention.[1]

Although this model was created to look at individual-level behaviours (e.g., PA) the model can be modified to examine how school-level (or organizational) factors might influence the amount of PE provided to students and how this provision, in turn, could influence PA behaviour (see Figure 2). This change to the EnRG takes into account that PE provision is not an individual-level outcome (or behaviour) but rather is an outcome at the school level, or organizational level. Thus, although never previously used with the EnRG, the Theories of Organizational Change would help to operationalize the school-level factors that might influence PE provision (see Figure 2). Such a strategy is proposed as constructs from the Theories of Organizational Change provide a framework for understanding why organizations perform certain activities in certain ways (e.g., why they might provide the amount of PE that they do). Further, these theories have proven useful in previous implementation studies relating to school-based PA[102] and PE.[98-100] The Theories of Organizational Change focus on how changes within different compartments of an organization can influence, or be influenced by, properties of the organizations themselves. Constructs described as important factors in the ability an organization possesses to implement changes include: [1] organizational climate: the preexisting and underlying collective sentiments of an organization towards any given factor (e.g. PE or PA provision); [2] organizational capacity: the ability an organization would have to change a factor (such as PE provision) if they wanted to; and [3] pre-existing policies: the current policy state of the organization related to a given factor (e.g. current PE or PA policies).[101]

After the integration of the Theories of Organizational Change into the EnRG (Figure 2), the framework suggests that organizational climate, organizational capacity, and existing PA/PE

policies would be associated with PE provision and would also be thought to influence student PA levels either directly or indirectly.

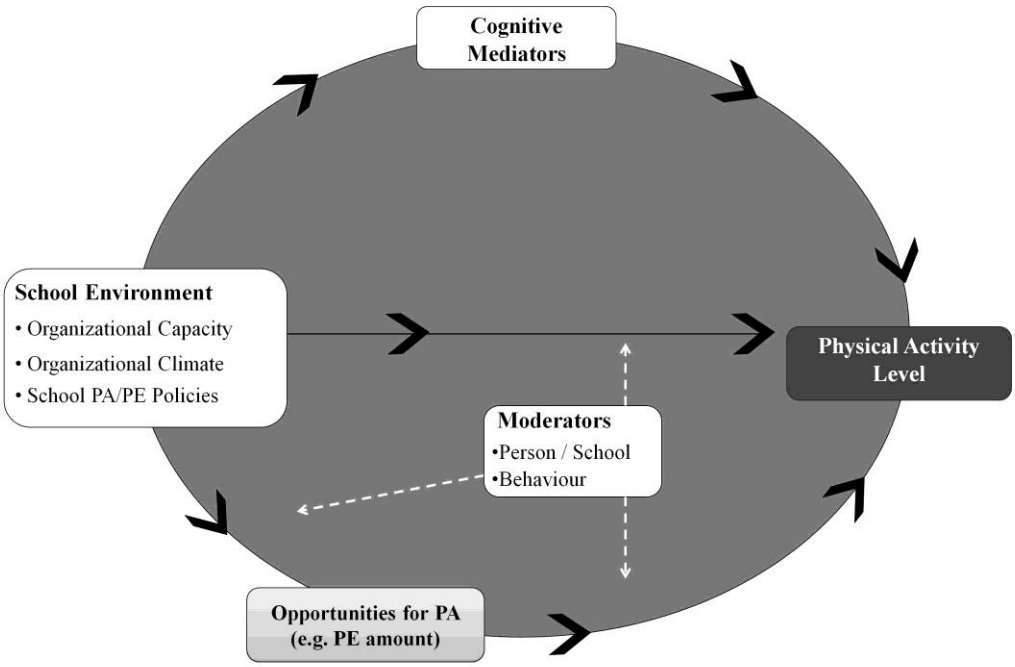


Figure 2. The Environmental Research framework for weight Gain prevention adapted and operationalized using the Theories of Organizational Change.

1.7 Purpose

The purpose of this study was to determine what school-level factors – as depicted in Figure 2 (e.g., organizational climate, organizational culture, and school policies), were associated with the number of PE classes provided to elementary school students in a given week (**aim 1**). In addition, this study strived to determine whether these same school factors, as well as the amount of PE students received, were associated with their overall levels of PA (**aim 2**).

1.8 Hypotheses

Aim 1: to determine whether a school's organizational climate, organizational capacity and policy factors were associated with the amount of PE that students reported receiving in the previous week.

Hypothesis for Aim 1: Schools that have a more favourable organizational climate towards PA/PE, have a greater organizational capacity for providing PE, and have a written PA/PE policy will provide significantly more PE classes per week to students, after controlling for relevant school-level and student-level covariates.

- See Figure 2: The pathway between "School Environment" and "Opportunities for PA" was explored for this hypothesis.

Aim 2: to determine whether a school's organizational climate, organizational capacity, and policy factors (including the frequency of PE) were associated with self-reported levels of PA in students.

Hypothesis for Aim 2: Schools that have a more favourable organizational climate towards PA/PE, have a greater organizational capacity for providing PE, have a written PA/PE policy, and have greater opportunities for PE at school will be significantly more likely to have students report high levels of PA, after controlling for student-level covariates.

- See Figure 2: The pathway between "School Environment" and "Physical activity level" were explored for this hypothesis, while "PE Amount" was explored as a school-environment factor.

The influence of cognitive mediators, while recognized as important, was not examined for this study as these variables were not measured. Therefore, the cognitive mediators incorporated in Figure 2 were included as a reminder that mediating cognitive variables are likely influencing some of the associations between the school environment variables and PA behaviour.

1.9 Rationale

While researchers and national agencies continue to stress the importance of daily PE,[57,83,87] little is known about whether schools have the means to provide more PE than they are currently providing. Understanding the school-level factors that are associated with the frequency of PE provided to students may be important, as these factors may represent barriers or facilitators for the implementation of future PE policies. The results may also help Canadian provincial governments and stakeholders in allocating financial or material aid to elementary schools that may be at risk of being unable to provide recommended amounts of PE to their students. In addition, these findings will add to the literature on the importance of PE for PA promotion.

Chapter 2: Methods

2.1 Research Design

The study questions were addressed by conducting secondary data analyses using data collected from the 2007-2008 wave of the Physical Activity of Youth in Ontario Schools (PLAY-ON) study. The PLAY-ON study was conducted by the School Health Action, Planning and Evaluation System (SHAPES) staff at the University of Waterloo. Both student-level (n=2,449) and school-level (n=30) data collected for the PLAY-ON study were analyzed. Ethics approval was granted for this secondary data analysis through the University of British Columbia Research Ethics Board in 2011.

2.2 Data Source

The PLAY-ON study was supported by the Heart and Stroke Foundation of Ontario during the 2007-2008 school year. Data was collected from 30 elementary schools across the province of Ontario. For the secondary data analyses that were undertaken for this study, two sources of data from the PLAY-ON study were used: school-level data and student-level data. School-level data for this study came from administrator responses to the elementary school version of the School Health Environment Survey (SHES). Student-level data for this study came from a survey of students in grades 5 through 8. Data collection for the PLAY-ON study was approved by the Research Ethics Board of the University of Waterloo, and consent was gathered from school boards, school administrators, students and parents of students who participated in the study.

2.3 **School – Level Data**

2.3.1 Participants

Due to constraints of time and budget, schools were not randomly selected to participate in the PLAY-ON study; however, the study attempted to include a diverse sample of school boards and subsequently schools. Note that Eastern Ontario schools were not eligible for participation as the school board did not provide approval to recruit schools for the study.

The final sample of schools was n=30 from seven different school boards. Of the 30 schools, 15 were classified by the research team as being in an urban area (had a minimum population concentration of 1,000 persons and a population density of at least 400 persons/km^2 based on the most recent census population count) and 15 were classified by the research team as being in a rural area (all areas not defined as urban). Of the schools recruited, six were from Northern Ontario, 15 were from Central Ontario, and nine were from South-Western Ontario.[102] All 30 administrators filled out and returned the SHES (100% response rate).

2.3.2 Data Collection/Design

School-level data were collected from one administrator in each school who filled out the elementary school version of the SHES (with suggested aid from other administrators, teachers and staff). This survey assesses demographic factors such as school size, urban/rural status, and number of teachers, and asks about facilities, programs, and policies relating to PA in the school environment. During the pilot phase of the SHES, agreement was assessed by re-administering the surveys one week apart (called test, re-test reliability), where it was found administrators answered 69% of the questions the same at Time 1 and

Time 2.[103] Upon completion of the SHES at Time 1 and Time 2 two staff from the same school completed the questionnaire together, and reached a consensus on the "best" response for their school for each item. Criterion validity was assessed by comparing the "best response" survey to their individual responses at Time 1. Agreement across Time 1 and the "best response" survey was 75% for administrators.[103]

2.3.3 Consent

School board approval was pursued prior to making contact with the school administrators. School boards were sent a recruitment package including all information regarding the project as well as sample questionnaires. Once participating school boards provided permission for the SHAPES staff to recruit schools within the district, principals at participating schools were mailed the SHES. School administrators then provided implied consent by returning the questionnaire.

2.3.4 Incentives

Schools received an honorarium of $150 for their participation in the project. Those schools with return rates for the parent consent forms (regardless of whether consent was provided or not) in excess of 70% received an additional $100 to be used as the school deemed fit.

2.4 Student – Level Data

2.4.1 Participants

In the 30 participating schools, a total of n=4,838 students were enrolled in grades 5 through 8 (n=8,764 enrolled in all grades). Of the eligible grade 5 to 8 students, 50.6% (n=2,449)

completed the survey, with non-participation mainly due to parental refusal (46.2%; n=2,237) or absenteeism on the day the survey was administered (3.2%; n=152). All students attending the 30 participating schools and in grades 5 through 8 were eligible to participate in the student questionnaire.

2.4.2 Data Collection/Design

Student-level data were obtained from consenting grade 5 to 8 students who filled out the SHAPES Physical Activity Module (PAM), a survey which takes a student approximately 20 to 30 minutes to complete. The PAM has questions pertaining to students' age, height and weight, sedentary behaviours, as well as factors relating to their levels of PA. The survey has demonstrated reliability using weighted kappa scores from a one-week test-retest reliability protocol for PA level ($K=0.58$; $P < 0.05$).[104] The PAM has also demonstrated criterion validity with a Spearman correlation for average daily MVPA ($r=.44$, $P<0.01$) using accelerometers and measured height and weight.[104] The kappa scores from the SHAPES survey are comparable to other questionnaires designed for youth such as the WHO Health Behaviour in School Aged Children survey, where weighted kappa coefficients on vigorous PA range from 0.22 to 0.60 depending on age and gender.[105] In addition, although the Spearman correlation score for MVPA is modest at $r=.44$, it is comparable with other youth surveys such as the PA Questionnaire for Adolescents ($r=0.39$, $P<0.05$) which has also been tested for criterion validity with accelerometers.[106]

2.4.3 Consent

Information letters were sent home with all students for their parents to read; a parental signature on this letter was required in order for their son or daughter to participate. Schools then collected the forms and sent them to the SHAPES staff for record keeping. Assent scripts were read to the students in their classrooms before questionnaires were filled out where they were informed that they could decline to participate at any point.

2.5 Measures

2.5.1 Dependent Variables

Aim 1 Outcome: Physical Education Amount (<u>Note:</u> also an independent variable for aim 2)

Grade 5 to 8 students were asked how many PE classes they were offered in the past seven days; answers were provided on a ratio scale where students could choose a response of zero through five classes. The responses to this question were treated as an individual-level continuous variable (rather than pooling the numbers and averaging by school).

Although the question of how many PE classes were provided in the last week was asked of both administrators and students, the student responses were chosen for use in this study. The rationale for this choice is that administrators were not asked how much PE was provided to each individual grade or class within the school. There is some evidence that students in different grades receive different amounts of PE. For example, a recent Canadian report found that the average minutes Canadian students spend in PE per week increases

consistently by grade.[107] As a result, the student responses were considered to be most appropriate for this study since they would take into account any differences by grade.

Aim 2 Outcome: Student levels of Physical Activity

Grade 5 to 8 students were asked to report how many minutes per week they had spent independently in VPA and MPA in each of the past seven days. Response options for these two questions ranged from zero minutes through to four hours and 45 minutes and response options were incremented by 15 minutes. As children are known to have difficulties recalling exact amounts of PA in self-report,[108] it was decided to categorize students into minimally-active, moderately active, and highly-active categories as has been used elsewhere.[109] To pool students into the three categories, first, minutes of VPA and MPA were combined to determine total weekly MVPA (see APPENDIX A for histogram of MVPA); then, the levels of MVPA were split into tertiles to represent the most minimally-active, moderately-active, and highly-active students.

2.5.2 Independent Variables

Various school environment factors based on administrator responses from the SHES survey were used as independent variables for **aim 1** and **aim 2.** Reliability and validity of this questionnaire have been discussed above. To examine **aims 1** and **2**, the same independent variables were used, but slightly different covariates were included in the analyses (i.e., control variables, described in more detail below).

School Organizational Climate Relating to Physical Activity / Physical Education

School organizational climate relating to PE/PA was operationalized for this study as a group of factors that represented the overall school attitude towards PA or PE (i.e., those of the administration, teachers, staff), or practices that created an environment more conducive to increased levels of PA or PE at school. The school organizational climate included factors relating to whether schools provided PA as a reward, the amount of support that was provided for active transportation (e.g., bicycling, walking, or running to school), the level to which parents were included in the PA-related dialogue within the school, and the level of gymnasium access schools provided to students both inside and outside of school-hours.

The use of PA as a reward: Administrators were asked whether their school used PA as a reward on a four-point scale consisting of "A lot", "Some", "Very little", and "Not at all". So as to not include small values in cells (only one administrator responded "A lot"), this variable was dichotomized into two categories: "High" ("A lot" and "Some"), and "Low" ("Very little" and "Not at all").

School active transportation: Two variables were used to assess school active transportation. [1] The first variable examined whether the school implemented safety provisions to encourage active transportation to and from school. Administrators were asked if the school designates a 'car free zone' to provide safe walking routes around the school. They were given the response options "Yes," "No," and "Don't know." This was treated as a dichotomous variable (Yes/No), while "Don't know" responses were coded as missing. [2] The second variable was an index variable that was created for this analysis. The index used

administrators' answers to two questions that asked whether they organized a walking/cycling-to-school program or whether they organized occasional 'walk to school days' or walking clubs. These two questions focused on the same concept, with the caveat that one question asked about 'occasional' and one question asked about 'programs' which implied regularity. Responses to these two questions were collapsed to create a binary variable indicating whether the school promotes active transportation by organizing a walking/cycling-to-school program *or* occasional 'walk to school' days. As both questions offered the responses "Yes," "No," and "Don't know," this variable was coded and analyzed as a binary variable (Yes/No), while "Don't know" responses were coded as missing.

Access to a gymnasium outside of school hours: Administrators were asked if students had regular access to the gymnasium outside of school time and given responses: "Yes", "No", "Don't know", and "N/A." This was analyzed as a binary variable (Yes/No) while "Don't know" responses were coded as missing. No administrators responded "N/A."

Access to gymnasium during school hours: Administrators were asked if students have access to the gymnasium during non-instructional hours of the school day and were given the responses: "Always", "Most of the time", "Sometimes", "Rarely", "Never", and "N/A." Due to the distribution of responses (only one administrator responded "A lot"), this variable was collapsed into three categories to avoid low values in cells: "Always/Most of the time" "Sometimes" and "Rarely/Never." These three categories were renamed as "Often" "Sometimes" and "Rarely." Two manual contrasts were run to examine the association

between this variable and the outcome variables: [1] Often versus Sometimes/Rarely; and [2] Often versus Rarely.

Parental involvement in the school PA decisions or dialogue: This variable was conceptualized as the extent to which the school included parents in decision-making, dialogue, and programs related to school-based PA. This variable was measured on a scale that was developed for this study and was created from four separate items. Two items asked whether the school had opportunities that encouraged parents/families/guardians to: [1] incorporate PA into family events and [2] be involved in organizing or planning events, school services and facilities related to PA. The other two questions asked administrators if in the past 12 months, their school: [1] met with a parents' organization (e.g., school council) to discuss PA at school, and [2] formally collected suggestions from parents/families/guardians about PA at school. For all of the questions the responses "Yes," "No," and "Don't know" were offered. Total "Yes" responses to these four items were totaled and then divided by the total number of questions that were answered. These items targeted the same conceptual domain, and the Cronbach's alpha for these items was 0.64 which is considered to be on the lower end of acceptability for a scaled item;[110] however, for studies with smaller sample sizes (such as this one), this score is considered to be acceptable (see Appendix A for a histogram of the scale).[111]

School Organizational Capacity to Provide Physical Education

School organizational capacity was conceptualized for this study as factors that might influence a school's ability to provide PE to its students, including the number of additional

facilities the school had available for PE provision, and whether the school provided intramural programs.

Additional facilities for PE provision besides gym: Administrators were asked if the majority of students at school had access to a variety of different facilities on school grounds. Only facilities which had the potential to act as a venue for a PE class were included in this measure. In addition, as all responding schools had an on-site gymnasium, it was decided to look only at additional facilities for PE classes. As such, a large room suitable for PA (other than a primary gymnasium), an outdoor field, and an outdoor paved area for PA (which must have included lines on the pavement to mark game areas) were the only items included. The survey choices were "No", "Yes, both on and off grounds", "Yes, off grounds only", "Yes, on grounds only", and "Don't know." Responses to the included items were recoded as a "Yes" if respondents answered "Yes, on grounds only" or "Yes, both on and off grounds" and were recoded as "No" if they responded "No" or "Yes, off grounds only." This variable was a summed score (maximum score = 3) which was then treated as a categorical variable. A summed score was used rather than creating indicator variables for each individual facility because it was hypothesized that the more different areas a school had, the greater the capacity the school had to provide more PE. For example, if one school only had a field and another school only had an outdoor paved area, it was hypothesized that these two schools were limited to the same extent by PE facilities. Alternatively, if another school had both a field and a paved area, this school was thought to have greater capacity for providing PE, since there were more separate areas to provide multiple concurrent PE classes. Two contrasts were computed for this variable: [1] schools with two additional facilities were

compared to schools with zero or one additional facility for PE; and [2] schools with three additional facilities for PE were compared to schools with zero or one additional facility for PE. Schools with zero or one additional facility were combined into one category as only one school had no additional facilities beyond a gymnasium.

School has intramural programs: Administrators were asked if their school offers an intramural program/club activities that involve PA. This question had a clarification below as follows: "Intramural programs/club activities are school sponsored physical/recreational 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." Administrators were offered the responses "Yes," or "No." This variable was analyzed as a binary variable (Yes/No).

Physical Activity / Physical Education Policies

For the purposes of this study, policy is theorized as an explicit written guideline or set of guidelines rather than practices, which is captured under school organizational climate. While conceptually similar (e.g., creating a PE policy could be conceptualized as a PE practice of sorts), a written policy does not always result in the implementation of practices.[112,113] For example, a recent study found that only 44% of elementary school teachers were aware of their school's PA policy, and that awareness was associated with policy implementation and the PA levels of the students.[113] Therefore, for the purposes of this study, having a PA/PE policy was conceptualized as separate from the school organizational climate, as the forces at work for creating a written PA/PE policy (e.g., district

pressure or for good public relations) may be different than the internal forces influencing organizational PA/PE climate.

School has written PA/PE policy: Administrators were asked if their school's priority on PA in the area of curricular education had been outlined through written policies or practices. Five categories were offered: "N/A", "No", "Yes, through practices", "Yes, through written policies still under development", and "Yes, through written policies". This variable was collapsed into three categories as no administrators responded "Yes, through written policies still under development," or "N/A." Thus, this was a three-level categorical variable with the categories "Yes, through written policies," "Yes, through practices," and "No." Two manual contrasts were created to test the associations of the variable with the outcome variables: [1] Yes, through written policies and Yes, through practices versus No; and [2] Yes, through written policies versus Yes, through practices and No.

2.6 Analyses

To examine the association between school-level factors and student-level outcomes, the school-level administrator data (from the SHES) was linked to student-level data (from the SHAPES - PAM survey) using the school-specific ID. Because of this nested or hierarchical structure of the data, multi-level statistical techniques (also called hierarchical linear modeling) were used. All analyses were completed using Stata v11. (StataCorp, Texas).

2.6.1 Analyses for Aim 1

Multi-level linear regression modeling was used to examine what school-level factors were associated with the amount of PE students received (**aim 1**). A two-step sequential modeling process was used to examine the influence of the school-level variables on the amount of PE students reported receiving. In step 1, a univariate mixed effects random-intercept model was used, which looked individually at the relationship between each independent variable and covariate and examined its relationship with the outcome variable. A random coefficient model (the random-intercept model being the simplest form of a random coefficient model) was chosen because: [1] the schools in this study are considered to be a sample of schools taken from a population of all possible schools; and [2] effects of group-level variables were to be tested, which in so-called fixed effects models cannot be performed since no unexplained variability would remain that could be explained by group-level variables.[114]

In step 2, a multivariate mixed-effects model that included all independent variables, the covariates, and a random slopes coefficient for the student-level covariates gender and grade was used.[114,115] In this model, all independent variables and school-level covariates were entered as fixed-effects, while the student-level covariates grade and gender were entered as random-effects. For this analysis it was hypothesized, for example, that boys and girls may be offered different amounts of PE depending on whether the school offered co-ed or single sex PE classes (which we did not have information about). In other words, it was hypothesized that in some schools gender might be associated with how much PE is provided to students while in other schools this association might be non-existent (i.e., in schools that provided co-ed classes). The association with grade was also thought to vary by school and

was also modeled with a random slope. In random-slopes models, the variables that are entered as random-effects variables (entered into the random component of the model) attempt to explain the residual (or random) error that would have existed had no variables been included in this random component of the model.

2.6.2 Analyses for Aim 2

The analyses used for **aim 2** followed the same two-step model that was used for the analyses in **aim 1,** with a univariate multi-level model being used in step 1 and a multivariate multi-level model with all independent variables and covariates in step 2. As the outcome variable for **aim 2** (PA amount) was a three-category variable, two separate multi-level logistic regression models were run. In Model 1, children classified as highly active were compared to children classified as minimally-active. In Model 2, children classified as moderately-active were compared to children classified as minimally-active. Unlike the multivariate analysis for **aim 1**, this analysis included fixed-effects only since no variables were conceptualized to have random effects at the student-level. Thus, all independent variables and covariates were modeled with random intercepts.

2.6.3 Covariates

Covariates for Aim 1

For **aim 1**, the school-level covariates were: [1] school setting (i.e., rural, urban, or suburban area – treated as categorical with urban schools as the referent group) was thought to be important since urban schools may have had greater access to neighbourhood facilities (e.g., community centres or public parks) that could have been used for PE classes than suburban

or rural schools. [2] school schedule *(*i.e., classes taught in semesters versus those taught in full-year cycles – treated as binary) was thought to be important since in semestered schools there was a potential that some students may have received PE in one semester (potentially daily PE) and no PE in the another semester. This discrepancy would have had large implications on the outcome variable depending on which semester the data were collected in; and [3] the number of students enrolled in the school (treated as continuous) was thought to be important as schools with higher enrollment might have been more likely to have a PE specialist teacher (which has been shown to be associated with increased PE), or, alternatively, may have been limited in their ability to provide PE due to lack of physical space.

Recent papers have supported the notion that age and gender [65] may be associated with differing levels of PA in school-aged children. Further, in some schools (especially in grades 7 and 8) PE might be provided separately by gender, or may differ by grade. Therefore, student grade and student gender were entered as random-effect student-level covariates (discussed above).

Covariates for Aim 2

The analyses used for **aim 2** included both grade and gender as student-level covariates to control for grade and gender differences in the PA levels of the students. No school-level covariates were included for **aim 2** as this aim focused on the association between school-factors and an individually-based behavioural characteristic (PA level). In contrast, school-level covariates were included for **aim 1** because PE amount was a school-level factor

(although it was measured at the student-level). Also, since this analysis investigated the relationship between school-based factors and inside-school PA, two additional student-level covariates attempting to control for out-of-school PA were included in the analyses for **aim 2:** [1] Participation in team sports outside of school (binary); and [2] Participation in other activities (e.g. jogging) outside of school (binary).

2.7 Missing Data

Table 1 lists the independent variables that were included in all of the analyses, as well as the number of missing values associated with each variable. Since these analyses were multi-level, missing administrator responses, if omitted, would result in the omission of student-level outcome responses associated with the given administrator responses as well. Due to the relatively small sample size of the independent variables (n=30 schools), complete-case analysis – in which any observation with at least one missing value in any of the variables included in the model would be removed from the analysis – would have greatly decreased the power of the study.[116] For example, the use of complete-case analysis would have resulted in 27.6% of the student sample being lost as missing data for the model used in aim 1, while 29.4% and 29.2% of the student sample would have been lost as missing data for the models used in aim 2, respectively (see Table 1). As a result, multiple imputation methods were used to adjust for the missing values in the independent variables and covariates. Multiple imputation has been suggested as the most effective statistical method for handling missing data, resulting in less biased estimates than complete-case analysis, the missing-indicator method, or overall mean imputation.[117-119]

Imputation techniques aim to replace (i.e., fill in) missing data with a reasonable estimated value for the variable.[119] These imputed values are created by estimating the distribution of results from the source population using a multivariate regression model, and subsequently drawing a randomly selected value from this distribution to be imputed for the missing variable.[117] This scenario outlines single imputation, which is known to produce unbiased coefficient estimates, but results in standard errors that are too small (overestimates the precision).[119] As such, in multiple imputation, a number of data sets, each containing an alternative randomly drawn value, are created to correct for the imprecision that results from estimating the distribution of the missing values.[117]

To further complicate things, the imputation procedure for this study had to consider the nested structure of the data (students nested within schools). The multiple imputation procedure for the independent variables and covariates at the school-level were undertaken by following the Gelman and Hill methodology,[115] which consisted of computing group means for the student-level outcome variable and merging this with the school-level data-set. Group means were included because the reason for missingness in survey data is often associated with the outcome variable of interest,[120] even if the outcome is at a different level than the missing data.[115] Thus, missing school-level variables were imputed in the school-level data-set, and missing student-level variables were imputed in the student-level data-set prior to the data sets being merged.

Table 1. Missing data at the school level (n=30) and student level (n=2,447).

Variables		School-level missing (n=30)	Student-level missing (n=2,449)
Outcome Variables			
Number of Physical Education (PE) classes in previous week			92 (3.8%)
Physical Activity (PA) Level			51 (2.0%)
School-level Factors			
Organizational Climate			
Uses PA as a reward (n=27)		3 (10.0%)	288 (11.8%)*
Provides a car free zone (n=28)		2 (6. 7%)	175 (7.2%)*
Provides a walking program or walk-to-school days (n=28)		2 (6.7%)	175 (7.2%)*
Provides access to gym: Outside school hours (n=28)		2 (6.7%)	201 (8.2%)*
Provides access to gym: During school hours (n=30)		0	0
Parental involvement in school PA decisions/dialogue: [a] • Parents included • Parents involved • Met with parents • Collected suggestions		 4 (13.3%) 3 (10.0%) 2 (6.7%) 2 (6.7%)	 328 (13.4%)* 352 (14.4%)* 183 (7.5%)* 125 (5.1%)*
Organizational Capacity			
Additional facilities for PE besides gym: [b] • Large room for PA • Outdoor field • Paved area with lines		 1 (3.3%) 0 4 (13.3%)	 66 (2.7%)* 0 435 (17.8%)*
School has intramural programs		0	0
School has written PA/PE policy		0	0
School-level Covariates			
Number of students enrolled at school		1 (3.3%)	37 (1.5%)
School setting		1 (3.3%)	37 (1.5%)
School schedule		1 (3.3%)	37 (1.5%)
Student-level Covariates			
Grade			6 (0.3%)
Gender			13 (0.5%)
Participation in team sports outside of school			86 (3.5%)
Participation in other activities (jogging) outside of school			94 (3.8%)
Percent of missing data for the analyses when using complete-case analysis (C-CA) [c]			
Aim 1 analysis "examining the school-level factors associated with the amount of PE provided per week" (n=2,447)		**6 (20%)**	**677 (27.6%)**
Aim 2 analyses "examining school-level factors associated with levels of PA"	Model 1: Comparing those who have High vs Minimal levels of PA (n=1,637)	**6 (20%)**	**487 (29.4%)**
	Model 2: Comparing those who have Moderate versus Minimal levels of PA (n=1,619)	**6 (20%)**	**474 (29.2%)**

*= Students within schools with missing data are excluded from complete-case analysis in multi-level modeling

[a]= The bullet points represent the four questions used for this scale variable

[b]= The bullet points represent the three facilities used for this summed variable

[c]= In complete-case analysis, any case with at least one missing value in any variable is excluded from the model.

To impute the data, Stata v. 11 (StataCorp, Texas) was used, using the `mi` commands included in the software package. A total of 20 imputed data sets were created for the imputation procedure. Although as few as five imputed datasets have been thought to be a sufficient number in order to produce unbiased results, the imputation of a larger number of datasets has been associated with reduced sampling variability.[121] The majority of the variables with values that were imputed were binary or categorical in nature; as such, rounding methods that have been shown to be successful elsewhere[122] were used after the imputation procedure had been run. This ensured that only plausible values (e.g., 0 and 1 for binary variables) for the formerly missing data were imputed.

Chapter 3: Results

3.1 Demographic Characteristics of Students and Schools

A total of n=2,449 students in grades 5 to 8 from the n=30 PLAY-ON schools consented and participated in the survey. Of those, two students were removed because they had over 90% missing data. Table 2 presents the characteristics of the students and schools included in the study.

As shown in Table 2, the number of participating students was similar for all grades, although slightly more grade 6 and 7 students participated (26.2% and 26.6% for grades 6 and 7, compared with 24.4% and 22.8% for grades 5 and 8, respectively). The sample was composed of n=1,153 males (47.4%) and n=1,281 females (52.6%). The majority of the students classified themselves as Caucasian (79.0%). The amount of PE students reported receiving in the previous week varied, although the majority of students reported attending two PE classes in the last week (38%). The student sample was split into tertiles relating to their PA levels (minimally, moderately, and highly active), though slightly more students ended up in the highly-active group (33.7%) than the minimally-active group (32.9%) based on where the cut-points were made. Most of the students participated in an organized team sport outside of school (72.3%), while slightly less participated in other outside of school PA such as jogging or yoga (61.8%).

Table 2. Descriptive information about the students (n=2,447) and schools (n=30).

	Responses	N (%)[a]	Mean (SD)[a] Range Inter-quartile Range (IQR)
Student-level Characteristics (n=2,447)			
Grade (n=2,441)	5 6 7 8	596 (24.4%) 640 (26.2%) 648 (26.6%) 557 (22.8%)	
Gender (n=2,434)	Male Female	1,153 (47.4%) 1,281 (52.6%)	
Ethnicity (n=2,449)	Caucasian Other	1,936 (79.0%) 513 (21.0%)	
Number of Physical Education classes in previous week (n=2,355)	0 1 2 3 4 5	248 (10.5%) 312 (13.3%) 929 (40.0%) 466 (19.8%) 183 (7.8%) 217 (9.2%)	2.29(1.35)
Physical activity amount (n= 2,396)	Minimally Active Moderately Active Highly Active	788 (32.9%) 801 (33.4%) 807 (33.7%)	
Participation in team sports outside of school (n=2, 325)	No Yes	643 (27.7%) 1,682 (72.3%)	
Participation in other activities (jogging) outside of school (n=2,318)	No Yes	886 (38.2%) 1,432 (61.8%)	
School-level Characteristics (n=30)			
School setting (n=29)	Urban/Inner-city Suburban Rural	5 (17.2%) 14 (48.3%) 10 (34.5%)	
Number of students enrolled at school (n=29)			377(105) Range: [214-630] IQR: 280-440
Number of students per school (n=29)			82(34) Range: [25-158] IQR: 58-105
School schedule (n=29)	Semestered Full-year classes	7 (24.1%) 22 (75.9%)	

[a] = Standard Deviation (SD)

[b]= Inter-quartile range (IQR) = the 25th – 75th percentile values

The majority of schools recruited for this study were from suburban and rural settings (n=14 and n=10, respectively). The average student enrollment was 377 students with the largest school having 630 students and the smallest having 214 students. The average number of students per school was 82, and ranged from 25 to 158 students. Most schools were un-semestered, or followed full-year class schedules (n=22) rather than providing classes on a semestered basis (n=7).

3.2 Description of the School Environment

Table 3 presents descriptive information about the schools that participated in this study. With respect to the organizational climate of the school, the majority of administrators reported using PA as a reward (n=18), providing a car-free zone for encouraging walking around the school (n=16), and providing access to the gymnasium outside of school hours (n=17). A minority of schools organized occasional walk-to-school days or walking programs (n=11), while most schools reported sometimes allowing access to the gymnasium during school hours outside of curricular time (n=17) compared to those who rarely did (n=4) and those that allowed access often (n=9). The mean value for the scale that represented parental involvement in the PA-related dialogue, decisions, and programs of the school was 52.5%.

In terms of the organizational capacity of schools, there was variability in the number of additional facilities for PE provision, although the majority of schools had two additional facilities (n=18). Most schools provided intramural programs (n=25). When looking at the PA/PE policies, most schools reported having written PA/PE guidelines or policies (n=18),

Table 3. Descriptive information on the underlying school-level factors hypothesized to be associated with the amount physical education (PE) provided at school and levels of physical activity (PA).

	Responses	N (%)	Mean (SD)[a] Range Inter-quartile Range (IQR)[b]
School-level Factors			
Organizational Climate			
Uses PA as a reward (n=27)	Very litte / Not at all A lot / Some	9 (33.3%) 18 (66.7%)	
Provides a car free zone (n=28)	No Yes	12 (42.9%) 16 (57.1%)	
Provides a walking program or walk-to-school days (n=28)	No Yes	17 (60.7%) 11 (29.3%)	
Provides access to gym outside school hours (n=28)	No Yes	11 (29.3%) 17 (60.7%)	
Provides access to gym during school hours (n=30)	Rarely/Never ('Rarely') Sometimes ('Sometimes') A lot/Always ('Often')	4 (13.3%) 17 (56.7%) 9 (30.0%)	
Parental involvement in school PA decisions/dialogue[c] (n=29)			52.6 (32.9) Range = [0-100] IQR: 25-75
Organizational Capacity			
Additional facilities for PE besides gym (n=30)	None One Two Three	1(3.3%) 7(23.3%) 18 (60.0%) 4(13.3%)	
School has intramural programs (n=30)	No Yes	5 (16.7%) 25 (83.3%)	
PA/PE Policy			
School has a written PA/PE policy[d]	No Yes, through practices Yes, through written policy	5 (16.7%) 7 (23.3%) 18 (60.0%)	

[a] = Standard Deviation (SD)

[b] = Inter-quartile range (IQR) = the 25th – 75th percentile values

[c] = Parental involvement variable is a scale from four questions relating to involvement of the school community. The construct represents the ratio of questions answered "yes" to total questions answered.

[d] = Question aimed to address *written* PE/PA policy, although participants were provided "Yes, through practices" as an option. This was to ensure that schools with *unwritten* but *practiced* policies would remain separate from those with no policy at all.

while n=7 felt they encouraged PA/PE through practices, and n=5 reported having no guidelines or policies relating to PA/PE at all.

3.3 School Factors Associated with the Amount of Physical Education Provided to Students. (Aim 1)

Results that examine the association between school-environment factors and the amount of PE students reported receiving in the past week are presented in this section. First, between-school variation was examined by running a multi-level model with only the constant included in the model (also called an empty model).[114] Significant between-school variation was seen in the amount of PE students received ($\sigma^2_{\mu 0}$=0.629, $p < 0.001$, where $\sigma^2_{\mu 0}$ is the school-level variance). The intraclass correlation (ICC) for students was 0.22 (calculated using the equation $\boldsymbol{\sigma^2_{\mu 0} / \sigma^2_{\mu 0} + \sigma^2_{e0}}$, where σ^2_{e0} is the individual-level variance and $\sigma^2_{\mu 0}$ is the school-level variance in the empty model),[114,115] indicating that 22% of the total variation in PE amount provided to students was explained by differences between schools.[114,115]

3.3.1 Univariate Results

Table 4 presents the univariate results of school-factors and covariates associated with the PE amount provided to students. Figure 3 graphically displays the coefficient values and confidence intervals for the school-factors. Only one of the nine school-factors hypothesized to be associated with the amount of PE students received was significant in the univariate analyses. The variable found to be significant was the scale representing the level of involvement of parents in school PA-related activities, which measured the extent to which schools included parents or other community members in the PA-related, dialogue, decisions,

or programs at the school. The original scale was divided by four to allow for more interpretable coefficients, thus the regression coefficient represents a 25% increase in the scale. The parental involvement in school PA-related activities variable was associated with an increase of 0.20 classes per week for each 25% increase in the scale.

Although the number of PA facilities a school had was not significantly associated with the amount of PE students received, a trend towards significance was seen. Specifically, students in schools with three additional facilities received 0.80 more PE classes than students in schools with zero or one additional facilities ($p=0.078$). As can be seen in Figure 3, the majority of the school-level variables were found to be positively associated with PE amount (i.e., in the hypothesized direction), although in most cases the standard errors were too large for statistical significance to be met.

The results showed the student-level covariates grade and gender were significantly associated with the amount of PE provided to students in the previous week. For each grade increase, students received, on average, .05 more PE classes per week while females received .01 more PE classes than males. The urban/rural setting variable showed a trend toward statistical significance where rural students received .61 more PE classes than urban students in the past week ($p=0.061$).

Table 4. Univariate multi-level linear regression results showing school-level factors associated with the amount of physical education (PE) provided to students.

		Estimate	P - Value	95% Confidence Interval (C.I.)
School-level factors				
Organizational Climate				
Uses physical activity (PA) as a reward [a]		0.36	.180	[-0.17 , 0.88]
Provides a car free zone [b]		0.37	.119	[-0.10 , 0.84]
Provides a walking program or walk-to-school days [b]		0.08	.750	[-0.40 , 0.55]
Provides access to gymnasium outside school hours [b]		0.23	.341	[-0.24 , 0.69]
Provides access to gym during school hours	Rarely * vs Sometimes or often	0.08	.478	[-0.15 , 0.31]
	Rarely * vs Often	-0.04	.743	[-0.30 , 0.22]
Parental involvement in school PA decisions/dialogue		0.20[c]	.037†	[0.01 , 0.39]
Organizational Capacity				
Additional facilities for PE besides gym	0 or 1 * vs 2	0.35	.373	[-0.42 , 1.11]
	0 or 1 * vs 3	0.80	.078	[-0.09 , 1.68]
School has intramural programs [b]		0.25	.416	[-0.36 , 0.87]
PA / PE Policy				
School has written PA/PE policy	No * vs Yes, through practices or Yes, through written policy	-0.25	.372	[-0.79 , 0.30]
	No or Yes, through practices * vs Yes, through written policy	0.32	.110	[-0.07 , 0.72]
Covariates (School Level)				
Number of students enrolled at school		0.00	.675	[0.00 , .002]
School Setting	Urban * vs Suburban	0.18	.561	[-0.42 , 0.78]
	Urban * vs Rural	0.61	.061	[-0.03 , 1.25]
School Schedule	Semestered * vs Full-year classes	-0.08	.774	[-0.62 , 0.46]
Covariates (Student Level)				
Grade		0.05	.045†	[0.00 , 0.09]
Gender	Male * vs Female	0.01	.030†	[0.00 , 0.01]

†= p<0.05

‡=p<0.001

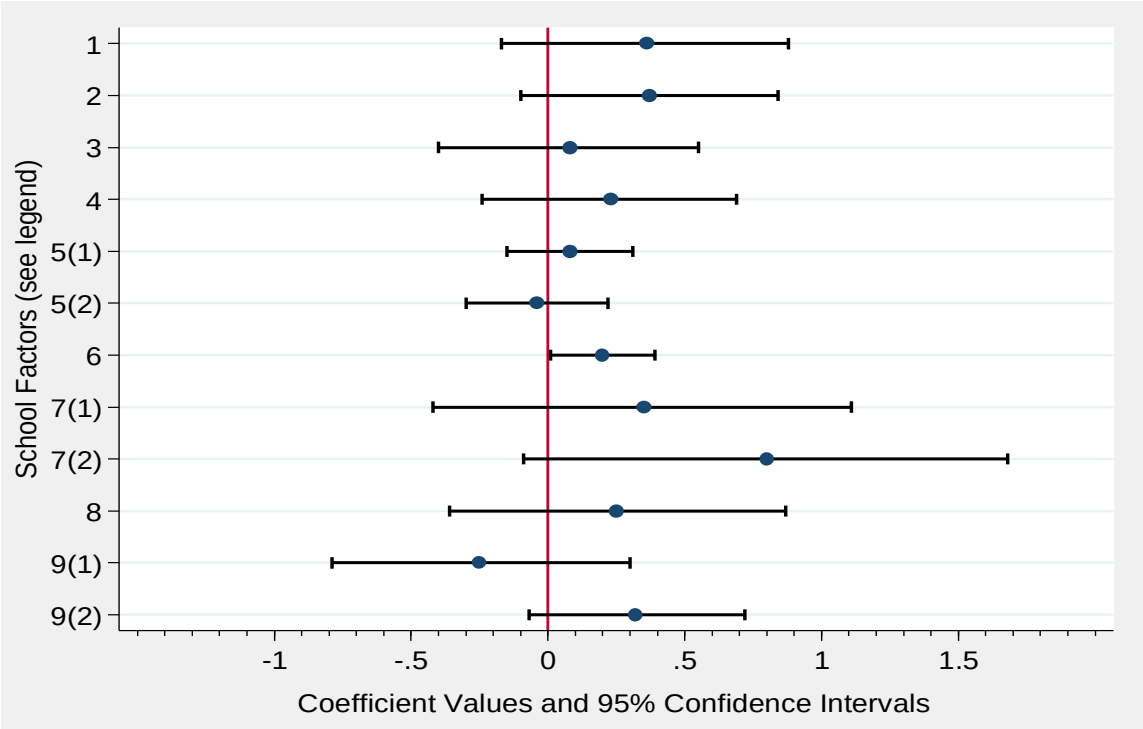
* = Referent group

[a] = Binary "Low versus High" variable, with "Low" as the referent group

[b] = Binary "Yes versus No" variable; with "No" as the referent group

[c] = Estimate for the continuous variable was scaled to represent a 25% increase in parental involvement.

Figure 3: Coefficients and 95% confidence intervals from univariate multi-level linear regression models examining the school-level factors associated with the amount of physical education (PE) provided to students.



Legend:

#	School – Level Factors	
	Organizational Climate	
1	Uses physical activity (PA) as a reward [a]	
2	Provides a car free zone [b]	
3	Provides a walking program or walk-to-school days [b]	
4	Provides access to gym outside school hours [b]	
5	Provides access to gym during school hours	(1) Rarely * vs Sometimes or often
		(2) Rarely * vs Often
6	Parental involvement in school PA decisions/dialogue [c]	
	Organizational Capacity	
7	Additional facilities for PE besides gym	(1) 0 or 1 * vs 2
		(2) 0 or 1 * vs 3
8	School has intramural programs [b]	
9	School has written PA/PE policy	(1) No * vs Yes, through practices or Yes, through written policy
		(2) No or Yes, through practices * vs Yes, through written policy

* = Referent group

[a] = Binary "Low versus High" variable, with "Low" as the referent group

[b] = Binary "Yes versus No" variable; with "No" as the referent group

[c] = Estimate for the continuous variable was scaled to represent a 25% increase in parental involvement.

3.3.2 Multivariate Results

Table 5 provides the multivariate (adjusted) findings that examined the associations between school factors and covariates with PE amount. This multivariate model included all hypothesized school-level factors thought to be associated with PE provision (regardless of significance in the univariate model), school-level covariates, and random-slope student-level covariates.

As shown in Table 5, parental involvement in school PA decisions/dialogue and having additional PE facilities were both found to be significantly associated with increased PE amount. Specifically, it was found that students received 0.53 more PE classes per 25% increase in their school's parental-involvement scale, and 1.13 more classes per week if their school had two additional PE facilities compared to students in schools with zero or one additional facility besides a gymnasium. Additionally, schools that provided intramural programs were associated with providing 1.97 less PE classes per week to students than schools that did not provide intramurals.

A significant amount of the error that existed without any variables included as random effects was explained when grade and gender were included. When the model was run without including these variables as random effects, the coefficient for the residual random error was 0.413(not shown); when run with grade and gender entered as random effects, this residual error decreased to 4.42^{-9}, indicating these variables explained almost all of the random error. Specifically, the grade variable explained the majority of the random error in PE amount at the student level as it was found to be statistically significant ($p<0.05$).

The model assumptions for multiple linear regression were checked, and all assumptions for the model were met. Specficially, there was no apparent heteroscedasticity of the residuals, nor were there any variables with unacceptable levels of multicollinearity.

3.4 School Factors Associated with Student Physical Activity Levels (Aim 2)

Results examining which school-environment factors and covariates were associated with the odds of students being highly active (compared to minimally active; model 1) and moderately active (compared to minimally active; model 2) are presented in this section. First, between-school variation was explored by including only the school-level constant in the empty model. Significant between-school variation was identified for being highly active ($\sigma^2_{\mu 0}$=0.16, $p < 0.05$). The ICC for students within schools was 0.046 (calculated using the ICC equation for binary outcomes: $\boldsymbol{\sigma^2_{\mu 0} / \sigma^2_{\mu 0} + (\pi^2/3)}$, where π =3.14),[114,123,124] indicating that 4.6% of the total variation in the odds of being highly active was explained by differences between schools. No significant between-school variation was found for being moderately active; however, this model was still used to determine if adjusting for other variables might uncover any significant associations between these school factors and the odds of being moderately active.

Table 5. Multivariate multi-level linear regression results showing school-level factors associated with the amount of physical education (PE) provided to students.

		Estimate	P - Value	95% Confidence Interval (C.I.)
FIXED EFFECTS PARAMETERS				
Constant		1.94	.002†	[0.78 , 3.23]
School-level factors				
Organizational Climate				
Uses Physical Activity (PA) as a reward [a]		0.00	.993	[-0.73 , 0.73]
Provides a car free zone [b]		0.37	.255	[-0.27 , 1.01]
Provides a walking program or walk-to-school days [b]		-0.38	.224	[-1.00 , 0.24]
Provides access to gym outside school hours [b]		0.50	.210	[-0.28 , 1.27]
Provides access to gym during school hours	Rarely * vs Sometimes or Often	0.06	.901	[-0.85 , 0.96]
	Rarely * vs Often	0.24	.631	[-0.72 , 1.19]
Parental involvement in school PA decisions/dialogue		0.53[c]	.001†	[0.23 , 0.82]
Organizational Capacity				
Additional facilities for PE besides gym	0 or 1 * vs 2	1.13	.048†	[0.01 , 2.26]
	0 or 1 * vs 3	1.32	.055	[-0.03 , 2.66]
School has intramural programs [b]		-1.97	.000‡	[-3.00 , -0.95]
PA / PE Policy				
School has written PA/PE policy	No * vs Yes, through practices or Yes, through written policy	-0.16	.684	[-0.91 , 0.60]
	No or Yes, through practices * vs Yes, through written policy	0.04	.914	[-0.76 , 0.85]
Covariates (School Level)				
Number of students enrolled at school		0.00	.441	[-0.01 , 0.00]
School Setting	Urban * vs Suburban	-0.30	.411	[-1.01 , 0.42]
	Urban * vs Rural	-0.10	.843	[-1.12 , 0.92]
School Schedule	Semestered * vs Full-year classes	-0.47	.187	[-1.16 , 0.23]
RANDOM EFFECTS PARAMETERS				
		Estimate	**Standard Error**	**95% C.I.**
Constant		4.42^{-9}	.	[0 , .]
Grade		.087	.025†	[0.05 , 0.16]
Gender	Male * vs Female	.01	.01	[0.00 , 0.04]

†= p<0.05

‡=p<0.001

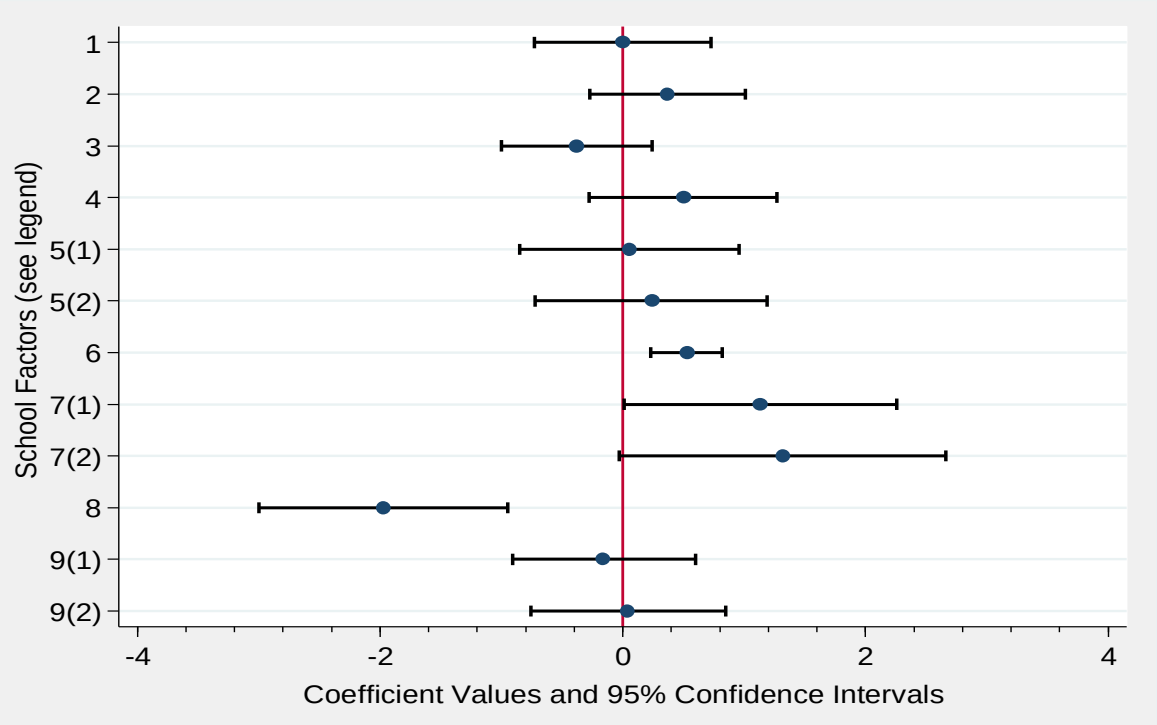
* = Referent group

[a] = Binary "Low versus High" variable, with "Low" as the referent group

[b] = Binary "Yes versus No" variable; with "No" as the referent group

[c] = Estimate for the continuous variable was scaled to represent a 25% increase in parental involvement.

Figure 4: Coefficients and 95% confidence intervals from multivariate multi-level linear regression models examining the school-level factors associated with the amount of physical education (PE) provided to students after controlling for student-level and school-level covariates.



Legend:

#	School – Level Factors	
	Organizational Climate	
1	Uses physical activity (PA) as a reward [a]	
2	Provides a car free zone [b]	
3	Provides a walking program or walk-to-school days [b]	
4	Provides access to gym outside school hours [b]	
5	Provides access to gym during school hours	(1) Rarely * vs Sometimes or often
		(2) Rarely * vs Often
6	Parental involvement in school PA decisions/dialogue [c]	
	Organizational Capacity	
7	Additional facilities for PE besides gym	(1) 0 or 1 * vs 2
		(2) 0 or 1 * vs 3
8	School has intramural programs [b]	
9	School has written PA/PE policy	(1) No * vs Yes, through practices or Yes, through written policy
		(2) No or Yes, through practices * vs Yes, through written policy

* = Referent group

[a] = Binary "Low versus High" variable, with "Low" as the referent group

[b] = Binary "Yes versus No" variable; with "No" as the referent group

[c] = Estimate for the continuous variable was scaled to represent a 25% increase in parental involvement.

3.4.1 Univariate Results

The univariate findings for the logistic regression models that examined the associations between school-level factors and school-level and student-level covariates with the odds of students being highly or moderately active are displayed in Table 6. In terms of the school-level predictor variables, the amount of PE students received in the past week, the number of additional facilities a school had for PE, whether a school had intramural programs, and whether the school had a written PA/PE policy were shown to be significantly associated with increased PA levels in both models. Specifically, for each additional PE class a student reported receiving in the past week his/her odds of being highly active went up by 20% and his/her odds of being moderately active went up by 9%. Having three additional PE facilities was associated with 1.79 greater odds of students being highly active and 1.74 greater odds of students being moderately active than students in schools that had zero or one additional PE facility. Students in schools that had an intramural program had 1.36 times greater odds of being highly active and 1.42 times greater odds of being moderately active than if their school had no intramural program. Another school factor significantly associated with PA levels was the presence of a written PA/PE policy. Students in schools with a written PA/PE policy had 1.26 times greater odds of being highly active and 1.20 times greater odds of being moderately active than students in schools with no PA/PE policy or a PA/PE policy that was implemented through practices only. How often a school allowed students to use the gymnasium during school hours but outside of class time was shown to be significantly associated with whether students were moderately active but not highly active. Specifically, students within schools that allowed access to the gymnasium during the school-day sometimes or often were 1.14 times more likely to be moderately active than those in schools

that allowed access rarely. Alternatively, students had 13% lower odds of being moderately active if they attended a school that allowed access often compared to those students in schools that allowed access rarely (OR=0.87).

Although not statistically significant, students in schools with two additional facilities showed a trend towards significance for being more highly active (OR=1.43, p = 0.061) and being more moderately active (OR=1.37, p=0.075) than students with zero or one additional facility. Similarly, whether a school provided a walking program or occasional walk-to-school days showed a trend towards significance for greater odds of students being highly active (OR = 1.25, p = 0.058). In addition, students in schools that allowed access to their gymnasium outside of school hours showed a trend towards significance for being more highly active compared to students who attended a school that did not allow access to the gymnasium outside of school hours (OR=1.23, p=0.078).

Looking at the student-level covariates, students who participated in team sports outside of schools were 3.01 times more likely to be highly active and 1.81 time more likely to be moderately active than students who did not. Similarly, students who participated in other activities (e.g. jogging) outside of school were 2.54 times more likely to be highly active and 1.66 times more likely to be moderately active than those students who did not. Females were found to be associated with 30% lower odds of being highly active than males (OR=0.70), while no gender differences in the odds of being moderately active were found. Finally, the grade a student was in was not significantly associated with their PA levels in the univariate models.

Table 6. Univariate multi-level logistic regression results showing school-level factors associated with the odds of being highly active versus minimally active (Model 1) or moderately active versus minimally active (Model 2).

		Odds Ratio	P - Value	95% Confidence Interval (C.I.)	Odds Ratio	P- Value	95% C.I.
		MODEL 1 (High vs Minimal) n=1637			MODEL 2 (Moderate vs Minimal) n=1619		
School-level factors							
Opportunities for Physical Education (PE) at School							
Number of PE classes in previous week		1.20	.000‡	[1.11 , 1.29]	1.09	.019†	[1.02 , 1.18]
Organizational Climate							
Uses Physical Activity (PA) as a reward [a]		0.93	.606	[0.71 , 1.23]	1.04	.783	[0.81 , 1.32]
Provides a car free zone [b]		0.96	.732	[0.76 , 1.20]	0.97	.795	[0.79 , 1.19]
Provides a walking program or walk-to-school days [b]		1.25	.058	[0.99 , 1.57]	0.90	.303	[0.73 , 1.11]
Provides access to gym outside school hours [b]		1.23	.078	[0.98 , 1.55]	0.94	.524	[0.77 , 1.15]
Provides access to gym during school hours	Rarely * vs Sometimes or Often	1.01	.830	[0.90 , 1.14]	1.14	.012†	[1.03 , 1.26]
	Rarely * vs Often	1.00	.940	[0.88 , 1.15]	0.87	.018†	[0.78 , 0.98]
Parental involvement in school PA decisions/dialogue		1.08[c]	.143	[0.97 , 1.19]	1.08[c]	.095	[0.98 , 1.18]
Organizational Capacity							
Additional facilities for PE besides gym	0 or 1 * vs 2	1.43	.061	[0.98 , 2.09]	1.37	.075	[0.97 , 1.92]
	0 or 1 * v. 3	1.79	.015†	[1.12 , 2.84]	1.74	.010†	[1.14 , 2.66]
School has intramural programs [b]		1.36	.036†	[1.02 , 1.81]	1.42	.009†	[1.09 , 1.84]
PA /PE Policy							
School has written PA/PE policy	No * vs Yes, through practices or Yes, through written policy	0.89	.426	[0.68 , 1.18]	0.92	.520	[0.72 , 1.18]
	No or Yes, through practices * vs Yes, through written policy	1.26	.010†	[1.06 , 1.51]	1.20	.044†	[1.01 , 1.43]
Covariates (Student-level)							
Participation in team sports outside of school [b]		3.01	.000‡	[2.38 , 3.81]	1.81	.000‡	[1.46 , 2.25]
Participation in other activities (jogging) outside of school [b]		2.54	.000‡	[2.05 , 3.16]	1.66	.000‡	[1.34 , 2.06]
Grade		1.05	.275	[0.96 , 1.15]	1.06	.188	[0.97 , 1.16]
Gender	Male * vs Female	0.70	.000‡	[0.57 , 0.85]	0.92	.406	[0.75 , 1.12]

†= p<0.05

‡=p<0.001

* = Referent group

[a] = Binary "Low versus High" variable, with "Low" as the referent group

[b] = Binary "Yes versus No" variable; with "No" as the referent group

[c] = Odds ratio for the continuous variable was scaled to represent a 25% increase in parental involvement.

3.4.2 Multivariate Results

Table 7 displays the multivariate (adjusted) multi-level logistic regression results which explored the associations between school factors and student-level covariates with the odds of students being highly active (model 1) and moderately active (model 2). As can be seen in Table 7, most of the variables that were shown to be significant in the univariate models were no longer found to be significant in the multivariate model. The only significant school-level variable in the multivariate model was the amount of PE students reported receiving in the previous week. Each additional PE class students reported receiving in the past week was associated with a 14% increase in their odds of being highly active. There was no significant difference in the odds of being moderately active based on the amount of PE students received in the past week. Students in a school with a car-free zone showed a trend towards significance of having lower odds of being highly active than students in schools without a car-free zone (OR=0.76, p=0.082).

The majority of the variables that were significant in the multivariate model were the student-level covariates. More specifically, after controlling for all other covariates and the school-level factors, students who participated in a team sport outside of school had 2.75 times greater odds of being highly active and 1.72 times greater odds of being moderately active than students who did not participate in a team sport. Likewise, students who participated in other activities outside of school such as jogging or yoga were found to have 2.48 greater odds for being highly active and 1.69 times greater odds for being moderately active than students who did not participate in these activities. Being female was found to be associated

with 44% lower odds of being highly active, although there were no significant gender differences in the odds of being moderately active.

Table 7. Multivariate multi-level logistic regression results showing school-level factors associated with the odds of being highly active versus minimally active (Model 1) or moderately active versus minimally active (Model 2).

		Odds Ratio	P - Value	95% Confidence Interval (C.I.)	Odds Ratio	P- Value	95% C.I.
		MODEL 1 (High vs Minimal) n=1637			MODEL 2 (Moderate vs Minimal) n=1619		
FIXED EFFECTS PARAMETERS							
Constant		-1.74	.000‡	[-2.70, -0.79]	-1.02	.027†	[-1.94 , -0.11]
School-level factors							
Opportunities for Physical Education (PE) at School							
Number of PE classes in previous week		1.14	.003†	[1.05 , 1.24]	1.05	.245	[0.97 , 1.14]
Organizational Climate							
Uses Physical Activity (PA) as a reward [a]		0.88	.445	[0.63 , 1.23]	0.94	.700	[0.67 , 1.31]
Provides a car free zone [b]		0.76	.082	[0.55 , 1.03]	0.81	.176	[0.60 , 1.10]
Provides a walking program or walk-to-school days [b]		1.31	.111	[0.94 , 1.82]	1.00	.986	[0.72 , 1.38]
Provides access to gym outside school hours [b]		1.15	.413	[0.82 , 1.63]	0.89	.450	[0.66 , 1.20]
Provides access to gym during school hours	Rarely * vs Sometimes or Often	0.80	.380	[0.48 , 1.32]	1.09	.729	[0.58 , 1.79]
	Rarely * vs Often	0.83	.530	[0.47 , 1.48]	1.01	.959	[0.58 , 1.82]
Parental involvement in school PA decisions/dialogue		1.00[c]	.987	[0.87 , 1.15]	1.01[c]	.902	[0.88 , 1.16]
Organizational Capacity							
Additional facilities for PE besides gym	0 or 1 * vs 2	1.28	.396	[0.72 , 2.30]	0.90	.687	[0.52 , 1.53]
	0 or 1 * v. 3	1.62	.160	[0.83 , 3.18]	1.20	.563	[0.64 , 2.24]
School has intramural programs [b]		1.05	.870	[0.58 , 1.90]	1.26	.407	[0.73 , 2.20]
PA /PE Policy							
School has written PA/PE policy	No * vs Yes, through practices or Yes, through written policy	1.16	.477	[0.77 , 1.74]	1.03	.894	[0.70 , 1.50]
	No or Yes, through practices * vs Yes, through written policy	1.15	.504	[0.77 , 1.71]	1.12	.536	[0.77 , 1.65]
Covariates (Student-level)							
Participation in team sports outside of school [b]		2.75	.000‡	[2.15 , 3.54]	1.72	.000‡	[1.38 , 2.15]
Participation in other activities (jogging) outside of school [b]		2.48	.000‡	[1.97 , 3.10]	1.69	.000‡	[1.37 , 2.10]
Grade		1.10	.062	[1.00 , 1.21]	0.87	.107	[0.71 , 1.07]
Gender	Male * vs Female	0.66	.000‡	[0.53 , 0.81]	1.08	.187	[0.98 , 1.18]
RANDOM EFFECTS PARAMETERS							
		Estimate	**Standard Error**	**95% C.I.**	**Estimate**	**Standard Error**	**95% C.I.**
Constant		2.05^{-10}	29.17	[0 , .]	1.26^{-11}	7.92	[0 , .]

†= p<0.05

‡=p<0.001

* = Referent group

[a] = Binary "Low versus High" variable, with "Low" as the referent group

[b] = Binary "Yes versus No" variable; with "No" as the referent group

[c] = Odds ratio for the continuous variable was scaled to represent a 25% increase in parental involvement.

Chapter 4: Discussion

The purpose of this study was to determine the school factors associated with how much PE was being provided to students, and to better understand the relationship between these school factors, PE provision, and the PA behaviour of students. First, consistent with other reports from both Canada[85,125] and the United States,[92] the results of this study highlight the inconsistent amount of PE that is being provided to elementary school students, and reinforces the importance of undertaking this study. For example, 10.1% of students in this sample reported receiving zero PE classes in the previous week, while 12.7% reported having received four or more classes. This study found that the involvement of parents in the school PA-related decisions and dialogue, the number of facilities suitable for PE that a school had on-site (beyond a gymnasium), and whether a school offered intramural programs were all associated with the amount of PE provided to students. Finally, it was also found that the more PE students reported receiving, the greater their odds of being highly active – which supports previous findings implicating PE as an important predictor of PA behaviour.[65,92] The results from this study will be of great use to policy makers who attempt to change PE requirements in elementary schools.

4.1 School Factors Associated with Physical Education Provision

4.1.1 Parental Involvement in School Physical Activity Decisions or Dialogue

This study found that parental involvement in the school dialogue, decisions, and programs related to PA was positively associated with PE provision. Although this relationship has not been previously examined, this result is supported by one of the tenets of the Theories of Organizational Change,[101] which hypothesizes that the organizational climate of a school

relating to PA would be associated with the PA-related decisions of the school (e.g., the amount of PE provided to students). Indeed, it seems as though schools that ensure an ongoing involvement and dialogue with parents regarding student PA at school are inherently different than schools that do not when it comes to providing PE. Due to the cross-sectional nature of this data, it is unclear whether schools had chosen to actively involve parents in the PA-related activities of the school, or whether parents of students in certain schools had chosen to involve themselves. Further understanding the direction of this association might be important to investigate in future studies. The extent to which parental involvement influences other school-based PA opportunities is currently unknown but will be worthwhile to examine.

How parental involvement in PA-related activities differs with the age of the child is presently unclear, as this study only looked at students in grades 5 through 8. It is possible that parents of younger students may be more involved in the school-based activities of their children than parents of older students. It is suggested that further investigation of this relationship be undertaken in a sample of students from diverse age groups.

If parental involvement in school PA-related activities is indeed associated with how schools approach other PA-related decisions (such as the amount of PE they provide to students), this finding could be of great importance to individual schools, school districts, and even provincial or national governments. A simple suggestion based on these findings would be for schools to try harder to include parents in the PA-related activities of the school. Unfortunately, this may not be so simple, as parental time constraints, language or cultural

barriers, and financial difficulties hinder some schools' ability to reach out to parents more than others;[126] for example, in schools that have a high density of immigrant students or those from a low socio-economic status.[126,127] Therefore, school administrators must begin to start thinking of new ways to get parents involved in their school's PA-related discussions and activities. Perhaps scheduling parent council meetings or sports days on weekends rather than on the evenings of school days may facilitate parental attendance.[126] Similarly, if some parents still find it difficult to attend these events, then perhaps schools should reach out to grandparents or other caregivers to ensure that all children have adult representation when it comes to the discussion, development, or organization of the PA-related activities of the school.

4.1.2 Additional Facilities for Physical Education Besides Gymnasium

Another important variable that was found to be associated with PE provision was the number of additional on-site facilities that teachers could use for PE classes (e.g. a field, another large room for PA, or an outdoor paved area with lines marked for specific activities). Results from this study indicate that students attending schools with two additional facilities received significantly more PE classes per week than students with zero or only one additional facility. Post-hoc analyses investigated whether any individual facilities had a positive association with PE provision (results not shown). Interestingly, while the cumulative number of facilities was shown to be significant, no specific facility was found to be associated with PE amount. It appears that for schools limited by the physical space to provide PE, the cumulative number of additional spaces besides a

gymnasium was a critical limiting factor for the provision of PE, rather than the presence or absence of any one facility.

Previous studies have found that having access to a gymnasium at school was associated with increased PE time[93] and greater PA opportunities at school;[128] however, these studies were undertaken in the US where it has been reported that 22.6% of schools do not have a gymnasium.[95] In contrast, a recent report indicates that about 95% of Canadian schools have access to a gymnasium during school time,[129] and, additionally, all participating schools in the current study reported having access to a gymnasium. Thus, the association between having a gymnasium and the amount of PE provided to students was unable to be examined in this study. Having additional facilities, however, which could be used for PE provision if the gymnasium were to be unavailable (e.g., occupied by another class or used for another purpose), was found to be associated with PE provision. A study by Fernandes and Sturm (2010) which touched upon this issue found that while having a gymnasium was positively associated with the amount of PE provided to students, the number of additional (or alternate) sites for PE classes was not associated with PE provision.[93] These researchers, however, chose to include auditoriums, cafeterias, and classrooms as potential alternatives to a gymnasium for the provision of PE, which are likely not used for curricular PE instruction unless taught by a highly trained PE teacher who could find creative ways to use these spaces for PE. In this study, only facilities which were likely used by regular classroom teachers to meet the curriculum requirements for PE (e.g., movement competence [skills], active living [physical fitness], etc.)[130] were included.

Unfortunately, increasing the number of facilities on school grounds for PE is not feasible for many schools due to lack of physical space or adequate funding. Given the findings of this study, perhaps an alternative method to increase PE opportunities in schools with limited PA facilities is to partner with nearby community centres, agencies, or private sporting facilities to facilitate the delivery of PE off school grounds. However, it is unclear whether schools with reduced facilities would have access to other resources in the surrounding community areas. Thus, it is important to work with schools that have fewer facilities for PE, as they might be at a disadvantage for providing adequate amounts of PE. Helping these schools with the development of partnerships, or perhaps providing subsidies (e.g. transportation to nearby community facilities), will be important for ensuring the increased delivery of PE to all students.

Another potential way to address the lack of facilities for PE is to adjust the PE curriculum to incorporate more effective techniques for the use of different school spaces. For example, activities like yoga and stretching could likely be taught in places other than a gymnasium. In addition, perhaps the non-movement elements of the PE classes could be taught in the classroom, while another class used the gymnasium for the PA components of the PE curriculum. Programs such as Action Schools! BC have shown encouraging results in their ability to help teachers think of novel ways of getting students active outside of PE.[54] Therefore, increasing the availability of programs like Action Schools! BC will help provide teachers with alternative methods for increasing PA without having to use any additional resources.

4.1.3 School Providing Intramural Programs

Although this study was exploratory in nature, it was initially anticipated that schools with an intramural program would also provide more PE to their students. Drawing on the Theories of Organizational Change, it was hypothesized that the provision of intramural programs represented a school's increased organizational capacity with which to provide PE. In other words, if schools had the ability to provide intramural programs, they would have also had a greater likelihood of having the ability to provide more PE. However, in opposition to our hypothesis, it was found that schools providing intramural programs actually delivered less PE than those that did not. A potential explanation for this trend is that intramural programming might be used by schools as an alternative to PE delivery for the purposes of getting students active. Although there are previously documented associations between the presence of intramural programs and greater levels of student PA,[131] if intramural programs are indeed associated with less PE provided to students, there is a risk of creating disparities in the PA levels of students within a given school. Since intramural programs are usually optional,[132] it is probable that the students who are already active or enjoy sports outside of school are more likely to participate in intramurals than the relatively inactive students who would benefit the most from PA administered in a required PE class. Although intramural programs might be useful for increasing the overall PA levels of children, they are not a suitable replacement for the curriculum demands of PE. Furthermore, intramural programs are an extra-curricular program; therefore, teachers voluntarily choose whether they want to supervise or provide these programs.[132] As a result, provision of intramural programs might be inconsistent among schools since these programs are not mandated. In addition, the

faculty supervision of extra-curricular programs can be prohibited during “job action” disputes.

Stark differences were seen in the unadjusted and adjusted relationship between the provision of intramural programs and the amount of PE provided to students. Specifically, in the unadjusted model, the provision of intramural programs was associated with providing more PE; however, in the adjusted models (i.e., when controlling for other school factors, as well as student-level and school-level covariates) the opposite was found. Initially, it was hypothesized that this relationship was confounded by the grade of the students, whereby students in grades 7 and 8 were thought to be more likely to have intramural programs than those students in grades 5 and 6. Post-hoc analyses using an interaction term between grade and intramural programs, however, found no significant findings (not shown). Thus, these results suggest that intramural programming is likely related to a number of the school-level variables in this adjusted model. While schools may be more likely to provide intramural programs if they have more PA facilities (especially indoor facilities), greater enrollment, or more faculty and staff, the post hoc analyses could not explain the negative association observed. As this was the first study to identify an inverse relationship between intramurals and PE amount, more research is necessary to examine the stability of this relationship and better understand this association.

4.1.4 The Utility of the Theoretical Framework

The utility of the Theories of Organizational Change for identifying school factors associated with PE provision was partially supported, as variables related to organizational climate (parental involvement in school PA) and organizational capacity (PE facilities & intramurals [although in an unanticipated direction]) were related to PE provision. However, having a PA/PE policy was not found to be significantly associated with the amount of PE provided to students. Perhaps since PE is a curricular-based program (as opposed to sports programs, intramurals, or recess), having a school-specific PA/PE policy may not have influenced PE provision because schools are required to follow provincial policies related to curriculum. Additionally, aside from parental involvement in the PA-related activities of the school, no other variables associated with the schools' organizational climate were found to be significantly associated with PE provision. These findings indicate the possibility that: [1] the variables chosen to represent the schools' organizational climate relating to PA/PE did not accurately characterize the construct; [2] the level of inclusion of parents in school decisions relating to any particular school factor (in this case, PE provision) might be the most important aspect of the organizational climate of the school; or [3] organizational climate, in its current conceptualized state, is of low importance for predicting the amount of PE provided to students in this sample. Thus, future research in this area should continue to try and clarify what school factors most accurately represent a school's organizational climate related to PA and PE, as well as try to determine if organizational climate is indeed associated with opportunities for PA at school, such as PE.

4.1.5 Covariates

This study did not support previous reports that school size and setting (i.e., an urban versus a rural setting) were associated with the amount of PE provided to students in Canadian elementary schools.[125] This may, in part, be the result of having a relatively small school sample (n=30), where, for example, only five of the schools were identified as being in an urban setting and most of the schools were of a relatively similar size.

Whether a school provided classes on a semestered versus full-year schedule was not significantly associated with the amount of PE provided to students. It was hypothesized that students in semestered schools might have received PE in one semester only; however, this was not supported by the results. This lack of association suggests that either students in different semesters (e.g., those in a semester where PE was provided versus those in a semester where it was not) cancelled each other out, or, alternatively, that PE might not follow the semestered system even if other classes do.

Including grade and gender as random effects in the adjusted model explained almost all of the residual random error at the school level, signifying the importance of these variables in explaining the within-school variation in PE amount. Since students within the same school – and even students within the same grade from the same school – reported having received different amounts of PE, this finding indicates that PE provision likely differs by individual classroom rather than being delivered to all students equally within the same school. Thus, future studies exploring the amount of PE provided to students should use a student-level or

classroom-level measure for the amount of PE provided to students, given the observed variation between grades within the same school that was seen in this study.

4.2 School Factors Associated with Student Physical Activity Levels

The only school-level factor found to be associated with PA levels of the students was the number of PE classes provided to students in the previous week. This corroborates findings from other studies that have found a positive association between PE amount and MVPA.[63,64,92] More importantly, this finding further justifies the importance of better understanding what factors influence PE provision, as PE has repeatedly been shown to be associated with increased PA levels in children, even when controlling for out-of-school PA.[63,64,92]

When looking at the associations between school factors and the PA levels of students, the discrepancies between the unadjusted and adjusted models were quite pronounced. Specifically, in the unadjusted models there were a number of significant findings that were not found in the adjusted models. It was thought that one possible explanation for these differences was that much of the significance between school factors and student PA behaviour in the unadjusted model was masked by the significant student-level covariates (e.g., participation in team sport and other activities outside of school), which, when controlled for, caused any significant school factor and PA behaviour associations to disappear. After examining this potential masking effect from the covariates further in post hoc analyses [not shown], it was found that removing the covariates representing participation in team sport and other activities outside of school from the model did not

change the odds ratios by any meaningful amount nor did it change the significance levels of any of the student level factors. Thus, the difference in the amount of significant variables between the unadjusted and adjusted models was not related to the significant covariates, and the over-controlling of the model can be ruled out.

The literature indicates that school environment factors, while important on a population level,[133] account for only a fractional amount of the variation in the daily PA accumulated by individual children.[134] For example, a study by Murray et al (2006) determined that the amount of variation in PA levels explained by school-level differences accounted for somewhere between 2.2% and 5.7% of the total variation in student PA levels, depending on factors such as time of year and how PA was measured.[134] Another study found that even the combination of home, neighbourhood, and school environments only accounted for about 5% of the variance in the PA levels of children.[135] In the current study, it was seen that school-level differences accounted for 4.6% of the variability in the odds of being highly active, and did not account for any differences in the odds of being moderately active. Thus, there was relatively little between-school variation in the PA levels of students that could have been explained by these school-factors – especially when compared to PE amount where 22% of the variability was explained by differences between schools.

The results of this study did not support previous findings demonstrating that the availability of PE facilities[93] or equipment[136] was associated with greater levels of PA in children. A potential explanation for not seeing this relationship here is that the facilities variable used for this study specifically assessed the number of facilities that could be used for PE

provision, rather than also including facilities that may have been used for other purposes such as recess, after-school, or weekend PA (e.g., playground facilities such as a jungle gym). Thus, these findings should be interpreted within the context of how facilities were operationalized for this study.

These results also did not support previous findings that school PA/PE policies were associated with the PA levels of students.[60] A potential explanation for this discrepancy is that this study had a much smaller sample size than other studies examining this relationship, making it more difficult for statistical significance to be met.[137]Associations between school policies and student behaviour are often quite modest, as the implementation of policies does not always results in adoption of the policy at the school or classroom level.[33,113,138] Thus, a larger sample size of schools was likely required for any significant association between the PA/PE policies of the school and PA levels of the students to be observed.

4.3 Limitations

The results of this study should be interpreted within the context of a few study limitations. This study utilized a cross-sectional design, which limited the ability to make any inferences about causality. However, due to the novel and exploratory nature of this study, measuring associations still provides an initial important step towards better understanding these relationships.

A few difficulties arose in this study due to the use of secondary data for answering the research questions of interest. First, because the data were collected before the current study

was conceived, the theoretical framework used to guide the analyses had to be retrofitted to answer the questions of interest. This resulted in a model that was not designed specifically for answering these questions. Second, there were a number of variables not included in the original surveys which would have been important to explore when attempting to answer these questions. For example, this study was unable to examine the influence of PE specialists as this was not asked explicitly, although previous findings have indicated that schools with a PE specialist provide more PE to their students.[91] Also, the socio-economic status of the parents would have been valuable to include as a covariate, especially for further exploring the parental-involvement scale that was found to be significant in this study.[126]

Another limitation of this study was the number of schools that participated (n=30), which restricted the statistical power of this study to examine between-school variations. Additionally, this study used a convenience sample of schools rather than a random sample, and, as such, the results cannot be extrapolated to all students and schools in the province of Ontario.

A number of general limitations also arose in this study relating to the use of survey data. Because it is known that students often misreport their actual PA levels in self-report,[108] and indeed in this study there were a number of students who reported an highly unlikely amount of weekly MVPA (see APPENDIX A for students' self-reported weekly MVPA), a categorical measure for the PA levels of students was used. Unfortunately, this measure does not allow for the interpretation of results in terms of the actual minutes of MVPA students participated in, which would likely be of some importance to policy-makers and other

interested parties. In addition, the self-report methods used for this study were subject to a number of potential biases. For example, students may have misreported their answers due to difficulties in understanding the questions or due to recall bias. Also, although honest administrator reporting was encouraged, social desirability bias may have existed in principals' responses to the survey based on their desire to provide a positive impression of their schools. Finally, because of the large amount of missing data that was accrued when student and administrator data sets were merged, adjustment for this missing data was required and multiple imputations were used. Although the use of multiple imputations has been shown to be valid for this type of data,[116] there is still potential for a variety of biases to be introduced when using data created from statistical models rather than original, raw data. Thus, the results of this study must be interpreted within the context of having used imputed data.

4.4 Strengths

This study also contained a number of methodological strengths. First, collecting both student- and school-level data was a major strength of this study, as it allowed for associations to be looked at across different levels. The ability to ask questions relating to how school factors (collected at the school level) might influence individual behaviours (collected at the student level) could not have been performed had data not been collected from both administrators and students. Second, unlike previous research examining the relationship between PE and PA levels of students, this study was the first to assess a number of large-scale, school-level organizational factors. Within the same study, this project provided evidence relating to the variation in PE amount that students in Ontario elementary

schools were receiving, linked the quantity of PE to the PA levels of students, and identified the factors that were associated with this level of PE provision.

4.5 Recommendations for Future Research

This study was exploratory in nature, thus future research is required in order to look more closely at a number of important relationships that were identified in this study, but also at factors that were unable to be looked at here. For example, because already collected data was analyzed for this study, there were a number of variables that were not examined, but should be included for future research. For example, a classroom level identifier should be included so as to determine whether PE at the elementary school level varies most by school, grade, or individual teacher (i.e. classroom). In addition, a variable looking at whether the schools had a designated PE specialist should be included since previous studies have found that the availability of PE specialists can influence PE provision.[91] Finally, parental socio-economic status is an important covariate to include as parental socio-economic status might moderate the association between PE amount and parental involvement in the PA-related activities of the school.

Future research in this area may benefit from using a mixed-methods approach, which combines qualitative and quantitative components. A benefit of such an approach is that information from a quantitative survey (e.g., the surveys used for the PLAY-ON study) could be further explored using in-depth qualitative interviews and exploration. With respect to this study, for example, it would have been helpful to interview administrators to better understand what factors limited their school's ability to offer more PE. The rich data

resulting from combining the quantitative survey and qualitative interview would have provided a more comprehensive look at what might be influencing schools' ability to provide more PE to their students.

Chapter 5: Conclusion

This study was exploratory in nature, and although not all of the variables that were hypothesized to be associated with PE provision and PA levels were found to be significant, this study has generated novel findings and provided a solid groundwork for future research in this area. For example, these results indicate an association exists between parental involvement in the PA-related dialogue, decisions, and programs of the school and greater provision of PE after controlling for other important factors. This finding should be replicated in a more diverse and large sample of students. Furthermore, it would be important to better understand the mechanisms of this association to determine whether schools are actively involving parents in these PA-related activities or rather if parents are volitionally involving themselves in these decisions.

The use of the Theories of Organizational Change, while helpful for identifying potential variables of interest, was not fully supported by the results. As this was a secondary data analysis, the model used for this study had to be retrofitted to the questions of interest; therefore, the variables included for the analyses were limited to those that were collected. Accordingly, the Theories of Organizational Change may still be useful for identifying potential predictors of PE amount in elementary schools; however, validated items for addressing the proper domains of school organizational climate and capacity related to PE or PA should be developed in future studies.

Importantly, this study found that Ontario students in grades 5 through 8 from this sample of schools are not meeting the daily PE recommendations advocated by many relevant health

agencies and the scientific community.[34,57,58,83] For example, only 9.2% of the students in this sample reported receiving five PE classes over the previous week. Unfortunately, the extent to which the schools analyzed in this study are representative of all Canadian schools in grades 5 through 8 is unclear as no surveillance system has efficiently tracked PE amount across the country. If the students in this study are indeed representative of all Canadian students in these grades, much work is required on a national level to ensure daily PE recommendations are being met.

PE provision fits within the broader context of a comprehensive school health framework, which posits that effective school health programming should not be focused on just PA or nutrition, but all school areas which might influence student health-related behaviours.[139] The comprehensive school health framework suggests that policies and programs targeting all areas of student health should compliment and support each other. Therefore, policies mandating daily PE requirements or programs that help teachers provide high quality PE programs should be implemented in concert with the nutrition, smoking, and general PA policies that are becoming more common in schools across the country.

This study may help inform policy makers when designing future PE or PA interventions. As this study found low parental involvement and fewer PA facilities influenced PE amount, it is important to address these issues when new PA/PE programs or policies are implemented. These results may also be relevant for understanding factors that influence the implementation of Daily Physical Activity policies (e.g., those that require schools to provide every student with a certain amount of supervised PA each school day) which are becoming

increasingly popular at the provincial level.[82,140,141] For example, the school-level factors found to be associated with PE provision in this study (e.g., facilities, parental involvement) may also be related to the implementation of provincial Daily Physical Activity policies.

As the PA levels of Canadian children continue to decrease at an alarming rate[27] it is vital that policy makers, researchers, and other key parties work together to address this critical issue. Although health promotion must be addressed in a number of different settings (e.g., home, schools, public policy), the school environment is an important piece of this puzzle. For example, it has been shown that PE is related to increases in both in-school[65,92] and out-of-school[71,74] PA. Thus, researchers must continue to determine what school factors influence how much PE can be provided to students, while pressure must be put on policy makers to mandate daily PE requirements. Currently, only 7% of Canadian children are meeting the PA guidelines;[27] finding ways to ensure increased PE provision to all students in all schools will no doubt help to improve this troubling statistic.

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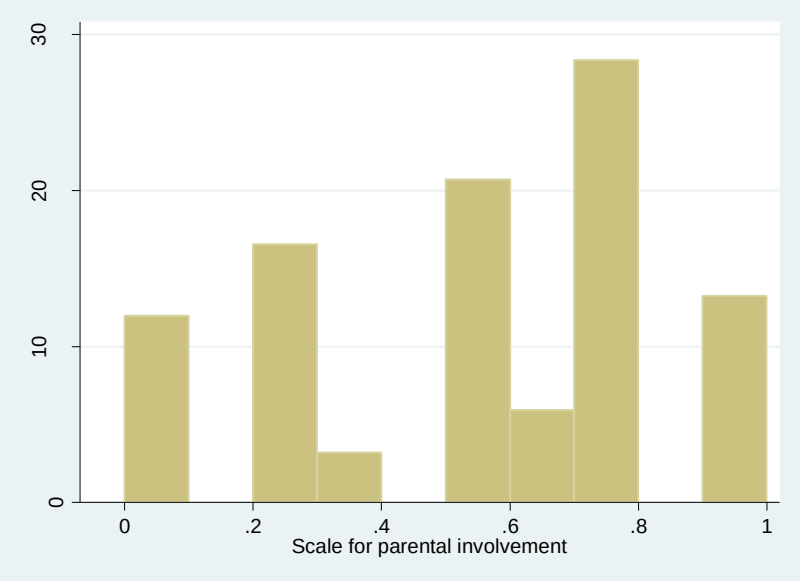
Appendix A:

Histograms for variables representing a) parental involvement in the PA-related dialogue, decisions, and events of the school; and b) the hours of moderate to vigorous physical activity (MVPA) self-reported by the students.

a)

Histogram for scale of parental involvement in PA-related decisions, dialogue, and events of the school



b

Histogram for hours of moderate to vigorous physical activity received in the previous week self-reported by students.