SCHOOL EFFECTS ON HEALTH BEHAVIOURS

DOES THE SCHOOL SETTING MATTER? EXAMINING ASSOCIATIONS BETWEEN SCHOOL AND CLASSROOM SETINGS AND HEALTH BEHAVIOURS AMONG STUDENTS IN ONTARIO

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Lay Abstract

Despite the known benefits of physical activity and harms associated with cannabis use, physical activity rates are low while cannabis use is high among Canadian youth. Previous research has highlighted the potential for the school environment to influence students' health behaviours. The current study examined the extent to which physical activity and cannabis use varied across school and classroom settings and identified characteristics of the school environment that were associated with these health behaviours. There was significant between school and classroom variability in levels of physical activity and cannabis use. School climate was positively associated with physical activity, and negatively associated with cannabis use. Identifying modifiable characteristics of the school environment that are associated with students' health behaviours can inform development of interventions, policies, and programs to increase physical activity and reduce cannabis use.

Abstract

BACKGROUND: Low rates of physical activity and high rates of cannabis use among adolescents are concerning given the health outcomes associated with these health behaviours. Although individual-level characteristics are strongly associated with physical activity and cannabis use, research also suggests that the school setting may influence these health behaviours.

PURPOSE: To: 1) Determine the extent to which students' cannabis use and physical activity vary across school and classroom settings, 2) Identify characteristics of the school setting that are associated with cannabis use and physical activity among students in grades 6-12 in Ontario.

METHODS: This study used data from the School Mental Health Surveys, a cross-sectional school-based survey of 31,124 students, 3,373 teachers, and 206 principals from 248 schools across Ontario. Multilevel modelling was used to explore school and class effects while controlling for student compositional effects.

RESULTS: About 5% of the variability in student physical activity and 14% of the variability in student cannabis use was attributable to between school and classroom differences. Students' perception of school climate was positively associated with physical activity, and negatively associated with cannabis use.

CONCLUSIONS: Findings highlight the potential influence of the school and classroom environment on students' physical activity and cannabis use. School and classroom contexts may be important environments for targeted interventions, policies and programs.

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List of Abbreviations

COMPASS	Cohort study on obesity, marijuana use, physical activity, alcohol use, smoking, and sedentary behaviour
HPRO	Health Promotion
ICC	Intraclass correlation coefficient
IGLS	Iterative Generalized Least Squares
NHS	National Household Survey
OCHS	Ontario Child Health Study
PQL	Predictive Quasi-Likelihood
SES	Socioeconomic status
SMHS	School mental health surveys

Declaration of Academic Achievement

I declare that I am the sole author of this thesis. I completed all research work, and was provided with guidance and feedback from my supervisor (Dr. Kathy Georgiades) as well as committee members (Dr. Emmanuel Guindon, Dr. Laura Anderson, Dr. Catharine Munn), and my external reviewer (Dr. Magdalena Janus). I understand that my thesis will be electronically available.

Chapter 1: Introduction

Health behaviours are comprised of modifiable factors that are formed within social, cultural, and physical environments (Statistics Canada, 2016). Often, these behaviours are categorized as either health promoting behaviours, such as physical activity, or health risk behaviours, such as cannabis use. Adolescence is a critical time period during which health behaviours are shaped and established (Viner et al., 2012). Patterns of health behaviours that are established in adolescence can persist into adulthood and can lead to numerous adverse health outcomes. Studies have shown that physical activity can track from adolescence into adulthood, meaning that high levels of physical activity in adolescence can predict high levels of physical activity in adulthood (Telama, 2009; Telama et al., 2005). Adolescence is also a sensitive period of development, during which consumption of substances such as cannabis can have detrimental impacts on brain development (Squeglia, Jacobus, & Tapert, 2009; Volklow, Baler, Compton, & Weiss, 2014). Thus, the development and evaluation of effective strategies that are designed to reduce health risk behaviours and increase health promoting behaviours during adolescence is essential.

A number of individual-level correlates of health behaviours have been established. For example, adolescent males are more likely to report cannabis use, and cannabis use tends to increase as students get older (Leatherdale & Rynard, 2013). However, less is known about school and classroom-level factors that are associated with health behaviors. Given that children spend a considerable amount of time in schools throughout their adolescence, identifying specific characteristics of the school environment that are associated with health behaviours is particularly important, as some of these factors could be modifiable with interventions delivered in the school setting.

Using a provincially representative sample of elementary and secondary schools in Ontario, the objectives of this study are to: 1) Determine the extent to which physical activity and cannabis use vary across schools and classrooms; 2) Identify characteristics of schools that are associated with physical activity and cannabis use.

This introductory chapter begins with an overview of the prevalence and associated impacts of physical activity and cannabis use on student health and well-being, followed by delineation of a conceptual framework that informed the empirical analyses for this study. The concept of "school effects" will be introduced, followed by a summary of existing literature exploring between-school and between-class variability in physical activity and cannabis use. Using the conceptual framework as a guide, student and school characteristics that have been associated with student health behaviours will be discussed. I conclude by describing the current study and its potential implications and research questions.

1.1 Prevalence and Impact of Physical Activity and Cannabis Use

The prevalence of many health behaviours including physical activity and cannabis use are of concern among school-aged children in Canada. According to data from the Canadian Health Measures Survey, only 6.9% of children aged 6-17 years met the physical activity guidelines in 2015 (Statistics Canada, 2015). Physical activity tends to decline throughout adolescent years, with students in younger grades often reporting higher levels of physical activity than those in lower grades (Boyce, King, & Roche, 2004; Leatherdale & Rynard, 2013). In 2017, the Ontario Student Drug Use and Health Survey found that 19% of students in grades 7-12 reported using cannabis in the last year (Boak, Hamilton, Adlaf, & Mann, 2017). The lowest prevalence of past-year cannabis use was among grade 7 students (2.0%) and highest among grade 12 students (36.9%) (Boak et al., 2017). As students get older, there tends to be a decline in physical activity, and an increase in cannabis use.

The benefits of health promoting behaviours among youth have been well documented (Janssen & LeBlanc, 2010; McIsaac, Kirk, & Kuhle, 2015). Increased physical activity has been associated with positive outcomes such as reduced risk of chronic diseases and stronger academic achievement among students (Janssen & LeBlanc, 2010; McIsaac et al., 2015). A systematic review of the benefits of physical activity found a dose-response relationship between physical activity and positive health outcomes, suggesting that higher physical activity levels was associated with better health outcomes (Janssen & LeBlanc, 2010). For instance, physical activity was associated with decreased blood pressure, lower rates of depression and overweight/obesity, however the effect sizes ranged substantially for each outcome from small to large (Janssen & LeBlanc, 2010). In contrast, cannabis use has been consistently associated with numerous immediate and long-term adverse health outcomes such as injuries and motor vehicle collisions, reproductive health complications, cardiovascular disease, decreases in cognitive functioning, and negative impacts on adolescent psychosocial development (Hall & Degenhardt, 2009; Squeglia et al., 2009; World Health Assembly, 2011). Longitudinal research has linked frequent cannabis use in adolescence to adverse outcomes in adulthood including increased odds of later cannabis dependence and use of other illicit drugs (Silins et al., 2014). Thus, delaying the age at which students initiate cannabis use and reducing the frequency of use can protect students from negative health outcomes throughout the life course. There are also growing concerns with youth engaging in multiple health risk behaviours, while concurrently not meeting recommendations for health promoting behaviours. Canadian youth report an average of 2.9 concurrent health behaviours, that include: being a current smoker, current cannabis user, current binge drinker, not meeting physical activity guidelines, exceeding sedentary behavior guidelines, inadequate fruit/vegetable consumption, and being overweight or obese (Leatherdale & Rynard, 2013).

Given the high prevalence of health risk behaviours and low prevalence of health promoting behaviours among Canadian youth, as well as the associated risks and benefits with each, there is a need to identify health promoting interventions and strategies. Identifying school-level characteristics that are associated with physical activity and cannabis use can inform the development of health promoting interventions and strategies in the school setting, which has the potential to impact a large number of students (Townsend & Foster, 2011).

1.2 Conceptual Framework

Social-ecological frameworks suggest that individuals and their health are influenced by their surrounding environments, and that there are multiple levels of the environment that influence health (Bronfenbrenner, 1979; McLeroy, Bibeau, Steckler, & Glans, 1988). McLeroy and colleagues proposed a social ecological model which suggested that behaviour is determined by intrapersonal, interpersonal, institutional, community, and public policy factors (McLeroy et al., 1988). Similarly, Bronfenbrenner proposed an ecological systems theory, which suggested interactions between five levels: the microsystem (immediate environment), mesosystem (connections), exosystem (indirect environment), macrosystem (social and cultural environment), and chronosystem (changes over time) (Bronfenbrenner, 1979). Townsend and Foster (2011) adapted these previous models to create a framework for exploring the health behaviours of students, particularly in the school setting. The model includes six main levels of influence: student demographics (non-modifiable characteristics), student intrapersonal (characteristics of an individual, such as their knowledge or skill), student interpersonal (relationships in individual's environment), school organization (such as its policies), school community (linkages and partnerships with other institutions), and macro-level organization (policies at municipal, provincial, or federal level) (Townsend & Foster, 2011). The conceptual framework is tailored to the school setting and has been previously applied to health behaviours, and thus was relevant to the current study. This conceptual framework will be used throughout this paper to describe the multiple levels of influence on health behaviours among children in schools.

1.3 School Effects

"School effects" refers to the extent to which selected student outcomes vary across schools, after controlling for compositional variables. In this study, compositional variables include student-level and school-level demographic variables. Controlling for student and school-level demographic variables that make up the composition of schools is important to do in order to control for the nonrandom selection of students into schools (Harker & Tymms, 2004). When compositional variables are adequately controlled for, the remaining effects can be largely attributed to school or class characteristics. Thus, researchers must ensure that compositional effects are controlled for in order to properly identify school effects (West, Sweeting, & Leyland, 2004).

School effects have been fairly well-established when it comes to academic achievement as an outcome (Konstantopoulos, 2005; West, 2006). Higher school-level socioeconomic status (SES), higher school attendance and low school dropout rates have been associated with higher student achievement (Konstantopoulos, 2005). Examining school and class effects, or between-school and between-class differences for physical activity and cannabis use, is important to allow for researchers and policymakers to quantify the amount of variation that is explained by school and classroom contexts. Identifying variation attributable to school and class contexts would suggest that there are factors of the school and classroom environment that may be associated with health behaviours, and thus suggest the potential for these environments to influence student health behaviours.

In multi-level modelling, estimates of variance at each level are often used to calculate intraclass correlation coefficients (ICCs), which represent the proportion of variation in outcomes that is accounted for by groups (Luke, 2004). The school-level ICC quantifies the extent to which students from the same school have similar outcomes (i.e. physical activity or cannabis use), whereas the classroom-level ICC quantifies the extent to which students from the same classroom have similar outcomes. The following section presents the school-level and classroom-level ICCs for null models as well as models adjusting for compositional effects (including both student-level and school-level demographic variables) reported in existing literature. Most of the literature reported school-level ICCs, however the class-level ICCs are reported as well, when available. While null models can provide an estimate of between-school and between-class variability, models that adjust for compositional variables (i.e. student and school demographic variables) are able to identify variance that may be attributable to school and classroom contexts.

1.3.1 Between school/class differences in physical activity (Null models).

Existing studies have reported school-level ICCs for physical activity ranging between 0.01 and 0.163 (Griew, Page, Thomas, Hillsdon, & Cooper, 2010; Harvey, Faulkner, Giangregorio, & Leatherdale, 2017; Hobin et al., 2012; Hobin et al., 2013; Ishibashi, 2007; Krisensten et al., 2013; Leatherdale, Manske, Faulkner, Arbour, & Bredin, 2010; Maes &

Lievens, 2003; Moore & Littlecott, 2015; Morgan et al., 2016). In other words, between 1% and 16.3% of the variability in student physical activity is attributable to between-school differences.

Only one study examined between-class variability in student physical activity, which reported 8.0% between-class variability for moderate-to-vigorous physical activity, and 10.0% of the variability in moderate-to-vigorous physical activity was accounted for when schools and school classes were combined (Krisensten et al., 2013).

1.3.2 Adjusted between school/class differences for physical activity.

While most studies only reported ICCs for null (unadjusted) models, a few examined changes in school-level ICCs after adjusting for individual and school-level demographic variables. On average, school-level ICCs remain unchanged or became smaller when individual-level correlates such as sex, ethnicity, and income were added to models (Griew et al., 2010; Krisensten et al., 2013; Maes & Lievens, 2003; Moore & Littlecott, 2015; Morgan et al., 2016). Between-class variability remained unchanged after adjusting for individual-level variables such as sex, SES, and grade (Krisensten et al., 2013).

While most school-level ICCs did not change after adjusting for school-level variables (Krisensten et al., 2013; Moore & Littlecott, 2015; Morgan et al., 2016), one study's school-level ICC decreased when school SES was added (Griew et al., 2010). Notably, in studies where adjustment for school-level variables had no further impact on school-level ICCs, the ICCs were already quite small, ranging from 1.0-2.0%.

1.3.3 Review of studies: Physical activity.

Previous studies examining school effects on physical activity have varied significantly in terms of the setting (country, municipality, or area where study was conducted), approaches to measurement, and age groups studied. While most studies reviewed were conducted in Canada

(Harvey et al., 2017; Hobin et al., 2012; Hobin et al., 2013; Ishibashi, 2007; Leatherdale et al., 2010), others were based in England (Griew et al., 2010), Denmark (Krisensten et al., 2013), Belgium (Maes & Lievens, 2003), and Wales (Moore & Littlecott, 2015; Morgan et al., 2016). Aside from two studies that used accelerometer data to measure physical activity (Griew et al., 2010; Krisensten et al., 2013), all other studies relied on self-report data including 7-day recall of physical activity. Most studies focused on secondary students in grades 9-12 (Harvey et al., 2017; Hobin et al., 2012; Hobin et al., 2013; Ishibashi, 2007), while two studied 11-16 year-olds (Moore & Littlecott, 2015; Morgan et al., 2016), one studied 11-15 year-olds (Maes & Lievens, 2003), one studied 10-11 year-olds (Griew et al., 2010), one studied 9 and 15 year-olds (Krisensten et al., 2013), and another studied students in grades 5-8 (Leatherdale et al., 2010). The varying settings, age groups studied in analyses, and approaches to measurement likely contributed to the variability in reported ICCs across studies.

1.3.4 Between school/class differences in cannabis use (Null Models).

Compared to physical activity, significantly fewer studies have examined between-school and between-class variability in cannabis use. One longitudinal study reported unadjusted school-level ICCs of 3.9% at the first follow-up interval, and 3.1% at the second follow-up interval (West et al., 2004). A cross-sectional study conducted by Kristjansson et al. (2013) reported a school-level ICC of 5.3% in a null model. One study reported between-class variability of 21% for lifetime cannabis use and 25.0% for lifetime use of cannabis 10 or more times (Karlsson, Ekendahl, Gripe, & Raninen, 2018).

1.3.5 Adjusted between school/class differences for cannabis use.

Another study by Johansen et al. (2006) did not report class-level ICCs for null models, but reported a class-level ICC of 14.55% after adjusting for sex, age, socioeconomic group, and type of family. Notably, the measure for drug use was whether students had ever used drugs and included hashish/other euphoriants (Johansen, Rasmussen, & Madsen, 2006). Karlsson et al. (2018) found that after adjusting for individual and school-level correlates, ICCs were reduced, but there was still between-class variance of 10.4% for lifetime use of cannabis, and 15.4% for use of cannabis 10+ times.

1.3.6 Review of studies: Cannabis use.

There were substantial differences between the studies exploring cannabis use. The studies were conducted in a number of different settings including in Iceland (Kristjansson, Sigfusdottir, & Allegrante, 2013), Scotland (West et al., 2004), Denmark (Johansen et al., 2006), and Sweden (Karlsson et al., 2018). While West et al. (2004) and Johansen et al. (2006) examined "ever use" of drugs, Kristjansson et al. (2013) and Karlsson et al. (2018) examined lifetime cannabis use. Karlsson et al. (2018) also examined lifetime use of cannabis 10 times or more. Two studies included only secondary students in the sample (Karlsson et al., 2018; Kristjansson et al., 2013), whereas West et al. (2004) followed up with their sample of 11-year-olds at 13 and 15, and Johansen et al. (2006) included students in grades 8 and 9 in their sample.

1.3.7 Summary of between school and class differences.

A number of studies were identified that explored health behaviours of youth in school settings. With some exceptions, the amount of between-school differences in physical activity and cannabis use decreased when individual and school-level demographic variables were included in models, which suggests that compositional effects, (i.e. student and school demographic variables) largely contribute to these differences. However, student health behaviours were shown to vary between schools even after adjustment for compositional variables, which suggests that the school may be an important environment to potentially modify health behaviours through delivery of interventions, programs, and policies (Sellstrom & Bremberg, 2006). Notably, only Johansen et al. (2006) and Karlsson et al. (2018) explored between-class variability in drug use, and Krisensten et al. (2013) explored between-class variability in physical activity. Given the limited understanding of between-class differences in these health behaviours, further exploration is warranted.

There were a number of notable methodological limitations of the existing literature, including: 1) Many studies exploring school effects had small sample sizes, with small numbers of schools reporting similar characteristics, such as schools within one municipality (Krisensten et al., 2013; Maes & Lievens, 2003). Thus, the generalizability of these studies is limited. 2) Some studies such as those conducted by Harvey et al. (2017) and Leatherdale et al. (2010) used convenience sampling, which also limits the generalizability of study results. 3) Only one study focusing on physical activity (Maes & Lievens, 2003) and one study focusing on drug use gathered data from teachers (Johansen et al., 2006), whereas all others relied on a single person (i.e. one informant) for school-level data. A number of potential biases are introduced when single informants within organizations such as schools are utilized (Hughes & Preski, 1994). There may be attributes of an individual such as the number of years they have been at the school that may impact their awareness of school-level variables. As well, especially when examining contextual variables, single informants may not adequately reflect the experiences of all individuals within that setting. 4) Most studies employed a two-level multilevel analysis which neglects the clustering of students at the classroom level. By ignoring classroom-level clustering, studies may have under-estimated the combined school and class effect (Martinez, 2012).

1.4 Student and School-Level Variables Associated with Physical Activity and Cannabis Use

1.4.1 Demographic variables.

Sex has been strongly associated with cannabis use, with males being more likely to report using cannabis (Johansen et al., 2006; Leatherdale & Burkhalter, 2012; Leatherdale, Hammond, & Ahmed, 2008; West et al., 2004), and more likely to be physically active compared to females (Boak, Hamilton, Adlaf, Henderson, & Mann, 2016; Harvey et al., 2017; Leatherdale et al., 2010; Morgan et al., 2016). While cannabis use increases with age or grade, physical activity tends to decline as students get older (Boak et al., 2017; Harvey et al., 2017; Leatherdale & Burkhalter, 2012; Leatherdale et al., 2008; Leatherdale & Rynard, 2013; West et al., 2004). Studies have found that youth living in families with both biological parents were less likely to report using drugs compared to other family structures (Johansen et al., 2006; West et al., 2004). Family affluence or individual-level SES has been positively associated with physical activity, whereas less clear associations between cannabis use and individual-level SES have been found (Ferreira et al., 2006; Hanson & Chen, 2007; Moore & Littlecott, 2015).

School SES has been negatively associated with physical activity in some studies (Ishibashi, 2007; Morgan et al., 2016), yet other studies have reported the opposite association, or mixed associations depending on grade (Griew et al., 2010; O'Malley, Johnston, Bachman, Schulenberg, & Kumar, 2006). School size has also been positively associated with physical activity in one study (Ishibashi, 2007), yet another study found inconsistent relationships between physical activity and school size (Harvey et al., 2017).

1.4.2 Student interpersonal variables.

Studies exploring aspects of school climate such as caring about students, perceptions of fairness, and perceptions of connectedness to school found that more positive school climate was associated with lower odds of drug use and higher odds of being physically active (Battistich & Hom, 1997; Carter, McGee, Taylor, & Williams, 2007; Resnick et al., 1997). While most literature explores school climate measured at the individual level, one study also found that school-level (aggregate) positive perceptions of school climate were inversely associated with cannabis use (Mayberry, Espelage, & Koenig, 2009). Thus, exploration of both individual and collective perceptions of school experience is warranted.

Peer behaviours have also been associated with student behaviours. One study reported that students with peers using cannabis had over seven times higher odds of reporting lifetime cannabis use compared to those who had no friends using cannabis (Kristjansson et al., 2013). Similarly, Leatherdale et al. (2010) found that students have higher odds of being physically active when they had 3 or more close friends who were active.

1.4.3 School organization variables.

The majority of existing multilevel studies examining school effects on physical activity have focused on the built environment, rather than other school experience factors such as school organization. Associations between characteristics of the built environment and student health behaviours have been mixed. Some studies found that physical activity facilities were not associated with student physical activity outcomes (Harvey et al., 2017; Ishibashi, 2007; Leatherdale et al., 2010; Morgan et al., 2016) while other studies found that having an indoor room for physical activity was associated with increased odds of physical activity (Hobin et al., 2012; Hobin et al., 2013).

School health promotion policies and programs have not been strongly associated with physical activity or cannabis use (Denny et al., 2011; Maes & Lievens, 2003; Morgan et al., 2016). Notably, the measures used in these studies do not capture the awareness and reinforcement of the policy, nor its effectiveness. For instance, Morgan et al. (2016) did not find significant associations between food/fitness policy with physical activity, however the measure was a binary (yes/no) response regarding whether or not a food and fitness policy was in place, and responses were only gathered from one representative from each school (typically one teacher within the school). Similarly, another study found that "health promoting schools organization" (characterized by presence of a committee designed to implement health promotion activities, allocation of school time for staff to carry out health promotion activities, and inclusion of health and well-being in school's strategic plan) was not found to be associated with health risk behaviours (Denny et al., 2011). However, it is important to recognize that these measures do not capture potentially important contextual information about the policies and programs. For instance, information was not available on how many health promotion programs were implemented, which health risk behaviours were targeted, and whether they were implemented in classrooms or the entire school.

1.4.4 School community variables.

Establishment of school partnerships with the community has been associated with physical activity (Leatherdale et al., 2010). Leatherdale et al. (2010) found that students were more likely to be highly active at schools with stronger community partnerships. However, there is a paucity of literature exploring associations between establishment of community partnerships and student cannabis use.

1.5 Current Study

A crucial aspect of this study is its exploration of between-classroom differences in addition to between-school differences. There may be unique characteristics of the classroom that differ from school characteristics which may also impact health behaviours, and thus there is a need to explore school class cluster effects (Krisensten et al., 2013). Given that classrooms are nested within schools, it is important to include classrooms in the analyses to differentiate between school and class variability. As previously described, some research has relied on convenience sampling, and explored schools within one municipality, where schools and students may share more similar characteristics. Further, only two studies gathered data from teachers within schools (Johansen et al., 2006; Maes & Lievens, 2003). To address these limitations, this study will use data from the School Mental Health Survey (SMHS), a large, representative sample of elementary and secondary schools in Ontario. This study examined both a health promoting behaviour (physical activity) and a health risk behaviour (cannabis use). This study adjusted for a number of well-established student-level and school-level demographic variables to adequately control for compositional effects. By using three-level multilevel modelling, this study addresses gaps in previous literature by differentiating school and class effects, accounting for compositional effects at the student and school level and identifying modifiable school level factors associated with health promoting and health risk behaviors that can serve as potential targets for health promotion programs in schools (Sellstrom & Bremberg, 2006).

1.6 Implications of Study

Results from this study could provide insights into characteristics of schools that are associated with health promoting and health risk behaviours. Further understanding of potential school characteristics that are associated with health behaviours is important to design targeted initiatives in schools and to support context-specific policy development (Saab & Klinger, 2010). This study also focuses on schools and students in Ontario, and thus the results will have direct, locally-relevant impact that is unique to Ontario's school context. While some studies have explored associations between school effects and health behaviours, research identifying between-classroom variability is far more limited, and thus this research will further the understanding of variability of health behaviours at multiple levels within the school setting (Johansen et al., 2006).

1.7 Research Questions

This study aims to answer the following research questions: 1) To what extent is variation in physical activity and cannabis use of elementary and secondary school students in Ontario attributable to between school and classroom differences? 2) What characteristics of schools are associated with physical activity and cannabis use of elementary school and secondary school-aged children in Ontarian schools?

Chapter 2: Methods

2.1 Study Design

This study used data from the School Mental Health Survey (SMHS). The SMHS is a cross-sectional, multi-informant study that collected data from students, teachers, and principals from 248 schools in Ontario in 2014-2015. The study was designed to examine associations between the school setting and student mental health and well-being.

2.2 Recruitment and Data Collection

Schools were selected to participate in this study based on the sampling design used in the 2014 Ontario Child Health Study (OCHS), such that schools included in the SMHS were selected within neighbourhoods selected to participate in the 2014 OCHS. The 2014 OCHS used a stratified, two-stage cluster design. In the first stage, neighbourhoods were identified (census tracts in urban areas and contiguous dissemination areas in rural areas). Neighbourhoods were stratified as urban versus rural as well as by median family income (low, medium, high) within these strata. In total, 180 neighbourhoods were selected for the 2014 OCHS. Schools that were located within these neighbourhoods were sampled for the SMHS.

For a school to be included in the SMHS sample, there were a number of eligibility requirements. The minimum school size for schools with Junior Kindergarten to grade 8 was 150, while other schools were required to have a minimum of 50 students attending. Elementary schools included in the sample were required to have grades 6-8 at their school. To be included in the SMHS, schools also had to be within the area sampling frame used in the 2014 OCHS.

2.3 Response Rates

Surveys were administered to all consenting students in grades 6-8 as well as a random sample of secondary students (grade 9-12) from three classrooms per grade within each school.

All elementary school teachers as well as the secondary school teachers from the classrooms selected were invited to complete the teacher questionnaire. School principals of the selected schools were also invited to complete the principal survey. Of the 359 schools selected to participate in the study, 248 schools agreed to participate (69%). Within the schools selected to participate, data were collected from 31,124 students (61.6% response rate), 3,373 teachers (71.2% response rate), and 206 principals (83.1% response rate). The majority of students completed paper-based surveys (57.8%), whereas 42.2% completed the survey online.

2.4 Ethical Considerations

Given that this study utilized secondary data, institutional research ethics was not required. However, for the primary data collection, the SMHS received ethical approval from Research Ethics Committees for school boards involved in the study, and also from the Hamilton Integrated Research Ethics Board at McMaster University. Parental consent was obtained for participating school boards. To obtain consent, information letters and consent forms were sent to parents requesting permission for their child to participate in the study. Students of consenting parents voluntarily completed the survey, with the option to refuse to participate. All surveys were anonymous.

2.5 Measures

The SMHS collected data on a range of student and school variables related to mental health and well-being. Student variables included self-reported mental health, health risk behaviours (tobacco use, cannabis use, and binge drinking), health promoting behaviours (physical activity, breakfast consumption, and sleep), bullying and victimization, and family SES. School variables included measures of school composition (such as school catchment areas SES), school capacity (such as availability of school programs), and school processes (such as school climate and classroom climate). A number of variables in the SMHS relate to health risk and health promoting behaviours, which were used for the purposes of this study. The measures selected for this study are described below. Scales and items were largely consistent with well-established measures from existing studies, and items were adapted based on results from a feasibility study implemented prior to the distribution of the SMHS. A summary of the measures can be found in Table 1.

2.5.1 Outcome variables.

In the SMHS, students self-reported their cannabis use. The cannabis use item was derived from the National Longitudinal Survey of Children and Youth (Statistics Canada, 2009). Students were asked to identify the category which best described their experience with marijuana and cannabis products. For elementary students, responses were classified as either "never used" (never tried cannabis) or "ever used" (including tried once or twice, used to smoke, smoke sometimes, and smoke at least once a week or more). For secondary students, responses were classified as "current user" (including sometimes but not every week, and smoke at least once a week or more) and "not current user" (including never tried, have tried once or twice, and used to smoke).

The physical activity item was similar to 7-day physical activity recalls used in the Cohort Study on Obesity, Marijuana Use, Physical Activity, Alcohol Use, Smoking, and Sedentary Behaviour (COMPASS), which has demonstrated both test-retest reliability and criterion validity (Leatherdale, Laxer, & Faulkner, 2014). Physical activity was measured in the SMHS by asking students to report the number of days in the past week that they had participated in at least 60 minutes of physical activity that increased their heart rate and made them get out of breath. For the purposes of this study, those who reported engaging in physical activity every day were categorized as "daily", while those who reported no days to six days were classified as "non-daily".

2.5.2 Demographic variables.

Demographic information was self-reported by students. Students self-identified as male or female. Students also indicated their age, with response options ranging from 9-22 (Categories included: 11 or younger, 12 years, 13 years, 14 or older for elementary students, and 14 or younger, 15 years, 16 years, 17 years, 18 or older for secondary students). Students also self-identified their race/ethnicity (Categories included: White, East Asian, Southeast Asian, South Asian, West Asian or Arab, Black African/Black Caribbean/ Black Canadian/Black American, Latin American/Central American/South American, Indigenous, and Other/Multiracial). Family structure was derived from the SMHS measure that asked students to indicate who lived in the home with them that they spent most of their time in (Categories included: two-parent, single parent, no parent). Family assets was measured by an index of material assets captured through a Z-score, which was derived using Principal Component Analysis, where a single factor accounted for 45.5% of the variance (Categorized into: low, medium, high, based on terciles within the data). School SES was derived from the before-tax median family income in the area where the school was located, based on the 2011 National Household Survey (NHS) [Categories included: <$60,000, $60,000 to $79,999, $80,000 to $99,999, $100,000 to $124,999, $125,000+]. School size was measured by the total student enrolment and was further categorized by terciles into subcategories of small (<423 for elementary schools, <788 for secondary schools), medium (Between 423 and 683 for elementary schools, between 788 and 1196 for secondary schools), or large (≥ 685 for elementary schools, ≥1197 for secondary schools).

2.5.3 Student interpersonal variables.

School climate was measured as a sum of 20 items that encompass perceptions of student to student relationships, student to teacher relationships, social and emotional learning, fairness, consistency/clarity of rules, and academic press. Students rated their perceptions using a Likert scale, from 1 (disagree a lot) to 4 (agree a lot). Scaled responses ranged from a minimum of 20 to a maximum of 80, where higher scores were reflective of more positive perceptions of school climate (Additional details about the school climate measure can be found in Table 1). The measure was derived from the Delaware School Surveys (Bear & Yang, 2011). The measure had good internal consistency (Cronbach alpha = 0.91). From the school climate variable, two measures were derived. The first measure captured individual perceptions of school climate, which was centered around the school mean. The second measure captured the collective perceptions of school climate at an aggregate level by estimating the mean ratings of school climate across all students in the school.

2.5.4 School organization variables.

The health promotion(HPRO)/risk prevention programs variable was derived from teacher surveys. Teachers were asked to indicate whether a range of programs such as social and emotional learning programs, violence prevention or peace promotion programs, or HPRO/risk prevention programs were implemented in their classrooms since the beginning of the year. The proportion of teachers within a school who reported implementing a HPRO/Risk prevention program was calculated.

2.5.5 School community variables.

Teacher perceptions of community relations was measured using a sub-scale of school climate (see Table 1 for measures include in the subscale). The measure was derived from the

Creating a Great Place to Learn Survey, which has demonstrated good reliability and validity (Search Institute, 2006). Teacher perceptions of community relations also demonstrated good internal consistency (Cronbach alpha = 0.70). Scores were aggregated to the school level by taking a mean across teachers' responses in a school. Scaled responses for community relations ranged from a minimum of 3 to a maximum of 12, where higher scores were indicative of more positive perceptions of community relations.

2.6 Data Analyses

Descriptive statistics were used to describe the primary variables of study. For continuous variables, means and standard deviations (SD) are reported and for categorical variables, the frequency distributions are reported. Descriptive statistics, means, and SD were calculated in SPSS version 25.0.

To determine the extent to which variation in student health behaviours is attributable to between school and classroom differences, intra-class correlation coefficients (ICCs) were calculated after adjusting for individual and school-level demographic variables (i.e. compositional variables). The ICC was then converted into a percentage to quantify the extent to which between-group variability was explained by classroom and school contexts. Calculations for the ICCs can be found in Appendix A.

To determine the characteristics of schools associated with physical activity and cannabis use, three-level (students, classrooms, and schools) binary logistic regressions were conducted. Multilevel modelling was done in MLwiN 2.35, using Iterative Generalized Least Squares (IGLS), with second order Predictive Quasi-Likelihood (PQL) estimation. The intercept was random at school and classroom levels, while all student demographic, student interpersonal, school organization and school community variables were fixed. Continuous variables were grand mean centred. Differences in the distributions of the outcome variables were distinct between elementary and secondary students, with 40% of elementary students reporting daily physical activity compared to only 28% of secondary students reported daily physical activity. Further, while only 3.1% of elementary students reported ever using cannabis, over 13% of secondary students were current users of cannabis. Due to these distinct differences in the outcome variables between the two age groups, analyses were done separately for elementary school students (grades 6-8, n=16,797) and secondary school students (grades 9-12, n=11,077). Only complete cases were included in the analysis, and characteristics of missing cases were examined, which will be described in the results chapter.

Chapter 3: Results

3.1 Sample for Analyses

The analyses for this study were performed on complete cases (n=27,874). Among elementary students, 12.2% of the overall sample were removed due to missing data (16,797 elementary students included in analyses out of 19,130 elementary students in the overall sample). Most students that were excluded were missing one item (7.5% of the overall sample) or two items (1.8% of the overall sample). The variables with the most missing data for elementary students were family structure (missing for 4.9% of the sample) and family assets (missing for 6.1% of the sample). There were some statistically significant differences between those included in the analyses (complete cases) and those excluded due to missing data. Elementary students with missing data were more likely to report being male, ever-users of cannabis, low family assets, and 11 years of age or younger (see Table 2).

Among secondary students, 7.6% of the sample were removed due to missing data (11,077 secondary students included in analyses out of 11, secondary students in the overall sample). Of the 7.6% of the overall sample that were excluded due to missing data, 5.4% were missing one item, while 2.2% were missing two or more items. Similar to elementary students, the variables with the most missing data among secondary students were family structure (missing from 2.3% of the sample) and family assets (missing for 3.2% of the sample). Missing cases were more likely to report being male, current users of cannabis, low family assets, and 14 or younger (see Table 3).

3.2 Descriptive Statistics

Table 4 demonstrates the student and school characteristics for the elementary sample. In the elementary sample, 47.3% (n=7,939) were male, whereas 52.7% (n=8,858) were female.

40.6% (n=6,818) of the sample reported engaging in daily physical activity. Most of the students (96.9%, n=16,276) had never tried cannabis, whereas 3.1% (n=521) had tried cannabis. The mean student-level perception of school climate was 59.3 (SD= 8.4), and the mean collective perception of school climate was 60.8 (SD=2.6).

Table 5 demonstrates the student and school characteristics of the sample of secondary school-aged students. About 52% (n=5,764) of the sample was female. Most of the sample reported less than daily physical activity (71.6%, n=7936), while 28.4% (n=3141) reported engaging in daily physical activity. Most students did not report current cannabis use (86.1%, n=9,540), while 13.9% (n=1,537) reported current cannabis use. The mean student-level perception of school climate was 57.9 (SD=7.8), whereas the mean collective perception of school climate was 57.0 (SD=1.6).

3.3 Between-School and Between-Class Variability

Table 6 highlights the ICCs for models adjusted by compositional variables (sex, age, family structure, race/ethnicity, family assets, school SES, school size). ICCs were used to quantify the proportion of variation attributable to between school and classroom differences. 1.4% of the variability in physical activity was associated with between-school differences and 1.4% was associated with between-classroom differences among elementary students. Among secondary students, 1.5% of the of the variability in physical activity was associated with between-school differences, whereas 3.2% was associated with between-classroom differences. For cannabis use, 7.7% of the variability was associated with between-school differences and 5.7% was associated with between-classroom differences among elementary students. However, 2.9% of the variability in cannabis use was associated with between-school differences, whereas

10.9% of the variability was associated with between-classroom differences among secondary students.

3.4 Results of the Multilevel Binary Logistic Regression Analysis

Results for the multilevel binary logistic regressions report fully adjusted models, which examine associations between physical activity and cannabis use with individual perception of school climate, collective school climate, proportion of teachers implementing a HPRO/Risk prevention program, and perceptions of community relations, while controlling for compositional variables (sex, age, family structure, family assets, race/ethnicity, school SES, and school size).

3.4.1 Associations between student and school-level characteristics with physical activity.

3.4.1.1 Elementary students.

At the student-level, age was significantly associated with the odds of reporting daily physical activity. Compared to students 11 years or younger, 12-year-olds (OR 0.81, 95% CI 0.74-0.89), 13-year-olds (OR 0.68, 95% CI 0.63-0.75), and students 14 years or older (OR 0.70, 95% CI 0.61-0.80) were significantly less likely to report daily physical activity (See Table 7). Females were less likely to report daily physical activity than males (OR 0.50, 95% CI 0.47-0.53). Students were less likely to report daily physical activity if they identified as East Asian (OR 0.49, 95% CI 0.40-0.59), Southeast Asian (OR 0.52, 95% CI 0.44-0.63), South Asian (OR 0.82, 95% CI 0.72-0.93), or Latin American/Central American/South American (OR 0.68, 95% CI 0.54-0.85) compared to White students. In contrast, Black students reported higher odds of achieving daily physical activity than White students (OR 1.23, 95% CI 1.05-1.43). Compared to students in families with low family assets, students in families with high (OR 1.59, 95% CI 1.47-1.73) or medium (OR 1.27, 95% CI 1.17-1.37) family assets had higher odds of achieving daily physical activity.

Individual students' perceptions of school climate were positively associated with daily physical activity (OR 1.02, 95% CI 1.02-1. 03), whereas aggregate estimates of climate at the school level was not associated with increased odds of daily physical activity (OR 1.00, 95% CI 0.98-1.03). Teacher perceptions of community relations at the school level were positively associated with daily physical activity among students (OR 1.08, 95% CI 1.01-1.15). The proportion of teachers at a school implementing a HPRO/Risk prevention program was not significantly associated with the odds of reporting daily physical activity (See Table 7*)*.

3.4.1.2 Secondary students.

As shown in Table 8*,* secondary students were similar to elementary students with respect to the associations between age, sex, race/ethnicity, family assets, and physical activity. Older secondary students were less likely to engage in daily physical activity, with 16-year-old students (OR 0.65, 95% CI 0.57-0.75), 17-year-olds (OR 0.43, 95% CI-0.37-0.50), and students 18 or older (OR 0.47, 95% CI 0.38-0.58) reporting significantly lower odds of engaging in daily physical activity compared to the students aged 14 or younger. Females were also less likely to report daily physical activity than males (OR 0.51, 95% CI 0.47-0.55). Similar to the elementary sample, East Asian (OR 0.45, 95% CI 0.34-0.58), South East Asian (OR 0.65, 95% CI 0.48-0.87), South Asian (OR 0.75, 95% CI 0.61-0.91) and Latin American/Central American/South American (OR 0.71, 95% CI 0.51-0.99) students were less likely to report daily physical activity compared to White students.

Students with more positive perceptions of school climate were more likely to report daily physical activity (OR 1.01, 95% CI 1.00-1.01) although the magnitude of the association was small. Aggregate estimates of school climate, proportion of teachers implementing a HPRO/Risk prevention study, and perception of community relations were not significantly associated with physical activity among secondary students after controlling for compositional variables. Although not statistically significant, the direction of the association between perceptions of community relations and physical activity was similar to that of elementary students, such that perceptions of community relations were positively associated with physical activity (OR 1.04, 95% CI 0.93-1.16).

3.4.2 Associations between student and school-level characteristics with cannabis use.

3.4.2.1 Elementary students.

At the student level, age was significantly associated with cannabis use, with 12-year-olds (OR 2.13, 95% CI 1.44-3.15), 13-year-olds (OR 4.98, 95% CI 3.46-7.17), and students 14 or older (OR 6.97, 95% CI 4.64-10.48) reporting significantly higher odds of using cannabis compared to students 11 or younger (See Table 7). Sex was not associated with odds of cannabis use. South Asian students (OR 0.33, 95% CI 0.19-0.57) were less likely to report engaging in cannabis use compared to White students, whereas Black students (OR 1.63, 95% CI 1.16-2.30) and Indigenous students (OR 2.07, 95% CI 1.20-3.56) were more likely. Students living in single parent and no-parent homes had 1.47 times (OR 1.47, 95% CI 1.17-1.84) and 2.99 times higher (OR 2.99, 95% CI 2.16-4.14) odds of using cannabis, respectively, compared to students in two-parent homes. Students in medium (OR 0.71, 95% CI 0.56-0.89) or high (OR 0.79, 95% CI 0.62-0.99) family asset households had lower odds of using cannabis compared to low family asset households.

Students' perceptions of school climate were negatively associated with cannabis use (OR 0.92, 95% CI 0.91-0.93). Ratings of climate at the school level were also negatively associated with cannabis use (OR 0.87, 95% CI 0.82-0.93). Compared to students attending schools with low area-level SES (i.e. areas with before-tax median family income of <$60,000), students attending schools with area-level SES of $100,000-$124,999 and $125,000+ had 37% lower odds (OR 0.63, 95% CI 0.42-0.95) and 49% lower odds (OR 0.51, 95% CI 0.27-0.93) of using cannabis, respectively. However, other school-level variables including the proportion of teachers implementing a HPRO/Risk Prevention program, as well as perceptions of community relations were not significantly associated with cannabis use among the elementary sample (See Table 7).

3.4.2.2 Secondary students.

Similar to the elementary sample, older students had higher odds of reporting cannabis use, with the oldest age group of students 18 or older being 5.6 times more likely to report current cannabis use compared to students 14 or younger (OR 5.64, 95% CI 4.30-7.39). Race/ethnicity was also significantly associated with cannabis use. Compared to students identifying as White, students who identified as East Asian (OR 0.21, 95% CI 0.12-0.35), Southeast Asian (OR 0.43, 95% CI 0.26-0.71), and South Asian (OR 0.33, 95% CI 0.23-0.48) were less likely to report current cannabis use, whereas Indigenous students were 2 times more likely to report current cannabis use (OR 2.00, 95% CI 1.28-3.14).

Both individual perceptions (OR 0.92, 95% CI 0.92-0.93) and aggregate ratings of school climate (OR 0.87, 95% CI 0.81-0.93) were negatively associated with secondary students' cannabis use. Students attending schools with before-tax median family income ranging from $60,000-$79,999 had higher odds (OR 1.54, 95% CI 1.12-2.12) of reporting cannabis use compared to those in schools with median family income <$60,000. Students attending schools with more positive perceptions of community relations reported higher odds of current cannabis use (OR 1.29, 95% CI 1.12-1.50), whereas the proportion of teachers implementing a

HPRO/Risk Prevention programs was not significantly associated with cannabis use among secondary students (See Table 8).

Chapter 4: Discussion

Using a large, representative sample of schools in Ontario, this study quantified the extent to which physical activity and cannabis use varied between schools and between classrooms within schools, as well as identified school-level variables that were associated with students' odds of reporting cannabis use and daily physical activity. Novel contributions of this research include: 1) The use of three-level models to separate between-school and between-class variability, 2) Identification of associations between a health promoting behaviour (physical activity) and a health risk behaviour (cannabis use) with individual and collective perceptions of school climate, 3) Inclusion of both elementary and secondary students in the sample.

4.1 Between-School and Between-Class Variability

Previous studies that have not accounted for the clustering of classes within schools may have misattributed between-class variation to the student level, thus resulting in an underestimation of the potential of schools to influence student health behaviours (Martinez, 2012). Notably, this study explored between-class and between-school variability, whereas most studies focused on between-school variability alone. The finding that there was between-class variability for both physical activity and cannabis use, and that it was typically larger than between-school variability suggests that interventions targeting the classroom level may be a viable strategy to address health behaviours. Although this study did not explore classroom characteristics associated with cannabis use or physical activity, this may be important to examine in the future to identify modifiable characteristics at the classroom level.

For student physical activity, school and class-level ICCs reported in this study was within the range of ICCs reported in existing studies, although the range of ICCs in existing studies is quite large, ranging from 1.0% to 16.3% (Griew et al., 2010; Harvey et al., 2017;

Hobin et al., 2012; Hobin et al., 2013; Ishibashi, 2007; Krisensten et al., 2013; Leatherdale et al., 2010; Maes & Lievens, 2003; Moore & Littlecott, 2015; Morgan et al., 2016). Although the ICCs found in this study are on the lower end of the range, studies reporting higher ICCs tended to examine school-time physical activity, during which it would be expected that students would be exposed to similar environments, thus resulting in higher similarities amongst clusters (Krisensten et al., 2013). In contrast, this study did not differentiate between school time or leisure time physical activity. The ICCs for student cannabis use reported in this study are also consistent with existing literature (Johansen et al., 2006; O'Malley et al., 2006; West et al., 2004).

4.2 Demographic Variables

The associations between physical activity and cannabis use with student-level characteristics largely aligned with existing literature. For instance, the finding that older students were more likely to engage in cannabis use and females were less likely to report daily physical activity was congruent with existing literature (Boak et al., 2016; Boak, Hamilton, Adlaf, & Mann, 2013; Harvey et al., 2017; Johansen et al., 2006; Leatherdale & Burkhalter, 2012; Leatherdale et al., 2008; Leatherdale et al., 2010; Leatherdale & Rynard, 2013; Morgan et al., 2016; West et al., 2004). One unanticipated finding was that sex was not significantly associated with cannabis use among elementary students, although males were more likely to have endorsed cannabis use, which was in the expected direction. This may be due to the relatively small number of students reporting cannabis use among the elementary sample. Further, males consistently report higher prevalence of cannabis use across all categories of use (i.e. ranging from 1-2 times per week to daily use) (Boak et al., 2017). Thus, even among the 3.1% of elementary students endorsing cannabis use, it is likely that there were a small number of females reporting cannabis use, resulting in inadequate power. The positive association between family assets and physical activity as well as somewhat inconsistent relationship between family assets and cannabis use also aligns with literature (Hanson & Chen, 2007; Moore & Littlecott, 2015).

Notably, East Asian, Southeast Asian, and South Asian youth had significantly lower odds of reporting daily physical activity among both elementary and secondary students compared to White students. Previous multilevel studies have predominantly included race/ethnicity in models as a binary variable (White compared to non-White) (Griew et al., 2010; Harvey et al., 2017; Morgan et al., 2016). Thus, this study contributes to a further understanding of associations between physical activity and racial/ethnic subgroups. Targeted physical activity interventions that consider differences in physical activity among different ethnic/cultural groups thus may be warranted, although further research is needed to develop an understanding of why certain groups are more likely to be physically active.

Among secondary students, larger school size was associated with greater odds of reporting current cannabis use, however this study did not find any other consistent associations between school size and physical activity or cannabis use. Given the mixed associations between school size with physical activity and cannabis use in the literature (Harvey et al., 2017; Ishibashi, 2007), further research is needed to understand this relationship. In addition to student-level family assets, a gradient was observed in which students in areas with higher area-level SES were more likely to achieve daily physical activity, and less likely to report using cannabis among elementary students. Among secondary students, the association between area-level SES and physical activity was less consistent, however higher area-level SES tended to be associated with higher odds of cannabis use. The lack of consistent associations was expected given the mixed associations demonstrated in existing literature for physical activity (Griew et al., 2010; Ishibashi, 2007; Morgan et al., 2016) and cannabis use (O'Malley et al., 2006).

4.3 Student Interpersonal Variables

More positive perceptions of school climate at the individual level were consistently associated with increased odds of daily physical activity and decreased odds of cannabis use among elementary and secondary school students. However, it should be noted that for physical activity, the magnitude of the association was small. A 1-unit increase in student perceptions of school climate was associated with 2% higher odds and 1% higher odds of achieving daily physical activity among elementary and secondary students, respectively. Existing literature has found similar associations between aspects of school climate, such as perceptions of fairness and caring within the school, and school connectedness and physical activity (Carter et al., 2007) and cannabis use (Carter et al., 2007; Resnick et al., 1997). School climates characterized as respectful by students have been associated with less friendships with peers engaging in risky behaviour and stronger perceptions of healthy school norms, which may explain why students who perceived more positive school climates were more likely be physically active, and less likely to engage in cannabis use (LaRusso, Romer, & Selman, 2008).

Perceptions of climate at the school level (i.e., aggregate measure of school climate across all students in the school) were inversely associated with secondary students' cannabis use. Few studies have explored collective perceptions of school climate, however one study also found an inverse association between positive school climate measured at the school level and cannabis use, thus highlighting the importance of contextual variables (Mayberry et al., 2009). The measure of school climate in this study included multiple sub-scales, which may explain the somewhat small magnitude of the associations between school climate and health behaviours.

Future research should explore sub-scales of school climate to identify whether certain aspects of school climate, such as student-teacher relationships or student-student relationships are more strongly associated with physical activity and cannabis use.

4.4 School Organization Variables

Although the direction of the association between the proportion of teachers implementing a HPRO/risk prevention program and cannabis use was in the expected direction, the association did not reach statistical significance. In this study, implementation of a HPRO/risk prevention program was gathered by asking teachers to indicate, from a list of types of programs (such social emotional learning programs as well as violence prevention or peace promotion programs), which had been implemented in the classroom. If teachers had implemented multiple programs, they were asked to indicate the program that had the greatest benefit for most students. Thus, even though a teacher may have implemented a HPRO/risk prevention program, it may not have been captured if they felt another program was more beneficial. As a result, the measure may have underestimated the total number of classrooms that implemented a HPRO/risk prevention program. As well, the measure did not capture potentially important aspects of programs such as its frequency/intensity, what the focus of the program was on (i.e. whether the program targeted physical activity or cannabis use), and whether the program's efficacy had been explored. Future research may consider more specific programming questions to better capture the nature and intensity of the programs being implemented within schools and classrooms.

4.5 School Community Variables

Another school-level variable that was associated with health behaviours was teachers' perception of community relations. Students attending elementary schools where teachers had more positive ratings of community relations were more likely to report daily physical activity. Similarly, Leatherdale et al (2010) found that students in grades 5-8 attending schools with established community partnerships had higher odds of being highly active. This association was not significant among secondary students in this study, although the direction of the association was consistent with the elementary student sample. Given that Leatherdale et al. (2010) only explored community partnerships among elementary students, further research is needed to explore the associations among secondary students and how community partnerships may affect these age groups differently.

An unanticipated finding was that positive perceptions of community relations was associated with higher odds of cannabis use among secondary students. A possible explanation for this finding is that schools with larger numbers of students engaging in risky behaviours such as cannabis use may be more likely to be focused on fostering partnerships with communities. Thus, the higher community relations score may be driven by higher need within the school. Given the nature of the measure, it is not possible to identify decisions that prompt schools to actively seek community partnerships. Since the survey is cross-sectional, we cannot infer causality for the relationship between cannabis use and community relations.

4.6 Study Limitations

While this study was able to determine associations between school characteristics with physical activity and cannabis use, causality cannot be established due to the cross-sectional design of the SMHS and the approaches to statistical analyses in this study. However, determining associations may highlight potentially important areas of focus that could be further explored in studies with longitudinal design. Future research should employ longitudinal design to determine the causal mechanisms for the associations observed in this study.

Since this study used secondary data analysis, additional limitations were introduced. The SMHS was designed and distributed before this study began, and thus was not designed specifically to answer this study's research questions. As a result, the measures and variables included in the study were limited to those used in the SMHS, and certain variables of interest were not able to be explored. For instance, additional details about the types of HPRO/Risk prevention programs implemented (i.e. duration/intensity, focus of program [such as targeting a specific health behaviour]) could not be explored in this study, but may be potentially important factors to explore in future research.

The study relied on self-reported data, and thus there was potential for information bias. Subjective measures such as the one used in this study to measure physical activity tend to result in over-reporting of physical activity compared to accelerometer data among youth (Hagstromer et al., 2008; LeBlanc & Janssen, 2010). Self-reported cannabis use generally demonstrates high levels of reliability, although its validity is difficult to establish given the limited objective measurements available (Brener, Billy, & Grady, 2003). As well, objective measurements of outcomes require substantial resources, and thus are not always practical in large studies such as the SMHS. However, to minimize the potential for information bias, items in this study were adapted from well-established measures that often demonstrated good reliability and validity, as previously described.

Given that the study had student, teacher, principal and school response rates ranging from 61-83% of those invited to participate, there was potential for selection bias, which occurs when those who participate differ systematically from those who do not participate (Sedgwick, 2015). While information on differences between participants and non-participants is unavailable for students, teachers and principals, differences between schools that chose to participate and those that did not were explored. There were no significant differences in socio-economic and demographic characteristics between participating and non-participating schools.

Although the sample size for this study was large, the number of students using cannabis was low, particularly among elementary students. As a result, cannabis use was dichotomized, which limits the ability to explore a dose-repose relationship as a function of frequency of use. Also, co-occurrence of other related health behaviours such as alcohol and tobacco use were not accounted for in this study. Future research should explore relationships between multiple health promoting and multiple health risk behaviours. As well, given limitations with the software used for multi-level analyses, this study was not able to assess model fit.

The analyses used complete cases only, and there were some differences between cases included and cases excluded from the final sample. Thus, the cases with complete cases may not be representative of the total sample. Another concern with complete case analysis is the reduced power that can occur when a large number of data is missing (Sterne et al., 2009). However, in this study missing data was relatively small (between 7-12%), and differences between cases included and excluded were small (see Table 2 and Table 3).

4.7 Study Strengths

Despite the study's limitations, there were also a number of notable strengths. This study used a representative sample of schools in Ontario, which allows better generalizability of results compared to studies that used convenience or other non-random samples. As well, the ability to differentiate between both between-school and between-class variability using three-level models reduces the potential misattribution of school-level variance to student-level variance, thus more accurately estimating the school effect. The design of the SMHS also allowed for exploration of collective school experience, which provides further evidence for contextual effects within schools.

Chapter 5: Conclusion

In conclusion, the present study contributes to existing research that suggests the potential influence of schools and classroom contexts on student health behaviour. Notably, school and classroom contexts accounted for 2-5% of the variability in student physical activity, and about 13% of the variability in student cannabis use after controlling for compositional factors. These between-school and between-class differences are important, especially when considered at a population level, given that small shifts in health behaviours can impact large numbers of students due to the clustering within the schools (Costello, Leatherdale, Ahmed, Church, & Cunningham, 2011). This research further supports the importance of a multi-level approach to designing programs, policies, and interventions aiming to modify physical activity and cannabis use by targeting both individual and environmental/contextual factors (Cale & Harris, 2006; O'Malley et al., 2006). While student-level variables were more strongly associated with physical activity and cannabis use, this study also identified school-level variables associated with these health behaviours. Even after controlling for compositional effects, more positive individual perceptions of school climate as well as positive perceptions of community relations (among elementary students) were positively associated with physical activity. More positive individual perceptions of school climate and collective school climate (among secondary students) were inversely associated with cannabis use, whereas perceptions of community relations (among secondary students) were positively associated.

Developing an understanding of the extent to which health behaviours vary between schools and classrooms as well as the associations between school contexts and health behaviours can inform intervention and policy design. Future research should build on existing literature by using a longitudinal design to further the understanding of the causal mechanisms that may explain associations found in this study, as well as to examine associations between classroom-level variables and health behaviours that may explain the observed between-classroom variability. Identifying classroom-level variables associated with the outcomes would identify potentially modifiable characteristics at a classroom level. Future research should also explore potentially important interpersonal factors such as peer physical activity and cannabis use, parental physical activity and cannabis use, as well as perceptions of peers regarding these health behaviours.

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Table 1. *Description of measures*

Variable	**Item details**	**Categorization**
Physical activity	Students were asked "over the past seven days, how many days did you engage in physical activity for at least 60 minutes, that increased your heart rate and made you get out of breath?". Response options included: "No days", "1-2 days", "3-4 days", "5-6 days", and "Every day".	Daily (7 days a week) or non-daily (<7 days a week)
Cannabis use	Students were asked "which of the following best describes your experience with using marijuana and cannabis products (also known as weed, blunt, cheeba, ganja, chronic or pot). Response options included: "I have never tried marijuana", "I have tried marijuana, but only once or twice", "I used to smoke marijuana about once a week, but have not done so in the last month", "I smoke sometimes, but not every week" and "I usually smoke marijuana at least once a week or more".	[Elementary] Never user, ever user [Secondary] Current user (including sometimes and once a week), not current user (including never tried, tried, used to smoke marijuana)
Sex	SMHS Students were asked "Are you…." Response options: female, male	Male, female
Age	SMHS Students were asked "How old are you?" (Response options: ranged from 9-22	[Elementary] 11 or younger, 12, 13, 14 or older [Secondary] 14 or younger, 15, 16, 17, 18+
Family structure	Students were asked "Who lives with you in the home that you spend most of your time in?". Response options included: biological mother, biological father, non-biological mother, non-biological father, other adult parent, grandparent(s), other adult relative(s), brother(s) or sister(s), others(s), I live alone	2-parent, single parent, no parent

Family Assets	Students were asked how many of each of the following items they owned: a car/van/truck, a desktop computer/laptop, a cell phone, a tablet/e-reader/iPad. Response options included: none, 1, 2, 3 or more. The responses were converted into a z-score.	High, medium, low
Race/Ethnicity	Students were asked "Which category best describes your race or cultural group?" Response options included: White, East Asian, Southeast Asian, South Asian, West Asian/Arab, Black African/ Black Caribbean/Black Canadian/Black American, Latin American/Central American/South American, Aboriginal/Native, Other	White, East Asian, Southeast Asian, South Asian, West Asian/Arab, Black, Latin Central South American, Indigenous, Other/multiracial
School SES	Derived from the NHS's Median Family Income measure (before-tax income), linked by postal code to school	<$60,000, $60,000 to $79,999, $80,000 to $99,999, $100,000 to $124,999, $125,000+
School size	Derived from the Ministry of Education's records of total school enrolment	Small, medium, large
Student perception of school climate	Students rated the following items on a 4-point Likert scale ranging from 1 (disagree a lot) to 4 (agree a lot): "Teachers treat students with respect", "Students are taught to feel responsible for how they act", "The school rules are fair", "Students are taught to understand how others think and feel", "Teachers care about their students", "The consequences of breaking school rules are fair", "Teachers expect all students to work hard", "Students know how they are expected to act, "Teachers require students to work hard and get good grades", "Students are friendly with each other", "Students are taught that they can control their own behaviour", "Teachers expect students to do their best all the time", "Students know what the rules are", "Students care about each other", "Teachers listen to students when they have problems", "Students are taught how to solve conflicts with others", "Adults in	Continuous variable
Aggregate school climate		Continuous variable

	this school treat students fairly", "Students are taught they should care about how others feel", "Students treat each other with respect", and "Students get along with each other"	
Proportion of teachers implementing a HPRO/Risk Prevention Program	Teachers were asked "since the beginning of this school year, please indicate if one of the following types of program has been implemented in your classroom. If more than one program has been implemented, please select the one program that had the greatest benefit for most students". [Program options included: social and emotional learning program, violence prevention or peace promotion program, risk prevention or health promotion program, emotion regulation/stress management/coping skill program, or other program] Proportion of teachers within a school reporting that they implemented a health promotion/risk prevention program was calculated.	Continuous variable
Teacher perception of community relations	Teachers rated the following items on a 4-point Likert scale ranging from 1 (disagree a lot) to 4 (agree a lot): "This school is well regarded by the community", "This school has effective partnerships with community organizations", and "Having strong community relations is a priority in this school" Scores were aggregated to the school level by taking a mean across teachers' ratings in a school.	Continuous variable

Table 2. *Comparisons of excluded cases by variable among elementary students*

Variable	Missing data[a]
Physical Activity	
Daily	10.0%
Non-daily	9.5%
Cannabis	
Never tried	8.1%*
Ever tried	11.1%*
Age	
9-11	15.7%*
12	12.3%*
13	10.2%*
14+	8.5%*
Sex	
Male	12.8%*
Female	10.8%*
Family Structure	
2-parent	7.2%*
Single parent	9.5%*
No parent	9.8%*
Race/Ethnicity	
White	10.4%*
East Asian	6.0%*
Southeast Asian	7.8%*
South Asian	10.7%*
West Asian/Arab	13.4%*
Black	15.9%*
Latin American, Central American, South American	5.4%*
Indigenous	15.6%*
Multiracial or Other	10.8%*
Family Assets	
Low	8.1%*
Medium	5.6%*
High	5.7%*

[a]Missing data column represents the missing data within each variable among cases excluded
*$p<0.05$

Table 3. *Comparisons of excluded cases by variable among secondary students*

Variable	Missing data[a]
Physical Activity	
Daily	7.2%
Non-daily	6.6%
Cannabis Use	
Non-current user	5.7%*
Current user	7.1%*
Age	
12-14	8.4%*
15	8.2%*
16	7.1%*
17	6.7%*
18+	7.8%*
Sex	
Male	8.0%*
Female	5.9%*
Family Structure	
2-parent	4.9%*
Single parent	6.7%*
No parent	10.6%*
Race/Ethnicity	
White	5.3%*
East Asian	5.7%*
Southeast Asian	6.4%*
South Asian	4.9%*
West Asian/Arab	6.0%*
Black	12.0%*
Latin American, Central American, South American	9.6%*
Indigenous	11.5%*
Multiracial or Other	8.0%*
Family Assets	
Low	6.0%*
Medium	3.9%*
High	4.0%*

[a]Missing data column represents the missing data within each variable among cases excluded
*$p<0.05$

Table 4. *Descriptive statistics for elementary school sample*

Category	%(n) or mean (SD)
STUDENT-LEVEL VARIABLES (n=16797)	
Physical Activity, %(n)	
Daily	40.6 (6,818)
Non-daily	59.4 (9,979)
Cannabis, %(n)	
Never tried	96.9 (16,276)
Ever tried	3.1 (521)
Age, %(n)	
9-11	25.8 (4,342)
12	31.9 (5,360)
13	33.6 (5,646)
14+	8.6 (1,449)
Sex, %(n)	
Male	47.3 (7,939)
Female	52.7 (8,858)
Family Structure, %(n)	
2-parent	79.3 (13,328)
Single parent	16.7 (2,803)
No parent	4.0 (666)
Race/Ethnicity, %(n)	
White	54.3 (9,213)
East Asian	4.4 (735)
Southeast Asian	4.4 (741)
South Asian	11.5 (1,936)
West Asian/Arab	1.6 (272)
Black	5.0 (848)
Latin American, Central American, South American	2.4 (400)
Indigenous	1.1 (179)
Multiracial or Other	15.3 (2,563)
Family Assets, %(n)	
Low	34.5 (5,799)
Medium	34.2 (5,740)
High	31.3 (5,258)
School Climate, M(SD)	59.3 (8.4)
SCHOOL-LEVEL VARIABLES (n=178)	
School SES, %(n)	
<$60,000	20.2 (36)
$60,000-$79,999	19.7 (35)
$80,000-$99,999	27.5 (49)
$100,000-$124,999	24.7 (44)

$125,000+	24.7 (14)
School Size, %(n)	
Small (<397)	33.1 (59)
Medium (397-555)	33.7 (60)
Large (>555)	33.1 (59)
School Climate (Aggregate), M(SD)	60.8 (2.6)
Proportion Teachers Endorsing HPRO/Risk Prevention Program, M(SD)	.06 (.08)
Teacher perceptions of community relations, M(SD)	9.2 (.87)

Table 5. *Descriptive statistics for secondary school sample*

Category	%(n)or mean (SD)
STUDENT-LEVEL VARIABLES (n=11077)	
Physical Activity, %(n)	
Daily	28.4 (3,141)
Non-daily	71.6 (7,936)
Cannabis Use, %(n)	
Non-current user	86.1 (9,540)
Current user	13.9 (1,537)
Age, %(n)	
12-14	24.1 (2,667)
15	24.9 (2,754)
16	24.4 (2,704)
17	20.1 (2,226)
18+	6.6 (726)
Sex, %(n)	
Male	48.0 (5,313)
Female	52.0 (5,764)
Family Structure, %(n)	
2-parent	77.9 (8,629)
Single parent	17.9 (1,978)
No parent	4.2 (470)
Race/Ethnicity, %(n)	
White	60.8 (6,738)
East Asian	5.2 (581)
Southeast Asian	2.9 (320)
South Asian	8.1 (901)
West Asian/Arab	2.7 (298)
Black	5.8 (641)
Latin American, Central American, South American	2.1 (235)
Indigenous	1.0 (116)
Multiracial or Other	11.3 (1,247)
Family Assets, %(n)	
Low	29.3 (3,248)
Medium	33.5 (3,708)
High	37.2 (4,121)
School Climate, M(SD)	57.9 (7.8)
SCHOOL-LEVEL VARIABLES (n=66)	
School SES, %(n)	
<$60,000	21.2 (14)
$60,000-$79,999	27.3 (18)
$80,000-$99,999	28.8 (19)

$100,000-$124,999	16.7 (11)
$125,000+	6.1 (4)
School Size, %(n)	
Small (<824)	33.3 (22)
Medium (824 to 1086)	33.3 (22)
Large (>1087)	33.3 (22)
School Climate (Aggregate), M(SD)	57.0 (1.6)
Proportion Teachers Endorsing HPRO/Risk Prevention Program, M(SD)	.05 (0.07)
Teacher perceptions of community relations, M(SD)	9.4 (.76)

Table 6. *Adjusted school-level and classroom-level ICCs*

	Adjusted School-Level ICC[a]	Adjusted Class-Level ICC[a]	School + Class
Physical activity (elementary)	0.014	0.014	2.8%
Physical activity (secondary)	0.015	0.032	4.7%
Cannabis use (elementary)	0.077	0.057	13.4%
Cannabis use (secondary)	0.029	0.109	13.8%

[a]ICCs were adjusted for compositional variables (sex, age, family structure, race/ethnicity, family assets, school SES, school size)

Table 7. *Three-level binary logistic regression for elementary school students (fully adjusted model)*

Category	Physical Activity (OR, 95% CI)	Cannabis Use (OR, 95%CI)
	DEMOGRAPHIC VARIABLES	
Age		
9-11	REF	REF
12	0.81 (0.74, 0.89) p<0.001***	2.13 (1.44, 3.15) p<0.001***
13	0.68 (0.63, 0.75) p<0.001***	4.98 (3.46, 7.17) p<0.001***
14+	0.70 (0.61, 0.80) p<0.001***	6.97 (4.64, 10.48) p<0.001***
Sex		
Male	REF	REF
Female	0.50 (0.47, 0.53) p<0.001***	0.89 (0.74, 1.07) p=0.221
Family Structure		
2-parent	REF	REF
Single parent	0.92 (0.84, 1.00) p=0.058	1.47 (1.17, 1.84) p=0.001**
No parent	0.83 (0.70, 0.98) p=0.03*	2.99 (2.16, 4.14) p<0.001***
Race/Ethnicity		
White	REF	REF
East Asian	0.49 (0.40, 0.59) p<0.001***	0.55 (0.28, 1.09) p=0.086
Southeast Asian	0.52 (0.44, 0.63) p<0.001***	0.69 (0.39, 1.24) p=0.219
South Asian	0.82 (0.72, 0.93) p=0.003**	0.33 (0.19, 0.57) p<0.001***
West Asian/Arab	0.81 (0.62, 1.05) p=0.107	0.36 (0.11, 1.21) p=0.099
Black	1.23 (1.05, 1.43) p=0.01*	1.63 (1.16, 2.30) p=0.005**
Latin American, Central American, South American	0.68 (0.54, 0.85) p=0.001**	0.96 (0.52, 1.77) p=0.897
Indigenous	0.81 (0.59, 1.12) p=0.212	2.07 (1.20, 3.56) p=0.009**
Multiracial or Other	0.94 (0.85, 1.03) p=0.185	1.00 (0.76, 1.32) p=0.982
Family Assets		
Low	REF	REF

Medium	1.27 (1.17, 1.37) p<0.001***	0.71 (0.56, 0.89) p=0.004**
High	1.59 (1.47, 1.73) p<0.001***	0.79 (0.62, 0.99) p=0.043*
School SES		
<\$60,000	REF	REF
\$60,000-\$79,999	1.03 (0.87, 1.21) p=0.753	0.89 (0.60, 1.31) p=0.547
\$80,000-\$99,999	1.04 (0.90, 1.21) p=0.578	0.79 (0.54, 1.15) p=0.221
\$100,000-\$124,999	1.10 (0.94, 1.29) p=0.229	0.63 (0.42, 0.95) p=0.027*
\$125,000+	1.17 (0.94, 1.44) p=0.16	0.51 (0.27, 0.93) p=0.029*
School Size		
Small (<423)	REF	REF
Medium (423-685)	1.08 (0.95, 1.23) p=0.256	0.78 (0.56, 1.09) p=0.146
Large (>685)	1.03 (0.90, 1.18) p=0.654	0.78 (0.55, 1.10) p=0.154
STUDENT INTERPERSONAL VARIABLES		
School Climate (individual)[a]	1.02 (1.02, 1.03) p<0.001***	0.92 (0.91, 0.93) p<0.001***
School Climate (Aggregate)[b]	1.00 (0.98, 1.03) p=0.82	0.87 (0.82, 0.93) p<0.001***
SCHOOL ORGANIZATION VARIABLES		
Proportion of teachers implementing HPRO/Risk prevention program	0.87 (0.47, 1.64) p=0.676	0.58 (0.11, 3.12) p=0.524
SCHOOL COMMUNITY VARIABLES		
Teacher perceptions of community relations	1.08 (1.01, 1.15) p=0.019*	0.92 (0.77, 1.09) p=0.347

*p<0.05, **p<0.01, ***p<0.001

[a]Individual perception of school climate, estimated as deviation from the school mean

[b]Collective perception of school climate, estimated as school mean

Table 8. *Three-level binary logistic regression for secondary school students (fully adjusted model)*

Category	Physical Activity (OR, 95% CI)	Cannabis Use (OR, 95%CI)
	DEMOGRAPHIC VARIABLES	
Age		
12-14	REF	REF
15	0.92 (0.81, 1.04) p=0.165	2.00 (1.59, 2.52) p<0.001***
16	0.65 (0.57, 0.75) p<0.001***	2.80 (2.24, 3.51) p<0.001***
17	0.43 (0.37, 0.50) p<0.001***	3.91 (3.11, 4.91) p<0.001***
18+	0.47 (0.38, 0.58) p<0.001***	5.64 (4.30, 7.39) p<0.001***
Sex		
Male	REF	REF
Female	0.51 (0.47, 0.55) p<0.001***	0.77 (0.68, 0.88) p<0.001***
Family Structure		
2-parent	REF	REF
Single parent	0.92 (0.82, 1.04) p=0.206	1.49 (1.28, 1.74) p<0.001***
No parent	0.93 (0.74, 1.17) p=0.543	2.55 (1.97, 3.29) p<0.001***
Race/Ethnicity		
White	REF	REF
East Asian	0.45 (0.34, 0.58) p<0.001***	0.21 (0.12, 0.35) p<0.001***
Southeast Asian	0.65 (0.48, 0.87) p=0.004**	0.43 (0.26, 0.71) p=0.001**
South Asian	0.75 (0.61, 0.91) p=0.004**	0.33 (0.23, 0.48) p<0.001***
West Asian/Arab	0.91 (0.69, 1.20) p=0.513	0.74 (0.48, 1.12) p=0.154
Black	1.20 (0.99, 1.46) p=0.063	0.86 (0.65, 1.13) p=0.279
Latin American, Central American, South American	0.71 (0.51, 0.99) P=0.041*	1.23 (0.83, 1.81) p=0.307
Indigenous	1.33 (0.89, 1.98) p=0.169	2.00 (1.28, 3.14) p=0.002**
Multiracial or Other	0.96 (0.84, 1.11) p=0.618	1.05 (0.87, 1.27) p=0.596
Family Assets		

Low	REF	REF
Medium	1.15 (1.02, 1.30) p=0.02*	1.06 (0.90, 1.26) p=0.478
High	1.44 (1.27, 1.62) p<0.001***	0.91 (0.77, 1.08) p=0.287
School SES		
<$60,000	REF	REF
$60,000-$79,999	0.94 (0.74, 1.19) p=0.6	1.54 (1.12, 2.12) p=0.008**
$80,000-$99,999	0.83 (0.67, 1.03) p=0.096	1.16 (0.86, 1.56) p=0.334
$100,000-$124,999	0.91 (0.72, 1.16) p=0.452	1.23 (0.89, 1.70) p=0.212
$125,000+	0.85 (0.60, 1.21) P=0.376	1.40 (0.86, 2.26) p=0.178
School Size		
Small	REF	REF
Medium	1.20 (1.00, 1.44) p=0.054	1.09 (0.85, 1.40) p=0.491
Large	0.99 (0.80, 1.21) p=0.885	1.31 (0.99, 1.73) P=0.061
STUDENT INTERPERSONAL VARIABLES		
School Climate (Individual)[a]	1.01 (1.00, 1.01) p=0.012*	0.92 (0.92, 0.93) p<0.001***
School Climate (Aggregate)[b]	0.97 (0.92, 1.02) p=0.21	0.87 (0.81, 0.93) p<0.001***
SCHOOL ORGANIZATION VARIABLES		
Proportion of teachers implementing HPRO/Risk prevention program	0.69 (0.23, 2.05) p=0.5	0.33 (0.08, 1.46) p=0.145
SCHOOL COMMUNITY VARIABLES		
Teacher perceptions of community relations	1.04 (0.93, 1.16) p=0.489	1.29 (1.12, 1.50) p=0.001**

*p<0.05, **p<0.01, ***p<0.001

[a]Individual perception of school climate, estimated as deviation from the school mean

[b]Collective perception of school climate, estimated as school mean

Appendix

Appendix A: Intraclass correlation calculations

ICC$_{\text{School}}$= $\frac{\sigma_v^2}{\sigma_v^2+\sigma_u^2+\frac{\pi^2}{3}}$

ICC$_{\text{Class}}$: $= \frac{\sigma_u^2}{\sigma_v^2+\sigma_u^2+\frac{\pi^2}{3}}$

where σ_v^2= school-level variance, σ_u^2= class-level variance