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By

SHAMINI SELVAKUMAR, BHSc., M.D.

McMaster University

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AUTHOR: Shamini Selvakumar BHSc., M.D.

SUPERVISOR: Kathy Georgiades, PhD

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Abstract

Background: The Canadian 24-hour movement guidelines recommend minimum 60 minutes of moderate/vigorous PA daily. Immigrant children and youth are reported to be less physically active, compared to third generation/non-immigrant children. Possible explanations for these differences are multifactorial.

Objectives: 1) Examine differences in PA by immigrant generational status; 2) Examine differences in PA between immigrant and non-immigrant children and youth when adjusting for socio-economic and demographic characteristics, including neighbourhood differences, and mental health (MH).

Methods: This was a cross-sectional study using Ontario Child Health Study data. A binary cut-off was determined for PA: meeting PA guidelines or not meeting PA guidelines. Descriptive statistics and basic and fully adjusted logistic regression models were conducted. Analyses were divided by age groups: 4–11-year-old and 12-17-year-old.

Results: Only complete cases were included, resulting in a final sample size of 8301 participants. Among the 4–11-year-old children, the odds of meeting guidelines were 50% less for first-generation immigrant children, compared to third generation/non-immigrant children ($p<0.001$) and 37% less for second-generation immigrant children ($p=0.001$). The odds of meeting guidelines were 30% less for females compared to males ($p<0.001$), and for each year older, the odds were 9% less ($p<0.001$). Among youth, the odds of meeting guidelines were 40% less for first-generation immigrant youth compared to third generation/non-immigrant youth ($p=0.01$). In the fully adjusted model with PMK-

reported MH measures, the odds of meeting PA guidelines were 15% higher for each increase in externalizing score (p<0.001) and 7% less for each increase in internalizing score (p=0.001). Similar findings were noted in the models with youth-reported MH measures. In both age groups, the addition of ethnicity had attenuated the OR associated with immigrant generational status and was non-significant.

Conclusion: Immigrant children and youth are less likely to meet PA guidelines. Future research should assess for underlying mechanisms that may be driving the observed associations.

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BACKGROUND
IMMIGRANT LANDSCAPE IN CANADA

In Canada, approximately 10% of children and youth are foreign-born immigrants, with the highest proportion in Ontario, estimated at 12.1% (Pottie K, 2015). This is a unique population with regards to health outcomes, due to the interplay of social, economic and acculturative challenges associated with the resettlement process that contribute to changes in nutritional and lifestyle habits (Lane et al., 2018). Literature describes a "healthy immigrant effect" whereby those who immigrate to a country are typically healthier than their non-immigrant counterparts (Lane et al., 2018). However, over time immigrants start to experience a decline in their health that often converges with non-immigrant population (Lane et al., 2018). The data is well described among adults (McDonald & Kennedy, 2004; Newbold, 2009), with some emerging evidence among children and youth (Kwak, 2016). In the United States, for example, García-Pérez conducted a population-based study assessing whether the 'healthy immigrant effect' existed among immigrant children and youth by examining rates of obesity (García-Pérez, 2016). Children of recent immigrants had lower odds of obesity compared to non-immigrant children, yet the odds increased the longer their mothers resided in the United States (García-Pérez, 2016). There are number of reasons hypothesized in the literature for this change in health including lack of equitable access to healthcare, parental health literacy regarding importance of physical activity or healthy eating habits (García-Pérez, 2016), and socio-economic hardship (Lane et al., 2021). A Canadian national study using data from the Canadian Community Health Survey assessed self-perceived general health, self-perceived mental health, and diagnosed health conditions among youth who

immigrated less than 10 years, long-term immigrant youth (defined as those residing in Canada for ten years or longer), and non-immigrant youth (Kwak, 2016). The study demonstrated similar findings with immigrant youth reporting better perceived health than their non-immigrant counterparts, but could not demonstrate consistent findings of worsening health the longer immigrant youth resided in Canada (Kwak, 2016).Vang et al., conducted a systematic review synthesizing the literature on the healthy immigrant effect across different age groups and differences in health outcomes between immigrant and non-immigrant participants within Canada (Vang et al., 2017). Seven pediatric studies were included in the review and did not demonstrate a consistent advantage in health outcomes for immigrant children and youth compared to non-immigrant children (Vang et al., 2017). Results were also inconsistent when looking at immigrant generational status and whether there was a protective effect for being foreign-born for measures such as body mass index (BMI), mental health, drinking, or illicit drug use (Vang et al., 2017). The authors concluded that the health advantage demonstrated among immigrant adults may not be applicable to immigrant pediatric population (Vang et al., 2017).

PHYSICAL ACTIVITY (PA) AMONG PAEDIATRIC POPULATION

The Canadian Society for Exercise Physiology released the Canadian 24-hour movement guidelines for children and youth in 2016 (Tremblay et al., 2016). The guidelines recommend that children and youth get at least 60 minutes of moderate to vigorous PA daily (Tremblay et al., 2016). This is in keeping with WHO guidelines that recommend youth get at least 60 minutes of moderate to vigorous PA daily (Guthold et al., 2020).

Globally, approximately 80% of adolescents aged 11-17 years were considered physically inactive in 2016 (Guthold et al., 2020). Between 2001 to 2016, the prevalence of physical inactivity had decreased among male youth, however remained unchanged for females (Guthold et al., 2020), with the difference between sexes being quite pronounced in high-income countries (Guthold et al., 2020). Females have been consistently noted to be less physically active than males in the general paediatric population (Hu et al., 2021), and as children grow older, they are more likely to be inactive (Hu et al., 2021).

PA AMONG IMMIGRANT CHILDREN AND YOUTH

Prior research has demonstrated that immigrant children are less likely to meet PA guidelines, compared to non-immigrant children (Allen et al., 2007; Besharat Pour et al., 2014; Koezuka et al., 2006), though there is a trend towards increasing participation across successive immigrant generations (Allen et al., 2007). A study conducted in the USA classified PA as being adequate if children participated in vigorous exercise 3 or more days per week (Kimbro & Kaul, 2016). Compared to 70% of US-born children classified as having adequate PA, only 50% of immigrant children reported similar levels (Kimbro & Kaul, 2016). The odds of being classified as having adequate PA among immigrant children remained low despite adjusting for maternal nativity origin, gender, and age (Kimbro & Kaul, 2016). Objective measures using a multi-sensor device have noted no difference in time spent doing light PA regardless of immigrant background, however significant differences were noted with regards to time spent doing moderate PA among immigrant and non-immigrant children residing in Germany (Kobel et al., 2019).

In Canada, immigrant youth, defined as youth who have immigrated to Canada in the last 1-2 years, were less likely to meet the recommended duration of moderate to vigorous PA compared to Canadian-born youth (Kukaswadia et al., 2014) and more likely to engage in sedentary behaviours (Kukaswadia et al., 2014). Youth who immigrated within the last 1-2 years were reported to be less likely to accumulate at least 60 minutes of moderate to vigorous physical activity for most of the week (Kukaswadia et al., 2014) . This difference was not significant between Canadian born youth and youth who immigrated more than 3 years ago (Kukaswadia et al., 2014; Lane et al., 2021).

Evidence suggests that levels of PA also vary by ethnicity (Lane et al., 2021), with children of Latin American background being more likely to be physically inactive and overweight compared to other ethnic backgrounds (Kukaswadia et al., 2014) in Canada. Other studies have also highlighted differences in PA levels of immigrant youth from certain ethnicities, when compared to non-immigrant youth (Besharat Pour et al., 2014; Bhatnagar et al., 2015; Labree et al., 2014). Irrespective of time since immigration, certain ethnic groups were still less likely to be active such as East and Southeast Asian youth (Kukaswadia et al., 2014). The reasons underlying why certain ethnic groups continue to have reduced PA is unclear and not fully explored.

BENEFITS OF PA

Literature has described positive benefits of PA with regards to anxiety and mood (Dimitri et al., 2020; Fitzgerald et al., 2022). Moderate to vigorous PA during childhood is linked to reduced risk of cardiovascular disease ((Fitzgerald et al., 2022). More importantly, PA practices during childhood may influence PA levels during adulthood

(Fitzgerald et al., 2022). A recent systematic review looking at cognitive functioning and physical activity in children, noted that children and youth engaged in PA are more likely to have improvements in memory, attention, and cognitive functioning (Bidzan-Bluma & Lipowska, 2018). There is evidence of a positive benefit of regular PA among children with chronic conditions. There have been some findings in the literature to suggest that PA can improve lung function and cardiovascular fitness in patients diagnosed with asthma, children with cancer, and in children with Diabetes Mellitus Type 1 (Dimitri et al., 2020). Obesity is an urgent public health concern, particularly given the cardiovascular morbidities and associated burden to the healthcare system (McCrindle, 2015). Children and youth with obesity are at increased risk of cardiovascular disease, premature death, chronic conditions including type 2 diabetes, asthma, fatty liver disease (Hampl et al., 2023; Loux et al., 2023). A survey conducted among youth in the United States noted that nationally, across a 20 year period, there was an increase in the proportion of youth having obesity (Loux et al., 2023). It also noted that PA decreased with age over time (Loux et al., 2023). Prior research has demonstrated that immigrant children and youth are at increased risk of having obesity or being overweight (Besharat Pour et al., 2014) and its associated long-term sequelae, when compared to third generation/non-immigrant children (Lane et al., 2018). The odds of reduced PA and being overweight were highest among children whose parents were both immigrants (Besharat Pour et al., 2014). Strategies for reducing obesity have often focused on healthy eating and PA (Tremblay et al., 2016).

BARRIERS TO PA ENGAGEMENT

Reasons underlying physical inactivity within the pediatric population, and specifically among immigrant children and youth, are multifactorial. Societal, family, and individual level covariates all interplay to impact PA engagement.

There is inconsistency regarding urbanicity when comparing Canadian literature to other countries. A national study conducted in Germany looking at children and youth aged 6-17 and migrant status did not find PA associated with urbanicity, but rather lower socio-economic status as defined by a parent's educational level, occupation, and household income (Lammle et al., 2012). This contrasts with a study where children residing in rural areas of Ontario were more likely to report significant barriers due to their neighbourhood environment or facilities, compared to children residing in suburban areas (Taylor et al., 2018). In a mixed-methods study conducted in Minneapolis, comparing families who identified as Caucasian with non-Caucasian families, researchers noted that Caucasian families were more likely to reside in neighbourhoods with factors that promote PA such as the presence of parks, play equipment, and the overall condition of public spaces and traffic (Berge et al., 2022). Similarly, neighbourhoods considered having a larger proportion of individuals with higher education levels (college graduate or greater) were more likely to have access to facilities that promoted PA in comparison to less advantaged neighbourhoods (Gordon-Larsen et al., 2006). Children residing in neighbourhoods that are considered more affluent are more likely to be physically active, compared to those residing in neighbourhoods that are less affluent (Stone et al., 2012). Immigrant children residing in neighbourhoods with a higher concentration of immigrants were less likely to be physically active, compared to neighbourhoods with smaller

concentration of immigrants (Brewer & Kimbro, 2014). Interestingly, the study noted that when it came to being physically inactive, U.S.-born white children were more likely to be inactive compared to immigrant children in neighbourhoods with increasing immigrant concentration (Brewer & Kimbro, 2014). This highlights there may be other variables influencing PA participation (Brewer & Kimbro, 2014). A longitudinal national study conducted in the United States noted that as the minority population in a neighbourhood increased, the odds of having access to facilities that promoted PA decreased (Gordon-Larsen et al., 2006).

Parental encouragement and education level have been noted to have an impact on PA participation among all children and youth (Hu et al., 2021). Lack of parental support to facilitate PA engagement and low parental educational attainment was associated with reduced odds of PA compared to children and youth with parental support, or higher parental educational levels (Hu et al., 2021). Data using the Canadian Health Measures Survey from 2007-2013 of parent-child pairs, aged 6-11 years old, noted a positive correlation between parental PA and child PA (Garriguet et al., 2017). Among immigrant children and youth, parental PA is noted as a potential reason why some immigrant children may not be as physically active (Bhatnagar et al., 2015). Furthermore, parental concerns that PA may have a negative impact on schoolwork or specifically discouraging females from playing outside have been noted in the literature (Bhatnagar et al., 2015). Some studies have identified that living in poverty was a barrier (Brewer & Kimbro, 2014), particularly in accessing organised sports (Lane et al., 2021). Third generation/non-immigrant born children were more likely to participate in organised

sports compared to immigrant children (Zaccagni et al., 2017), and are more likely to have access to equipment and sport club memberships (Labree et al., 2014). Furthermore, the concept of organized sports may not be familiar to newcomers immigrating from countries outside of United States or Western Europe (Lane et al., 2021). Another Canadian study had noted that due to costs associated with organized PA and for fear of running out of money for essentials, PA was typically sacrificed (Lane et al., 2021). Barriers due to language, neighbourhood safety concerns, and constraints secondary to parental work schedules have also been highlighted (Berge et al., 2022; Bhatnagar et al., 2015; Georgiades et al., 2018; Hu et al., 2021; Kim et al., 2020; Koezuka et al., 2006; Lane et al., 2021).

Neighbourhood, socio-demographic, and economic characteristics can explain some of the variability in PA levels, between immigrant and non-immigrant children and youth, but cannot fully account for all differences (Labree et al., 2014). Within a Canadian landscape, among youth residing in Ontario, youth who identified as being a visible minority were more likely to report social barriers to engaging in PA, such as not knowing other children (Taylor et al., 2018).

Mental health has also been explored as a potential mechanism of differences in PA among immigrant versus non-immigrant individuals. Among immigrant adults, negative mood, anxiety, and stress have been associated with decreased PA levels (BeLue et al., 2009). Another study examined the prevalence of anxiety and depression among first generation adults compared to second and third generation adults in Sweden, and it's association with PA (Siddiqui et al., 2014). Participants were provided a screening

questionnaire related to anxiety and depression, and self-reported their PA levels.
(Siddiqui et al., 2014). Anxiety and depression was strongly associated with decreased
PA levels among first generation adults, but not among second and third generation adults
(Siddiqui et al., 2014). Among youth in general, those with low mood were more likely to
consume daily soda, have decreased PA levels, and decreased social support for PA
(Morrison et al., 2017). A cross-sectional study using data from Statistics Canada's
National Longitudinal Survey of Children and Youth that included youth aged 14-15,
reported that youth with higher symptoms of depression and anxiety were more likely to
be physically inactive (Belair et al., 2018). Youth who reported having a more positive
mood were more likely to have higher levels of PA as measured objectively with an
accelerometer, in addition to more vigorous PA per day, and support for PA (Morrison et
al., 2017). This association has not been fully explored among immigrant children and
youth.

RATIONALE

Studies conducted in both Canada and the United States have identified that living in
poverty, difficulties in accessing organised support, lack of proficiency in the host
language, and safety concerns, are a barrier to engaging in PA, though the literature
within a Canadian setting remains limited (Kim et al., 2020; Lane et al., 2021). Though
there has been some literature looking at PA levels among immigrants within a Canadian
landscape, many of these studies have not been able to examine PA level by generational
status (Kim et al., 2020; Kukaswadia et al., 2014). In addition, many of these studies have
primarily focused on adolescents, and thus the findings may not be generalizable to

younger age groups, who may have their own unique barriers to engaging in PA (Lindsay et al., 2019) There have been some studies conducted in a non-Canadian setting that have suggested mental health may also play a role in PA participation for general youth (Morrison et al., 2017), but has not been fully assessed with immigrant children and youth. Though prevalence of mood and/or anxiety disorders and behaviour disorders are typically higher in second and third generation adolescents compared to first generation youth, variation exists across ethnic groups with certain ethnic subgroups at increased risk for mood/anxiety disorders (Georgiades et al., 2018). Targeted interventions on PA may need to account for other comorbidities (BeLue et al., 2009). We hypothesize that immigrant children and youth are less likely to engage in PA compared to their Canadian-born peers; and that mental ill-health and socio-economic disadvantage will partially account for these between group differences. This cross-sectional study is an attempt within a Canadian landscape to understand differences in PA across immigrant and non-immigrant children and youth, and the extent to which mental ill-health and socio-economic and demographic covariates may account for differences. These findings will be useful for targeting interventions in high-risk children and youth.

Study Objectives

The objectives of the thesis were to:

1. Examine differences in PA by immigrant generational status among children and youth aged 4 to 17 years old in Ontario, Canada from 2014-2015.

2. Examine differences in PA between immigrant and non-immigrant children and youth when adjusting for covariates such as socio-economic and demographic characteristics, including neighbourhood differences, and mental health (i.e., depression, anxiety).

METHODS

Study Design

This study used data from the Ontario Child Health Study (OCHS), a cross-sectional provincial study conducted by Statistics Canada. The survey was conducted between October 2014 to October 2015. This was a stratified random cluster 3-stage survey design using the 2014 Canada Child Tax Benefit (CCTB) file as the sampling frame. Dwelling clusters were created based on the sampling frame by identifying residential areas using census tract (CT) or dissemination area (DA) coordinates from the 2011 census. Clusters were stratified by residency type (i.e., Urban, rural) and by income level. Households within each cluster were also stratified by family income. Households were then randomly selected from each stratum. The primary caregiver was considered the person most knowledgeable (PMK) and provided information on up to four children per household. For youth aged 12-17 years old, youth completed self-report measures as well. Interviews were conducted at home in either English or French. Data collection was completed either through computer assisted personal interviews, self-complete, pen and paper personal interview, telephone, or mail. Detailed description of the survey design, content, and collection has been published previously (Boyle, Georgiades, et al., 2019).

Response Rates

12,871 households were invited to participate, of which 6537 households (50.8%) agreed

to participate. The sample included 10,802 children and youth aged 4 to 17.

Ethical Considerations

Given that this study used secondary data, institutional research ethics was not required.

The original study and data collection received ethics approval from the Hamilton

Integrated Research Ethics Board at McMaster University. Participation was voluntary

and parents and children were consented to participate. Data was stored and accessed at

the research data centre (RDC) at McMaster University. A RDC analyst vetted all output

to ensure it met requirements for release and to ensure no study participant could

potentially be identified.

Study measures

 Primary outcome: physical activity

In the OCHS, PA was a self-report measure for youth between the ages of 12 - 17 years

old. For children between the ages of 4- 11 years old, this was reported by PMK.

Participants were asked to add up all the time spent on PA each day. A definition for PA

was provided as any activity that increased heart rate and made the participant get out of

breath for some of the time. Examples were also provided such as sports, school

activities, playing with friends, walking to school, or playing active video games.

Participants were then asked: "Over a typical or usual week, on how many days are you

physically active for a total of at least 60 minutes?" Respondents were able to select a

response from 0 to 7. For the proposed study, the outcome PA was coded as a

dichotomous (binary) variable as follows: 1 if they reported being physically active for 7

days per week, and 0 if less than 7 days were reported. This was in keeping with

guidelines published by the Canadian Society for Exercise Physiology that recommended

children and youth should have at least 60 minutes of moderate to vigorous PA daily

(Tremblay et al., 2011). As the recommendation was based on achieving 7 days of PA,

the variable was dichotomized to meeting recommended guidelines versus not. Self-

report PA measures have been compared to direct measures in previous studies. One

study examined the correlation between parent-reported PA to measured accelerometer

data among children under six and reported weak to moderate associations (Sarker et al.,

2015). For adolescents, one study comparing self-report PA report to accelerometer data

among 15-17 year old had demonstrated moderate validity (Ridgers et al., 2012).

Specifically when assessing the use of single-item PA self-report measure such as asking

adolescents to report the number of days from 0 to 7 that they had done a total of 60

minutes of PA or more, when compared to accelerometer data and a more comprehensive

measure of PA (Oxford Physical activity Questionnaire), the single-item measure

demonstrated test-retest reliability (ICC=0.75) and moderate validity (r=0.46) (Scott et

al., 2015).

Independent variables

Immigrant generational status

Immigration and generational status were collected in the OCHS study from the PMK.

Country of birth of the partner was based on information from either the PMK or partner.

Children and youth who were foreign born and born to parents who were also foreign

born were classified as first generation. Children and youth who were born in Canada but

who had at least one parent who was born in another country were classified as second generation. Finally, children and youth who themselves and their parents were born in Canada were classified as third generation/non-immigrants (reference category).

Mental Health

The Ontario Child Health Study Emotional Behavioural Scales (OCHS-EBS) was developed for the 2014 Ontario Child Health Study to measure the following disorders based on DSM-5 criteria: generalized anxiety disorder (GAD), separation anxiety disorder (SAD), major depressive disorder (MDD), social phobia/social anxiety disorder, Attention-deficit hyperactive disorder (ADHD), oppositional defiant disorder (ODD), conduct disorder (CD). PMK and youth aged 12-17 years reported on the frequency of experiencing specific emotions and behaviours consistent with DSM criteria over the past 6 months. This was done by rating how well a statement described the participant as 0 (never or not true), 1 (sometimes or somewhat true), and 2 (often or very true). The raw scores were summed to form a scale score. The analysis included an externalizing score (summation of the scores for ODD and CD), ADHD, and internalizing score (summation of the scores for the disorders GAD, SAD, MDD, social anxiety disorder/social phobia). Higher scores indicated greater symptom severity. The reliability and validity of the OCHS-EBS has been demonstrated in previous literature (Boyle, Duncan, et al., 2019; Duncan et al., 2019). Average internal consistency and test-retest reliability of the scales are greater than 0.80 for the externalizing and internalizing scales completed by PMK or youth (Duncan et al., 2019).

Socio-Economic and demographic Variables

Age

Age as of December 31, 2014 was determined based on demographic information provided by PMK. This was provided in years.

Sex

Sex was determined based on demographic information as reported by the PMK. This variable was dummy coded as 0 for male (reference category) and 1 for female.

Ethnicity

Ethnicity of the participant was determined by asking PMK which racial or ethnic background the PMK identified with. The PMK was provided the following racial groups: White, South Asian, Chinese, Black, Filipino, Latin American, Arab, Southeast Asian, West Asian, Korean, Japanese, and other. Those who identified with more than one ethnic group were considered as 'multi-race' and grouped with 'Other'. Categories were collapsed into a binary variable. This variable was dummy coded as 0 for Caucasian (reference category) and 1 for non – Caucasian.

Household income below the low-income measure

Total income from all sources for all household members in the past 12 months was provided by PMK. This was then used to classify whether households were above or below the Statistics Canada Low Income Measure (LIM) threshold before taxes (Canada., 2015) Households considered as low income were coded as 1, and households not considered low income were coded as 0.

Neighbourhood level family income

The average neighbourhood family income at the CT level based on postal code, in $1 increments among the population who was 15 years or older, was provided from the 2011 Canadian census. This was reported as a continuous variable.

Parental educational level

The PMK and partner were asked to report their highest certificate, diploma, or degree that was completed. Between both the PMK and partner, the maximum educational level was identified, and dummy coded as: high school only or less (coded as 1), college graduate/trade school/some university (coded as 2), or university graduate (reference category).

Family structure

Information on who the child lived with was based on demographic information collected from the PMK. This was categorized as a binary variable as lived with both biological parents (reference category) or lived with none or one biological parent (coded as 1).

Urbanicity

The urbanicity in which the household of each child was located was determined at the DA level. This was defined as living in a large urban area (reference category) or living in a small to medium-sized urban centre/rural area (coded as 1).

Percent of Population born outside of Canada at the Neighbourhood level

This variable was based on the 2011 census. It was the percent of the population that was born outside of Canada at the DA level. It was a continuous variable in 1% increments.

STATISTICAL ANALYSIS

All data analyses were conducted at McMaster Research Data Centre using SPSS and STATA. Due to vetting requirements, variables were categorized as above to meet RDC vetting rules.

Weighting

Sampling weights for both the selected child and siblings was applied at the child level. Given the complex survey design, bootstrap method was used to obtain accurate variance estimation.

Only complete cases were included in the analysis, and respondents missing on variables were removed from the models resulting in a sample for analyses of 8301 (See further details below on patterns of missing responses).

Descriptive statistics

Descriptive statistics were used to describe the primary variables of the study. Weighted means and standard deviations were reported for continuous variables and percentages for categorical variables.

Statistical analysis plan

Objective 1: To address the first objective, we conducted logistic regression with meeting PA guidelines as the outcome and immigrant generational status as the primary variable of interest, controlling for age and sex.

Objective 2: Fully adjusted logistic regression analyses were conducted to examine the change in magnitude of difference in meeting PA guidelines between immigrant and non-immigrant children and youth when accounting for covariates.

 For youth aged 12-17, given that some variables did have youth self-report in addition to PMK report, two separate analyses were conducted, one with youth reported mental health measures and the other with PMK reported mental health measures. A separate regression analysis was conducted for 4 – 11 years old with PMK reported data. We progressively added covariates to understand their impact on the coefficients of interest. The covariates considered in the models are those that have been highlighted in the literature as potentially being associated PA and may not be similarly distributed across immigrant and third generation/non-immigrant children and youth. Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated from these analyses. Model 1 included immigrant generational status and meeting PA guidelines, when controlling for age and sex. Model 2 included mental health covariates: externalizing, internalizing, and ADHD scores. Model 3 included PMK-reported ethnicity. Model 4 included family socio-economic and demographic level covariates, specifically parental educational attainment, household income below low-income measure, and family structure. Finally, Model 5 included neighbourhood level covariates including neighbourhood level family income, percent of population born outside of Canada at DA level, and urbanicity. The models are outlined in table 1.

Table 1: Description of models for regression models

Model	Variables
1	Generational status, age, and sex
2	#1 and mental health variables: externalizing, internalizing, and ADHD scores (PMK report and separate model for youth-self report)

3	#2 and individual level variables: PMK-reported ethnicity
4	#3 and family level variables: parental education, household income below low-income measure, family structure
5	#4 and neighbourhood level variables: neighbourhood level family income, percent of population born outside of Canada at DA level, urbanicity

Missing Data

8301 participants had complete data with 2501 participants (23.1%) having one or more missing responses. I first examined the proportion of missing data for each variable by age group. A binary variable was created where complete cases were dummy coded as 0 and those that were missing on one or more responses were coded 1. The dummy coded variable was used to then assess bivariate associations between each variable and missingness, to see if it was meaningful. In table 3, we demonstrated the level of missingness and whether there was any selective non-response.

Missingness ranged from 0% (sex, age, urbanicity) to 6% for average neighbourhood family income and percent of the population being born outside of Canada among children aged 4-11 years old (table 2). For participants aged 4-11, reduced odds of missing responses was associated with not meeting PA guidelines, being first or second generation children, and identifying as non-Caucasian. Parental educational level less than university graduate, low-income, residing with none or one biological parent, higher

PMK reported ADHD or externalizing scores were associated with increased odds of missing responses (see table 3).

Missingness ranged from 0% (sex, age, urbanicity) to 13% for PA among youth aged 12-17 years old (table 2). For participants aged 12-17 years, reduced odds of missing responses were associated with not meeting PA guidelines, first or second generation youth, identifying as non-Caucasian, and residing in an area with a higher concentration of foreign born individuals. Parental education level less than university graduate, residing with none or one biological parent, higher PMK or youth reported internalizing, externalizing, or ADHD scores were associated with increased odds of having missing data (see table 3).

Table 2: Weighted proportion of missing data for included variables

Variable	% Missing among 4-11 year old	% Missing among 12-17 year old
PA Canadian guidelines being met based on PMK report	1.50%	
PA Canadian guidelines being met based on self-report		13.7%
Ethnicity	2.50%	2.7%
Sex	0%	0%
Age	0%	0%
Parental education	3.8%	4.7%
household income less than low-income measure	2%	2.6%
Family structure	0.5%	1%

Average family income in of those with income in the population 15+ at CT level AND percent population born outside of Canada at DA level	6%	18%
PMK reported OCHS Internalizing Score	1.6%	2%
PMK reported OCHS Externalizing score	1.2%	1.8%
PMK reported OCHS ADHD score	1.5%	2.1%
Immigrant Generational status	2.4%	1.7%
Urbanicity	0%	0%
Youth reported OCHS Internalizing Score		12.1%
Youth reported OCHS Externalizing score		12%
Youth reported OCHS ADHD score		12.2%

Table 3: Weighted unadjusted logistic regression on characteristics of respondents with

missing data versus complete data

Variable	4- 11 year old	12-17 year old
	OR (95% CI)	OR (95% CI)
PA Canadian Guidelines being met during usual week per PMK report		
PMK reported PA level per usual week: meeting guidelines		
PMK reported PA level per usual week: not meeting guidelines	**0.60 (0.47, 0.75)***	
PA Canadian Guidelines being met during usual week per youth report		
Youth reported PA level per usual week: meeting guidelines		

youth reported PA level per usual week: not meeting guidelines		0.65 (0.45, 0.92)*
Generational status		
1st generation	**0.36 (0.21, 0.63)***	**0.40 (0.26, 0.61)***
2nd generation	**0.22 (0.16, 0.31)***	**0.30 (0.21, 0.42)***
3rd generation/non-immigrants		
Ethnicity		
Caucasian		
Non-Caucasian	**0.31 (0.23, 0.41)***	**0.34 (0.26, 0.44)***
Parental education		
High school	**2.27 (1.62, 3.20)***	**2.12 (1.53, 2.96)***
college graduate, trade school, or some university	**3.32 (2.49, 4.42)***	**2.01 (1.54,2.62)***
university graduate		
Household income less than low-income measure		
Low income	**1.35 (1.08,1.70)**	0.98 (0.77, 1.23)
Not low income		
Family structure		
Two biological parents		
No or one biological parents	**1.49 (1.18, 1.89)**	**1.49 (1.17, 1.90)**
CT level: average family income of those with income in the population 15+	1.0 (1.0,1.0)	**1.0 (1.0,1.0)***
Percent of population born outside of Canada at DA level	**0.94 (0.93,0.95)**	**0.97, (0.96,0.97)***
PMK reported OCHS Internalizing Score	1.02 (1.0, 1.04)	**1.03 (1.01, 1.05)***
PMK reported OCHS Externalizing score	**1.04 (1.01, 1.07)**	**1.06 (1.03, 1.09)***
PMK reported OCHS ADHD score	**1.04 (1.01, 1.07)***	**1.08 (1.04, 1.12)***
Youth reported OCHS Internalizing Score		**1.02 (1.00, 1.03)***
Youth reported OCHS Externalizing score		**1.04 (1.01, 1.06)**
Youth reported OCHS ADHD score		**1.05 (1.01, 1.10)***

Note: Results are presented as ORs and 95% Cis; ***p<0.001, **p<0.01, *p<0.05

RESULTS

There were 8301 participants in the final sample for analysis (Figure 1). Table 4 provided

the characteristics of the participants and differences by generational status for 4-11 years

old, and table 5 for 12-17 years old.

Figure 1. Final sample for analysis
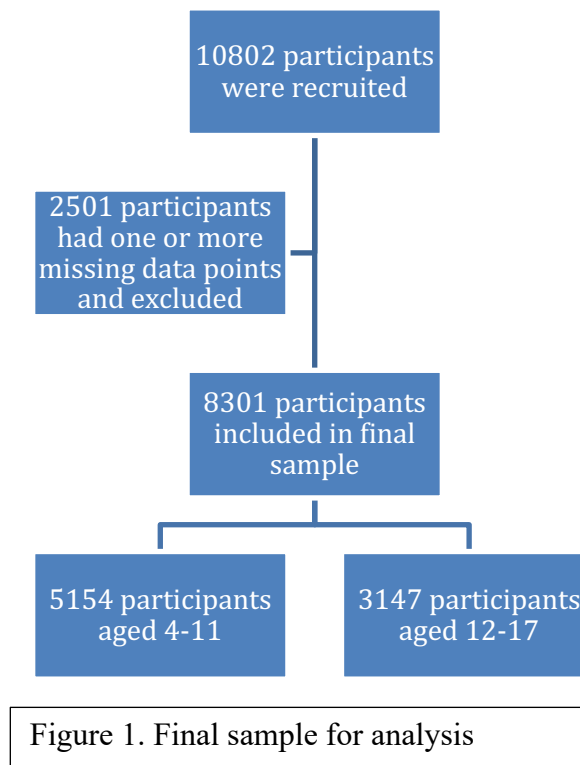
Of the 4-11 years old, 8.26% of the group were first generation, 31.79% were second

generation, and 59.95% were third generation/non-immigrant children. Table 4 provides

the weighted characteristics of participants aged 4-11 years old. Among the 4-11 year old,

the average age was 7.48 years old (95% CI 7.37 7.59), with 52.13% being male and

47.87% being female. 45.48% of the cohort met Canadian guidelines for PA, and this was

highest among third generation/non-immigrants (50.55%) than first generation

immigrants (32.37%) and second generation immigrants (39.31%). 56.07% of the sample

was Caucasian, with 77.61% of first generation and 86.54% of the second generation making up the non-Caucasian sub-group. The average time since immigrating to Canada among first generation children was 3.37 years (95% CI 3.02, 3.72). Among first generation immigrants, 78.10% of the group had at least one parent who was university graduate. 18.57% of the total sample lived in a household considered low income. Specifically, 37.54% of first generation immigrants had a household income considered low income. 78.34% of the sample lived with two biological parents. 84.34% of the sample lived in a large urban area, with 96.33% of the first generation cohort living in a large urban area. First and second generation children were more likely to reside in a neighbourhood where almost half the population was born outside of Canada at the DA level (45.8% and 49.03%, respectively). PMK reported internalizing and externalizing scores were similar across all three generations. PMK reported ADHD score was 3.09 (95% CI 2.89, 3.29) for third generation/non-immigrants while for first generation and second generation, the score was significantly lower [2.30 (95% CI 1.90, 2.69) and 2.15 (95% CI 1.92, 2.38), respectively].

Table 4: Weighted characteristics of participants aged 4-11 (n=5154)

	First generation	Second generation	Third Generation/non-immigrants	Total	p value
PMK reported PA meeting or not meeting guidelines (%)					**p<0.001**
PMK reported PA level per usual week: meeting guidelines	32.37%	39.31%	50.55%	54.52%	

PMK reported PA level per usual week: not meeting guidelines	67.63%	60.69%	49.45%	45.48%	
Ethnicity (%)					**p<0.001**
Caucasian	22.39%	13.46%	83.31%	56.07%	
Non-Caucasian	77.61%	86.54%	16.69%	43.93%	
Gender (%)					p=0.40
Male	47.62%	54.03%	51.75%	52.13%	
Female	52.38%	45.97%	48.25%	47.87%	
Age (mean, SE)	8.16 SE=0.14	7.52 SE=0.11	7.37 SE=0.069	7.48 SE=0.06	**p<0.001**
Parental education (%)					**p<0.001**
High school	8.93%	15.40%	9.82%	11.52%	
college graduate, trade school, or some university	12.97%	28.46%	39.98%	34.08%	
University graduate	78.10%	56.14%	50.20%	54.39%	
Household below low-income measure (%)					**p<0.001**
Low income	37.54%	25.87%	12.09%	18.57%	
Not Low income	62.46%	74.13%	87.91%	81.43%	
Family structure (%)					**p=0.02**
Two biological parents	82.51%	81.06%	76.32%	78.34%	
No or one biological parents	17.49%	18.94%	23.68%	21.66%	
Neighbourhood level family income (mean, SE)	97340.92 SE=2232.15	96933.49 SE=1155.24	108902.00 SE=1164.04	104142.50 SE=815.12	**p<0.001**
Urbanicity (%)					**p<0.001**

Rural and small/med urban centre	3.67%	5.99%	22.43%	15.66%	
large urban	96.33%	94.01%	77.57%	84.34%	
Percent of population born outside of Canada at DA level (mean, SE)	45.80 SE=1.56	49.03 SE=0.79	25.98 SE=0.58	34.94 SE=0.52	**p<0.001**
PMK reported OCHS Internalizing Score (mean, SE)	5.29 SE=0.35	5.09 SE=0.29	5.37 SE=0.19	5.27 SE=0.15	p=0.72
PMK reported OCHS Externalizing score (mean, SE)	3.13 SE=0.24	2.83 SE=0.12	3.12 SE=0.12	3.03 SE=0.09	p=0.35
PMK reported OCHS ADHD score (mean, SE)	2.30 SE=0.20	2.15 SE=0.12	3.09 SE=0.10	2.73 SE=0.08	**p<0.001**

There were 3147 youth aged 12-17 years old in the final sample for analysis (figure 1). Of the 12-17 year old, 18.69% of the youth were first generation, 24.53% were second generation, and 56.78% were third generation/non-immigrant youth. Table 5 provides the weighted characteristics for this age group. Among this sample, the average age of participants was 14.57 years old (95% CI 14.46, 14.68) with 51.25% being males and 48.75% being females. Only 15.31% of youth self-reported meeting PA guidelines, with the lowest proportion being among first generation youth (11.11%). Among first generation youth, the average time since immigrating to Canada was 6.37 years (95% CI 5.67, 7.08). 57.5% of the sample was Caucasian. 83.35% of the first generation youths were non-Caucasian as were 87.59% of the second generation youth. 46.54% of the sample had at least one parent who was a university graduate. Among first generation

specifically, 70.57% of the group had at least one parent who was a university graduate.

18.05% of the total sample had a household income considered low income, with 30.06%

of first generation youth being considered low income. 82.81% of the sample lived in a

large urban area, with again the majority of first and second generation youth residing in a

large urban area (91.97% and 93.46%, respectively), compared to only 75.2% of third

generation/non-immigrants. Youth reported internalizing score for third generation/non-

immigrants was 11.70, compared to a mean score of 9.71 among first generation youth

and 9.30 among second generation youth. Youth reported OCHS externalizing score was

5.46 among first generation and second generation youth compared to 7.22 among third

generation/non-immigrant youth. Youth reported ADHD scores was also lower among

first generation (3.15) and second generation youth (3.08), compared to third

generation/non-immigrants (4.09). PMK reported scores were lower than youth report,

however, was again significantly higher among the third generation/non-immigrant cohort

compared to first and second generation youth.

Table 5: Weighted characteristics of participants aged 12-17 (n=3147)

	First generation	Second generation	Third Generation/non-immigrants	Total p value
PA Canadian Guidelines being met during usual week per youth report (%)				p=0.09
Youth reported PA level per usual week: meeting guidelines	11.11%	13.75%	17.36%	15.31%
youth reported PA level per usual	88.89%	86.25%	82.64%	84.69%

week: not meeting guidelines				
Ethnicity (%)				**p<0.001**
Caucasian	16.65%	12.41%	90.44%	57.50%	
Non-Caucasian	83.35%	87.59%	9.56%	42.49%	
Gender (%)				p=0.84
Male	53.33%	50.60%	50.84%	51.25%	
Female	46.67%	49.40%	49.16%	48.75%	
Age (mean, SE)	14.90, SE=0.12	14.41, SE=0.12	14.53 SE=0.074	14.57 SE=0.056	**p=0.008**
Parental education (%)				**p<0.001**
High school	8.36%	18.26%	10.46%	11.98%	
college graduate, trade school, or some university	21.07%	41.26%	48.30%	41.48%	
university graduate	70.57%	40.48%	41.24%	46.54%	
Household income less than low-income measure (%)				**p<0.001**
Low income	30.06%	27.37%	10.07%	18.05%	
Not low income	69.94%	72.63%	89.93%	81.95%	
Family structure (%)				**p=0.002**
Two biological parents	71.23%	76.32%	63.63%	68.16%	
No or one biological parents	28.77%	23.68%	36.37%	31.84%	
Neighbourhood level family income (mean, SE)	95430.66 SE=2575.68	95289.81 SE=1808.44	109067.30 SE=1776.57	103138.60 SE=1220.37	**p<0.001**
Urbanicity (%)				**p<0.001**

rural and small/med sized centre	8.03%	6.54%	24.80%	17.19%	
large urban	91.97%	93.46%	75.20%	82.81%	
Percent of population born outside of Canada at DA level (mean, SE)	47.64 SE=2.01	46.35 SE=1.50	22.66 SE=0.72	33.14 SE=0.75	**p<0.001**
Youth reported OCHS Internalizing Score (mean, SE)	9.71 SE=0.66	9.30 SE=0.45	11.70 SE=0.45	10.74 SE=0.30	**p=0.0004**
Youth reported OCHS Externalizing score (mean, SE)	5.46 SE=0.40	5.46 SE=0.28	7.22 SE=0.26	6.46 SE=0.18	**p<0.001**
Youth reported OCHS ADHD score (mean, SE)	3.15 SE=0.21	3.08 SE=0.15	4.09 SE=0.15	3.66 SE=0.10	**p<0.001**
PMK reported OCHS Internalizing Score (mean, SE)	4.10 SE=0.38	4.58 SE=0.33	6.70 SE=0.30	5.69 SE=0.21	**p<0.001**
PMK reported OCHS Externalizing score (mean, SE)	2.18 SE=0.23	2.11 SE=0.17	2.85 SE=0.15	2.54 SE=0.11	**p=0.0026**
PMK reported OCHS ADHD score (mean, SE)	1.46 SE=0.16	1.61 SE=0.13	2.42 SE=0.12	2.04 SE=0.082	**p<0.001**

Table 6 provides the results of the weighted logistic regression for youth aged 4-11 years

old with PMK reported data.

Model 1: Immigrant generational Status

Model 1 shows that the association between generational status and PA when controlling

for age and sex. The association between generational status and meeting Canadian PA

guidelines as reported by PMK was statistically significant and negative. The odds of

meeting the Canadian PA guidelines were 50% less for 1st generation immigrant, compared to 3rd generation/non-immigrant children (OR=0.50, 95% CI 0.35, 0.72, p<0.001) and 37% less for 2nd generation immigrant children (OR=0.63, 95% CI 0.49, 0.82, p=0.001).

Model 2: Mental Health co-variates

Mental health measures were not associated with PA and the ORs for immigrant generational status remained essentially unchanged (i.e., OR for first generation went from 0.50 to 0.49 and 0.63 to 0.61 for second generation).

Model 3: Individual Level covariates

The addition of PMK reported ethnicity did significantly decrease the association between generational status and meeting PA guidelines. The ORs were attenuated and now non-significant. The OR for first generation children changed from 0.49 to 0.73, and for second generation children from 0.61 to 0.99. The odds of meeting PA guidelines were 50% less for non-Caucasian children compared to Caucasian children (OR=0.50, 95% CI 0.36, 0.70, p<0.001).

Model 4: Family Level covariates

Model 4 added socio-economic and demographic characteristics to the model. The OR for immigrant generational status remained relatively unchanged and not significant. The odds of meeting PA guidelines were 45% higher for children who resided with none or one biological parent (OR=1.45, 95% CI 1.10, 1.9, p=0.008) compared to children who resided with both biological parents.

Model 5: Neighbourhood Level covariates

Model 5 added neighbourhood level covariates to the model. In the fully adjusted model, the OR associated with ethnicity remained relatively unchanged. The odds of meeting PA guidelines were 47% less among non-Caucasians compared to Caucasians (OR=0.53, 95% CI 0.38, 0.74, p<0.001). The ORs associated with being female and age also remained relatively unchanged with each progressive addition of covariates. The odds of meeting PA guidelines were 30% less for females compared to males (OR=0.70, 95% CI 0.57, 0.85, p<0.001). For each year increase in age, the odds of meeting PA guidelines were 9% less (OR=0.91, 95%CI 0.87, 0.96, p<0.001). The OR associated with residing with none or one biological parent also remained unchanged and significant in the fully adjusted model.

Table 6: Weighted logistic regression results for respondents aged 4-11 years old (ORs and 95% CIs)

	Model 1	Model 2	Model 3	Model 4	Model 5
First generation	0.50*** (0.35, 0.72)	0.49*** (0.34, 0.70)	0.73 (0.48, 1.12)	0.74 (0.48, 1.13)	0.83 (0.53, 1.29)
Second Generation	0.63** (0.49, 0.82)	0.61*** (0.47, 0.80)	0.99 (0.70, 1.38)	1.01 (0.73, 1.41)	1.13 (0.81, 1.61)
Female	0.74** (0.61, 0.89)	0.72** (0.59, 0.88)	0.70*** (0.58, 0.86)	0.70*** (0.57, 0.85)	0.70*** (0.57, 0.85)
Age	0.92*** (0.88, 0.96)	0.92*** (0.89, 0.96)	0.92*** (0.88, 0.96)	0.92*** (0.88, 0.96)	0.91*** (0.87, 0.96)
PMK reported OCHS externalizing score		1.02 (0.97, 1.07)	1.02 (0.97, 1.07)	1.01 (0.97, 1.06)	1.01 (0.97, 1.06)
PMK reported OCHS internalizing score		0.99 (0.96, 1.02)	0.99 (0.96, 1.02)	0.99 (0.96, 1.02)	0.99 (0.96, 1.02)

PMK reported OCHS ADHD score		0.97 (0.93, 1.01)	0.97 (0.93, 1.01)	0.96 (0.92, 1.00)	0.97 (0.93, 1.01)
Non-Caucasian			0.50*** (0.36, 0.70)	0.50*** (0.36, 0.69)	0.53*** (0.38, 0.74)
Max parental educational attainment: high school				0.73 (0.47, 1.15)	0.78 (0.50, 1.22)
Max parental educational attainment: College graduate, trade school or some university				1.07 (0.82, 1.38)	1.10 (0.84, 1.45)
household income < low-income measure: Low income				1.13 (0.84, 1.51)	1.13 (0.84, 1.52)
Resides with none or one biological parent				1.45** (1.10, 1.91)	1.45** (1.11, 1.90)
% of population born out of Canada at DA level					0.99 (0.99, 1.00)
Neighbourhood level family income					1.00 (1.00, 1.00)
Household within rural or small/med urban area					1.09 (0.76, 1.57)
Note: Results are presented as ORs and 95% Cis; ***p<0.001, **p<0.01, *p<0.05					

Table 7: Weighted logistic regression results for participants aged 12-17 years old using PMK reported data (ORs and 95% CIs)

	Model 1	Model 2	Model 3	Model 4	Model 5
First generation	0.60* (0.40, 0.89)	0.56** (0.39, 0.81)	0.70 (0.44, 1.09)	0.70 (0.44, 1.11)	0.76 (0.47, 1.23)
Second Generation	0.75 (0.49, 1.15)	0.73 (0.48, 1.11)	0.91 (0.52, 1.61)	0.85 (0.47, 1.52)	0.91 (0.48, 1.71)
Female	0.50*** (0.36, 0.69)	0.54*** (0.39, 0.75)	0.54*** (0.38, 0.75)	0.53*** (0.38, 0.74)	0.53*** (0.38, 0.74)
Age	0.93 (0.84, 1.02)	0.92 (0.83, 1.01)	0.91 (0.83, 1.01)	0.91 (0.83, 1.01)	0.91 (0.82, 1.01)
PMK reported OCHS externalizing score		1.14** (1.06, 1.22)	1.14** (1.06, 1.23)	1.15*** (1.06, 1.23)	1.15*** (1.06, 1.24)
PMK reported OCHS internalizing score		0.94** (0.92, 0.97)	0.93** (0.90, 0.97)	0.93** (0.90, 0.97)	0.93** (0.90, 0.97)
PMK reported OCHS ADHD score		0.99 (0.92, 1.07)	0.99 (0.92, 1.08)	0.99 (0.91, 1.07)	0.99 (0.92, 1.07)
Non-Caucasian			0.74 (0.48, 1.17)	0.75 (0.46, 1.21)	0.80 (0.51, 1.25)
Max parental educational attainment: high school				1.69 (0.96, 2.98)	1.75 (0.997, 3.08)
Max parental educational attainment: College				1.03 (0.75, 1.42)	1.04 (0.74, 1.47)

graduate, trade school or some university					
household income < low-income measure: Low income				0.96 (0.66, 1.41)	0.98 (0.66, 1.46)
Resides with none or one biological parent				0.73 (0.49, 1.08)	0.73 (0.50, 1.08)
% of population born out of Canada at DA level					0.995 (0.99, 1.01)
Neighbourhood level family income					1.00 (1.00, 1.00)
Household within rural or small/med urban area					0.96 (0.63, 1.45)
Note: Results are presented as ORs and 95% Cis; ***p<0.001, **p<0.01, *p<0.05					

Table 8: weighted logistic regression for youth aged 12-17 year old with youth reported

data (ORs, 95% CI)

	Model 1	Model 2	Model 3	Model 4	Model 5
First generation	0.60* (0.40, 0.89)	0.62* (0.42, 0.92)	0.77 (0.49, 1.20)	0.76 (0.48, 1.20)	0.82 (0.51, 1.32)

Second Generation	0.75 (0.49, 1.15)	0.75 (0.49, 1.15)	0.94 (0.54,1.63)	0.87 (0.49, 1.55)	0.93 (0.49, 1.74)
Female	0.50*** (0.36, 0.69)	0.58** (0.42, 0.80)	0.58** (0.42, 0.80)	0.58** (0.42, 0.80)	0.57** (0.41, 0.79)
Age	0.93 (0.84, 1.02)	0.91 (0.83, 1.01)	0.91 (0.83, 1.003)	0.91 (0.83, 1.01)	0.91 (0.82, 1.01)
Non-Caucasian			0.75 (0.49, 1.16)	0.76 (0.48, 1.20)	0.81 (0.52, 1.24)
Youth reported OCHS externalizing score		1.11*** (1.05,1.17)	1.11*** (1.05, 1.17)	1.11*** (1.05, 1.17)	1.11*** (1.05, 1.17)
Youth reported OCHS internalizing score		0.96** (0.94, 0.98)	0.96** (0.94, 0.98)	0.96** (0.94, 0.98)	0.96** (0.94, 0.98)
Youth reported OCHS ADHD score		0.91 (0.81, 1.02)	0.91 (0.81, 1.02)	0.91 (0.81, 1.03)	0.91 (0.81, 1.02)
Non-Caucasian			0.75 (0.49, 1.16)	0.76 (0.48, 1.20)	0.81 (0.52, 1.24)
Max parental educational attainment: high school				1.54 (0.87, 2.74)	1.59 (0.90, 2.81)
Max parental educational attainment: College graduate, trade school or some university				1.02 (0.73, 1.41)	1.03 (0.73, 1.45)
household income < low-income measure: Low income				0.96 (0.66, 1.39)	0.98 (0.66, 1.43)

Resides with none or one biological parent				0.72 (0.48, 1.08)	0.73 (0.49, 1.08)
% of population born out of Canada at DA level					0.99 (0.99, 1.01)
Neighbourhood level family income					1.00 (1.00, 1.00)
Household within rural or small/med urban area					0.91 (0.61, 1.37)
Note: Results are presented as ORs and 95% CIs; ***p<0.001, **p<0.01, *p<0.05					

Table 7 provides the weighted adjusted models for youth aged 12-17 year old with PMK reported mental health measures.

Model 1: Immigrant Generational Status

Model 1 shows that the association between generational status and PA when controlling age and sex. The odds of meeting Canadian PA guidelines were 40% less for first generation immigrant youth compared to third generation/non-immigrant youth (95% CI 0.40,0.89, p=0.01). The odds were 25% less for second generation youth (95% CI 0.49,1.15, p=0.19) compared to third generation youth, though not statistically significant.

Model 2: Mental Health Covariates

The association between meeting PA guidelines and immigrant generational status remained relatively unchanged. The OR associated with first generation youth went from 0.60 to 0.56. Unlike the 4-11 year old age group, ORs for PMK reported mental health measures were associated with PA. The odds of meeting PA guidelines were 14% more for each increase in the externalizing score (OR=1.14, 95% CI 1.06, 1.23, p=0.001). In contrast, the odds of meeting PA guidelines were 7% less for each increase in the internalizing score (OR=0.93, 95% CI 0.90, 0.97, p=0.001).

Model 3: Individual Level Covariates

The addition of PMK reported ethnicity attenuated the association between generational status and meeting PA guidelines, and the OR was no longer significant. The OR for first generation changed from 0.56 to 0.70. Unlike the younger age group, the OR associated with ethnicity was not significant (OR=0.74, 95% CI 0.48, 1.17, p=0.20). The ORs associated with externalizing and internalizing scores remained essentially unchanged.

Model 4: Family Level Covariates

Model 4 included measures of socio-demographic and economic characteristics at the family level. The OR associated with these covariates were not significant. The ORs associated with PMK reported externalizing and internalizing scores remained unchanged.

Model 5: Neighbourhood level covariates

Model 5 provides the fully adjusted model with the addition of neighbourhood level covariates. The ORs associated with PMK reported externalizing and internalizing scores remained unchanged and significant. The OR associated with being female also remained

essentially unchanged throughout all models. The odds of meeting PA guidelines were 47% less among females compared to males (OR=0.53, 95% CI 0.38, 0.74, p<0.001), similar to the 4-11 year old children.

Table 8 provides the results of the weighted logistic regression for youth aged 12-17 year old with youth - reported mental health measures. Similar to PMK reported mental health measures, with the addition of youth reported mental health measures, the OR associated with first generation remained relatively unchanged. The odds of meeting PA guidelines were 38% less among first generation youth compared to third generation/non-immigrant youth (OR=0.62, 95% CI 0.42, 0.92, p=0.017). Again, it was noted that the odds of meeting PA guidelines were 11% higher with each increase in youth reported externalizing score (OR=1.11, 95% CI 1.05, 1.17, p<0.001), and 4% lower for each increase in youth reported internalizing score (OR=0.96, 95% CI 0.94, 0.98, p=0.001). Again, similar to the younger age group, the addition of ethnicity attenuated the OR association of immigrant generational status and meeting PA guidelines and was non-significant. The OR associated with first generation changed from 0.62 to 0.77. Similar to table 7 with PMK reported mental health measures, the addition of family level covariates and neighbourhood level covariates were not associated with meeting PA guidelines. Model 5 provided the fully adjusted model with all included covariates. The OR associated with youth reported externalizing and internalizing scores remain relatively unchanged. The odds of meeting PA guidelines were also 43% less among females compared to males (OR=0.57, 95% CI 0.41, 0.79, p=0.001).

DISCUSSION

Immigrant children (first and second generation) aged 4 to 11 years old were significantly less likely to meet Canadian PA guidelines as reported by PMK compared to third generation/non-immigrant children. For youth aged 12-17 years old, first generation youth only were less likely to meet PA guidelines based on self-report compared to third generation/non-immigrant youth. This was in keeping with previous literature. Previous studies conducted among youth in the United States have noted that immigrant youth had lower odds of meeting adequate PA levels (Allen et al., 2007; Kimbro & Kaul, 2016). Similar to our results, they noted an increasing trend for participation across generations (Allen et al., 2007). A similar cross-sectional study conducted in The Netherlands among primary school children aged 8-12 years, found immigrant children (first and second generation combined) had lower PA scores compared to non-immigrant/third generation children (Labree et al., 2014).

Ethnicity appears to have a significant association with meeting PA guidelines for children aged 4-11 years old in our findings. The inclusion of ethnicity in our models rendered immigrant generational status no longer statistically significant across both age groups and informants. While the majority of first and second generation immigrant children and youth were non-Caucasian, a sizeable proportion within each generational group still identified as Caucasian. These findings help differentiate further the subgroups of immigrant children and youth at greatest risk for not meeting PA guidelines. For children aged 4-11 years old, mental health did not account for the differences in meeting PA guidelines between immigrant generational groups. Consistent with previous literature, we found that females were less likely to meet PA guidelines, and that the odds

of meeting PA guidelines decreased with age. This is reflected in the results where the proportion of first and second generation children and youth meeting PA guidelines significantly decreased between the two age groups. Regarding sex, previous literature has highlighted that non-Caucasian females were more likely than Caucasian females to report no PA any day (Pontes et al., 2021). Cultural norms have been highlighted in previous studies as a limiting factor for female participation in PA (Lane et al., 2021; Pontes et al., 2021). Some families have highlighted that male presence at an activity was a barrier for female participations in one Canadian qualitative study (Lane et al., 2021). This is echoed in other qualitative studies in other countries, where certain sports have been culturally identified as being associated with a specific gender, thus limiting PA participation (Marconnot et al., 2020). Interestingly, children who lived with none or one biological parent were more likely to meet PA guidelines. There is contrasting literature in whether children living in single parent households are less physically active compared to those living with two parents (Duriancik & Goff, 2019; Kobel et al., 2019; Singhammer et al., 2015). There is a paucity of literature that has looked at comparing biological parents compared to non-biological guardians and its role on PA. It is also interesting to note that the same difference was not noted among youth.

Previous literature suggested other socio-demographic characteristics including neighbourhood level covariates and socio-economic status, play a role in PA participation (Bhatnagar et al., 2015; Zaccagni et al., 2017). Despite most first and second generation children and youth having parents who were university graduates, they also made up a significant portion of families considered low income. Furthermore, majority of first and

second generation children and youth lived predominantly in urban areas. Low income

has been highlighted as a reason for decreased PA levels due to lack of access to facilities

that promote PA (Brewer & Kimbro, 2014; Gordon-Larsen et al., 2006). Increased

supervision and concerns of safety and crime in urban neighbourhoods are associated

with decreased PA among children and youth (Berge et al., 2022; Brewer & Kimbro,

2014). Regardless, in the fully adjusted models, there was no association between these

covariates and meeting PA guidelines.

Among youth aged 12-17 years old, mental health scores were lower for first and second

generation youth, compared to third generation/non-immigrants. This is in contrast to

other literature noting higher depression and anxiety scores among immigrants who

recently immigrated (Blackmore et al., 2020). A reason for why there may be a difference

in results may be that the average time since immigration in our cohort of first generation

youth was 6.37 years, while previous results have noted higher prevalence in the first two

years since immigrating (Blackmore et al., 2020). These differences could be due to the

difference in sampling. Similar to the younger cohort, females were less likely to meet PA

guidelines among youth aged 12-17. Youth with higher externalizing scores, either self-

report or as reported by PMK, were more likely to meet PA guidelines, while youth or

PMK reported internalizing scores were associated with decreased odds of meeting PA

guidelines. A study conducted among youth who identified as Hispanic in Florida had

also found that overall PA was associated with higher levels of externalizing symptoms,

but not with internalizing symptoms (Lila et al., 2016). This was also demonstrated in a

cross-sectional study of adolescents aged 9 to 10 years old in the United States that

examined the association of meeting the 24-hour Canadian movement guidelines with internalizing and externalizing behaviours as measured by the Child behaviour Checklist (Sampasa-Kanyinga et al., 2021). Researchers had found that youth who met PA guidelines had a higher likelihood of externalizing problems than those who did not meet PA recommendations (Sampasa-Kanyinga et al., 2021). The researchers had postulated if this may be due to PA being a means to manage externalizing symptoms, however, were not able to examine this hypothesis (Sampasa-Kanyinga et al., 2021). Future research will be needed to better understand temporality between externalizing symptoms and meeting PA guidelines. They did not find an association between meeting PA guidelines and internalizing symptoms (Sampasa-Kanyinga et al., 2021), as this current study did. A reason for this difference may be the difference in age, as the current study results had noted not meeting PA guidelines with internalizing symptoms in youth aged 12-17. The prevalence of internalizing problems such as depression is lower in the younger age groups and increases significantly in adolescence (Thapar et al., 2012). In previous literature, among first-generation immigrants, youth who reported positive mood had higher levels of PA as measured objectively with a pedometer (Morrison et al., 2017). Other studies have noted a correlation between mood and PA levels only in youth males (McKercher et al., 2012), however our study still noted a significant association, while adjusting for sex. This is concerning as there have been documented association of increased sedentary behaviour with poorer mental health, particularly among females (Straatmann et al., 2016). Again, the addition of family and neighbourhood level

covariates did not explain differences in meeting PA guidelines between immigrant generational groups.

Given the increase in immigrant children and youth having obesity, and being at risk for long-term sequelae, PA is one important pillar in terms of targeting and preventing obesity (Tremblay et al., 2016). Our study highlights that first and second generation children and youth are less likely to meet PA guidelines compared to third generation/non-immigrant children and youth. It also highlights that the approach taken to address PA engagement may be different depending on the age of the child. Our study highlights that we may need a targeted approach to addressing PA among non-Caucasian children. Furthermore, our study supports that as children grow older, the odds of meeting PA guidelines is reduced. Further research should assess the reasons that may be underlying decreasing participation in a Canadian landscape. Across both age groups, females are less likely to meet PA guidelines. Our study also highlights reduced PA among youth with higher internalizing scores. As females are noted to experience greater internalizing symptoms in early adolescence and later (Thapar et al., 2012), this group is particularly at risk for not meeting guidelines. Further research should look at strategies that may be effective among younger children, particularly females or those who identify as non-Caucasian. Studies have noted that increased parental education is associated with increased likelihood of female participation (Lane et al., 2021). Potential strategies to increase PA engagement may be parental engagement (Ornelas et al., 2007), educational sessions, and culturally safe programming that considers the language the program is delivered, location of the programming, and considering the personnel delivering the

programming (D'Alonzo et al., 2018; Gagliardi et al., 2022). Most of the research has been among adult women and further research should determine whether similar strategies may be effective among younger children and youth.

Strengths of study

Previous Canadian literature assessing youth noted that immigrants who have resided in Canada for 3 or more years had similar PA levels to children who are Canadian - born (Kukaswadia et al., 2014), but the study had limitations in that it could not address immigrant generational status and its sample was predominantly Canadian born participants and who identified as Canadian (Kukaswadia et al., 2014). Our study was able to look at immigrant generational differences in addition to ethnicity within a large sample size. Most data have also predominantly looked at youth and older age groups. The OCHS study was able to provide data on a larger age range (4-17 years old), allowing for findings to be examined both within a younger age group and among adolescents. This is important given that there are differences by age group that were highlighted in our study. The use of the OCHS data has other strengths. Due to its sampling strategy, families were over-sampled from the same residential areas in order to help assess contextual influences such as neighbourhood level socioeconomic status, demographic characteristics, and resources (Boyle, Georgiades, et al., 2019). In addition, both clusters and households were each stratified by income, allowing for the selection of neighbourhoods and families that are cross-classified at either ends of the income continuum. This provides a better understanding of the impact of low socio-economic status on children and youth well-being (Boyle, Georgiades, et al., 2019).

Limitations of study

Limitations of the current study include it being a cross-sectional study design and therefore the temporality of observed associations are unknown and are unable to infer causality. Furthermore, PA was measured through self-report. This can be affected by recall bias and can be under or overestimated. Furthermore, there may be some social desirability bias. Regardless, other studies have demonstrated self-report measurement of physical activity is both reliable and valid (Prochaska et al., 2001; Ridgers et al., 2012). The OCHS study is also provincial level data, based in Ontario. Though the study provided a large sample, this may not be generalizable to children and youth residing in other areas of the country. Furthermore, there are limitations to the sampling strategy and eligibility criteria, where non-English or French speaking families were not included and children and youth without CCTB tax file would be missed. In addition, families that consent to participate in Statistics Canada surveys, may be different from those that do not. Both the survey design and selective participation ay lead to selection bias. The OCHS study does include sample weights that are applied to all analyses and to generate estimates that are representative of the target population of children and youth in Ontario. Finally, due to vetting requirements, we were unable to disaggregate ethnicity further. This is an important area for future research as previous literature had demonstrated that particular ethnic subgroups may be at higher risk of not meeting PA guidelines (Kukaswadia et al., 2014). Lastly, though several covariates that have been highlighted in the literature across individual, family, and neighbourhood levels were included, there may be other confounders that are at play and were not addressed in this study.

Directions for future research

Future studies should use the addition of accelerometers or pedometers in addition to self-report measures of PA regarding PA engagement among immigrant children and youth in a Canadian setting. Furthermore, future research should look at disaggregating ethnicity further to see if certain ethnic subgroups may be more likely to not meet PA guidelines. Finally, our paper did not look at what mechanisms may be underlying the observed associations. This may be an area of research to pursue further.

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