CORRELATES OF PHYSICAL ACTIVITY AND OUTDOOR TIME IN CANADIAN SCHOOL CHILDREN FROM FAMILIES SPEAKING A NON-OFFICIAL LANGUAGE AT HOME

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Dedication

In memory of my father who always believed in my ability to be successful and who taught me to strive towards my goals and dreams. You are gone but your belief in me and memory of your guiding hand on my shoulder has made this journey possible.

My mother who I am forever indebted for selflessly encouraging me, and always standing behind me while I explore new directions in life and seek my own destiny.

This journey would not have been possible if not for them, and I dedicate this thesis to them with heartfelt gratitude.

ABSTRACT

Research suggests that physical activity (PA) and outdoor times are lower in Canadian children who speak a non-official language at home. Using data from the Active Transportation and Independent Mobility study, we investigated the correlates of PA and outdoor time among schoolchildren from this population to inform future interventions.

The sample included 1,699 children recruited in 37 schools and was stratified by area-level socioeconomic status and type of urbanization (urban, suburban, rural). Among these, 478 spoke a non-official language at home. PA was measured using pedometers for 7 consecutive days. Children's outdoor time and data on potential correlates were collected via child and parent surveys and weather data from Environment Canada.

Correlates of PA and outdoor time differ according to gender and span through the ecological model underscoring the need for gender-sensitized interventions targeted at the individual, family, social and environmental level correlates to increase children's PA and outdoor time.

Contributions of Authors

I would like to acknowledge all the co-authors of manuscripts 1 and 2 including the original researchers from the "Active Transportation and Independent Mobility (ATIM) study". This thesis is a continuation of the analysis of data collected by the ATIM study. Thus, my thesis would not have been possible without the prior work completed by these researchers

Manuscript 1:

Conceptualization: Ransimala Nayakarathna (R.N.), Richard Larouche (R.L.), and Nimesh Patel (N.P).; Data curation: R.L.; Formal analysis: R.N.; Funding acquisition: Mark Tremblay (M.T.), R.L., Guy Faulkner (G.F)., and François Trudeau (F.T.); Investigation: R.L., M.T., G.F., and F.T.; Methodology: R.L., R.N., M.T., G.F., and F.T., and N.P.; Project administration: R.L., and Negin Riazi (N.R).; Supervision: R.L., N.P., and Cheryl Currie (C.C.); Visualization: R.N.; Writing – original draft: R.N.; Writing – review & editing: R.L., N.P., C.C., N.R., M.T., G.F., and F.T.

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List of Abbreviations

PA – Physical activity

MVPA – moderate- to vigorous-intensity physical activity

SES – Socioeconomic status

IM – Independent mobility

AT- Active transportation

MET- metabolic equivalents

CHAPTER 1
Introduction & Review of the Literature

Background and significance

Physical activity (PA) is defined as human movements involving skeletal muscles that expend energy, including activities performed during working, playing, engaging in daily chores, traveling, and recreational activities (1). In children and adolescents, the recommended level of PA is at least 60 minutes of moderate- to vigorous-intensity physical activity (MVPA) per day (2). A 2020 pooled analysis of 298 population-based surveys with 1.6 million participants found that worldwide, 70-80% of adolescents are insufficiently active (3). Based on accelerometry data from the 2007-2015 Canadian Health Measures Survey, only 35% of children and adolescents (5-17 years) met this recommended guideline in Canada (2).

Insufficient PA is becoming a worldwide public health concern due to advancements in technology, increasing urbanization, increasing sedentary behavior, and the use of motorized travel methods (4). Insufficient PA is associated with an increased risk of obesity (5), increased cardiometabolic risk factors (6), lower cognitive abilities (7), and decreased academic achievement (8) during childhood and adolescence. Low rates of PA among children are a major health concern worldwide as PA tends to decline with age and children who are insufficiently active are likely to remain inactive in adulthood (9,10). This could result in serious health effects (diabetes, hypertension, heart diseases, stroke, etc.), an increase in mortality, and loss of productivity in adulthood (9).

As a behavior, PA can be categorized in different ways, such as by type, frequency, duration, and intensity (11). For research purposes, the intensity of PA can be classified according to multiples of resting metabolic rate (METs) as light (< 4 METs), moderate (4 to < 6 METs), and vigorous (≥ 6 METs) (12). There are different ways to assess PA, such as self-reported questionnaires, self-reported diaries on daily activities, direct observation, and using devices such as accelerometers, pedometers, and heart rate monitors (13). All of these methods have their own merits and disadvantages. For example, the use of self-reports can provide insight into the context in which PA occurs, but is associated with social desirability and recall biases. In contrast, devices are free from these biases, but they generally cannot provide insight into the context in which PA occurs.

Many interventions have been implemented to address the issue of lack of PA among school children. A systematic review (published in 2008) on the effectiveness of interventions to promote PA in children and adolescents that included 57 interventional studies of which 33 were aimed at children, reported that there is limited effectiveness of current PA interventions in children (14). Another systematic review and meta-analysis (2012) of 30 randomized controlled trials and controlled clinical trials found that the pooled intervention effect across all studies was trivial to small for total PA (standardized mean difference = 0.12; 95% CI = 0.04; 0.20) (15). A recent 2019 systematic review of reviews on how to promote PA among children and adolescents performed with 74 papers emphasizes the importance of multi-component interventions to increase PA level in children (16). This underscores the need for a better understanding of the correlates and determinants of PA and how they vary between subpopulations, to design effective

interventions. For instance, there is evidence that engagement in MVPA is even lower in children from families who primarily speak a different language than English or French at home in Canada (hereafter referred to as children from families speaking a non-official language at home) (17). There may be a need for culturally sensitive interventions to reach such subpopulations.

Study rationale

In order to develop effective interventions, it is important to understand the correlates of PA. These correlates of PA span all levels of social-ecological theory, such as individual (biological, psychological), interpersonal, environmental, social, and policy factors (18, 19). Examples of correlates of PA include age, gender, active transportation (AT), independent mobility (IM), outdoor time, parental education, socio-economic status, traffic, weather, neighborhood safety, walkability, school PA policies, etc. (17-21). According to Sallis and colleagues, PA intervention programs should be based on the distribution of PA and its correlates in population subgroups and the strongest correlates of PA (18). A systematic review (2007) of 150 studies reported that the most consistent correlates of children's PA were school PA-related policies, father's PA, mother's education level, low crime incidence in the neighborhood, and family income (20). A recent systematic review of 130 studies (2016) stated that gender, parental PA, parental support, and outdoor time were the most consistent correlates (21). This review also emphasizes the need for studies exploring correlates across all levels of the ecological model. A 2019 systematic review of reviews also indicates that there are limited studies on the efficacy of interventions that go beyond the individual level correlates (16). This study also points out the importance of the role played by the parents in PA promoting in

children (16). In order to plan multi-component interventions as suggested by these systematic reviews, it is important to find the most consistent correlates of PA for a specific population.

Over the last few decades, declines in AT, IM, and outdoor time have been reported in many countries (22-25). These correlates warrant further study as having greater IM enables children to engage in AT and spend more time outside, which can increase PA (26). IM is defined as children's freedom to get around on their own without adult supervision (27). Literature indicates that higher IM is associated with higher PA levels, better risk assessment, spatial consciousness, wayfinding skills, and environmental knowledge (22, 26, 27). In recent years, IM has declined steeply in many countries and this decline is often attributed to social norms and parental concerns about safety and traffic (28). A recent multicenter Canadian study found that IM is significantly lower in boys and girls from families who speak a different language at home than English or French (28). Furthermore, Larouche and colleagues reported that IM was associated with more AT and PA regardless of where children lived, emphasizing the need for IM interventions (29).

AT is another correlate of PA that could be promoted to increase daily PA levels. A 2015 systematic review reports that utilitarian walking and cycling were found to be associated with higher daily MVPA in youth (30). A 2018 systematic review on the effectiveness of active school transport interventions states that out of 30 interventions, 13 reported increased AT, 8 no changes, and 4 inconsistent findings (31). This review further highlights the importance of conducting studies to promote AT to other places (parks, friends/family places, shops, etc.) apart from school.

Outdoor time

A 2015 systematic review of 28 studies indicate that increasing outdoor time could be an effective strategy for increasing the level of PA in children (25). It is difficult to confirm causality because almost all the studies were cross-sectional (25). The same systematic review revealed the overall positive effects of outdoor time on physical activity, sedentary behavior, and cardiorespiratory fitness (25). Position Statement on Active Outdoor Play states when children spend more time outdoors, they move more so it is associated with several physical (body composition, blood pressure, improved cholesterol levels, bone density, cardiorespiratory and musculoskeletal fitness), mental, social, and environmental benefits (32). In parallel with the reduction in PA and IM, it is reported that the outdoor time of children is declining in frequency and time compared to the generation of their parents (33). A study conducted in Canada using 2012–2013 Canadian Health Measures Survey data also reports that each additional hour/day spent outdoors was associated with extra 10 minutes of moderate to vigorous PA in children (34). This study further highlights the necessity of examining the correlates of outdoor time to plan new PA promotion interventions in the future (34).

A 2019 systematic review of 21 papers conducted to identify parental correlates of outdoor play in 0-12 years old identified 5 main correlates. These include, the ethnicity of mothers, employment status of the mother, parents' education level, the importance parents assign to outdoor play, and perceived social cohesion in the neighborhood (35). One interesting finding of this review is that children from mothers of ethnic minorities spent less time outdoors compared to children from mothers of the ethnic majority. This paper also states that only four studies have discussed gender-stratified results

emphasizing the need for gender-specific research to determine if the correlates of outdoor time vary by gender (35). A recent study examining the correlates of outdoor play in childcare centers found that duration and frequency of outdoor time changed according to the season and the child's age (36). The most consistent correlates reported in this study were educator certification, educator professional development, and size of play areas (36). All of these studies highlight the importance of outdoor time to increase children's PA levels. There is a need for further studies to examine the correlates of outdoor time, especially in the context of cultural and gender differences, to inform novel PA promotion interventions. A systematic review published in 2021 examining 107 studies for correlates of outdoor time reported there are around 33 significant correlates reported in these studies (37). This review further states that these correlates span throughout the ecological model (37).

Immigration and PA

It is important to explore whether correlates of PA are consistent across different population groups to determine whether generic or tailored interventions are more appropriate. Several studies conducted in the USA, Canada, and Australia reported that immigrant children are less physically active than native-born (38). A 2020 systematic review on the global prevalence of physical activity, sedentary behavior, and sleep of immigrant children, revealed several concerning findings (38). This systematic review reports that immigrant children and adolescents are underrepresented in the current literature and even in the available studies, PA prevalence of children and adolescents varies greatly, due to inconsistency in methods of measuring. It also mentions that there is a lack of age and gender-specific data on PA for immigrant children and adolescents (38).

Acculturation and PA

Acculturation can be broadly defined as behavioral and psychological changes that occur as individuals adopt the norms and values of the host culture while balancing these norms with those of their heritage culture (39-41). Understanding acculturation as a potential correlate of PA among immigrants is important given that migration and the process of acculturation can influence health-related outcomes and determinants such as stress, coping strategies, dietary practices, and PA (42). Due to its multidimensional nature, measuring the concept of acculturation is challenging. A 2012 systematic review found that time since immigration, immigration generation (e.g., first and second-generation), and language spoken at home are commonly used as proxy measures of acculturation (42). These measures assume that higher immigration generation, increased time since migration, and speaking the host language at home are associated with increased acculturation (17, 43).

In their systematic review, Gerber and colleagues (2012) examined the relationship between acculturation and leisure-time PA (42). Across 44 studies, 9 found that acculturation was associated with higher PA, 16 reported mixed findings and 19 reported no associations with PA. Among the 8 studies that focused on children and adolescents, 63% reported that acculturation was associated with higher PA. A limitation of this review is that the majority of studies used cross-sectional designs, making it difficult to draw causal conclusions. The review provides preliminary evidence suggesting that efforts should be taken to increase acculturation (e.g., language learning) in an attempt to increase children's PA. Another recommendation is that interventions to increase PA among less acculturated individuals should use culturally sensitive methods

(42). An evaluation of a program designed to increase immigrant families' exposure to provincial and national parks also identified the importance of language learning (44). This study also identifies and makes recommendations to minimize the barriers (financial, transport, equipment, etc.) immigrants face while adopting the new cultures.

O'Driscoll et al. stated that the health risks that immigrants face are exacerbated by their insufficient participation in healthy behaviors like PA and sports (45). This systematic review of 72 studies (6 interventions, 18 qualitative studies, 48 quantitative studies) was performed to identify studies that examined the correlates of sports and PA participation in immigrant populations. This study also highlights that while increased acculturation was associated with increased PA, participation in sports activity was considered as a way to increase acculturation as well. This paper also emphasizes that very few studies have measured acculturation as a correlate of PA (45). Another study was done in the USA to examine the associations between PA and neighborhood socio-economic disadvantage, parents' concept on safety, and how these associations vary according to ethnicity/race (46). This study used data from a nationally representative sample of 17,510 school children and it highlights that immigrant children from all ethnicities are less active than US-born children (46).

The current literature is mostly based on studies from the USA, Australia, or the UK. Many of these studies have focused on specific ethnic or racial groups living within a single geographical area, thus limiting their generalizability (38,40,41). The mixed evidence in existing literature suggests that the association between acculturation and PA may depend on the national, cultural, and geographical context, emphasizing the need for country-specific studies.

A systematic review published in 2014 also highlights that correlates of PA are not uniform across culturally and linguistically diverse populations (45). This review also highlights the need for understanding the correlates of PA of specific population subgroups to effectively promote PA.

With regard to the Canadian immigrant population, Kukaswadia and colleagues investigated the association between immigrant generation, time since immigration, and ethnicity with PA using data from adolescents who participated in the Health Behavior in School-aged Children survey (47). Only 11% of immigrant youth in Canada reported engaging in 60 min of MVPA on 7 days/week compared to 15% among Canadian-born peers. This difference was significantly greater for recent immigrants (OR= 0.66; 95% CI= 0.53; 0.82). A recent Canadian multi-center study found that elementary school girls from families who spoke a different language at home accumulated less daily MVPA than girls who spoke English or French (β = -3.7 min/day), but this associationwas not significant in boys (17). Riazi and colleagues also reported that speaking a language other than English or French at home was significantly negatively associated with IM (28). Furthermore, a mixed-methods study that assessed the barriers and facilitators to meeting recommended physical activity levels among young children from new immigrant and refugee children in Saskatchewan, Canada reported that boys' PA level was predicted by age and family income while girls' PA was predicted by parent's education level (48). One of the main drawbacks of this study is that they have used only questionnaires to assess PA levels which is prone to biases like recall bias and social desirability bias (48). Qualitative findings of this study identify barriers to PA such as low income, the unfamiliarity of the concept of organized PA, gender norms, language barriers, children's

preference to screen time activities, parents' work schedules, and safety concerns (48). Despite its importance, there is a lack of research investigating the correlates of PA in children in this subpopulation in Canada. In 2012, 28% of children in Canada were from immigrant families. (49) According to Statistics Canada's population projections, the proportion of Canada's foreign-born population could reach between 24.5% and 30.0% by 2036 (50). Due to the rapidly growing size of the immigrant children population in Canada, this group warrants a specific study. Given the known age-related decline in PA (9,10), childhood is an ideal developmental period for cultivating regular PA to gain health benefits across the lifespan. It is crucial to identify the correlates of PA in this population in order to design effective and culturally sensitive ways of promoting PA to minimize the future burden of non-communicable diseases in Canada.

Purpose

Using the language spoken at home as a proxy measure of acculturation, the primary purpose of this study was to explore the individual, social, environmental, and policy-level correlates of PA among Canadian elementary school children from non-English/French speaking families at home. The secondary purpose was to study the correlates of outdoor time in children from non-English/French speaking families. Although this is an exploratory study, I anticipate a gender difference in correlates of PA, based on previous research (17,28,35). This could occur due to variations in parental perception and concern about safety, walkability, and traffic, as well as parents being more protective towards their daughters than their sons (51) among other reasons. Thus, it is necessary to understand these variations in correlates of PA to inform effective culturally sensitive interventions for this subpopulation in Canada.

Methods

Study design & justification

This cross-sectional study used data from the Active Transportation and Independent Mobility Study. Since this is an exploratory study to find out the correlates of PA in a population subgroup that was insufficiently studied earlier in Canada, starting with a cross-sectional study to inform the future direction of research would be cost-effective and justifiable.

Study setting

In this study the school children were recruited from the regions of Ottawa, Ontario, Trois-Rivières, Québec, and Vancouver, British Columbia (N = 1951; response rate = 54.2%). In each region, schools were stratified according to the location: urban, suburban, and rural (52). Then schools were further stratified according to area-level SES based on the median household income within their census tract according to the 2006 Canadian Census. The data were collected between May 2016 and June 2017.

Participants

All the students in grades 4 to 6 from selected classrooms were eligible for the study. Data were collected from all students who returned a signed parental consent form (Appendix 1) and a child assent form (Appendix 2). A subsample of students (n=478) who spoke another language at home than English or French (as reported by their parent or guardian) was used for the current study.

Sample size

The IM index (defined in the measures section) was used as the exposure for the calculation of sample size, as this correlate has been studied widely in the literature. Given both the exposure and outcome variables are continuous, a correlation coefficient was used to conduct a power calculation. Based on an expected association of r = 0.20 (53) between IM and PA after adjustment for confounders, a sample size of 194 children is needed to achieve 80% power with a two-sided type 1 error of 5%. Given the clustering of children within the school, the design effect was estimated as per Cerin (54), assuming a school-level intra-class correlation coefficient of 0.10 and an average of 13 participants speaking neither English nor French at home per school. Based on the design effect, a total sample size of 427 children was needed. Since the available sample size from the main study is 479, it was deemed sufficient for the analytical purpose.

Data collection

PA was measured using sealed pedometers (Steps Count, Deep River, ON). Data were collected for 8 consecutive days, except sleeping and when doing water-based activities. The first day was considered a practice day and removed from the data analysis. Most exposure variables were assessed using child (Appendix 3) and parent questionnaires (Appendix 4). Parents and children were asked to complete the questionnaires (~15 min each) and return them to school after 1 week with the pedometer. Both questionnaires were available in English and French and researchers at the Vancouver site provided Mandarin and Punjabi translations as these languages were very common at the Vancouver site.

A custom map was provided to children to draw their route from home to school to estimate the distance between home and school. The maps included the road network and the location of the child's home, school, and local parks were emphasized to facilitate this process. Children were instructed to draw this with the help of their parents. In line with previous research, the children's home addresses and school addresses were geocoded with DMTI 2014 route file and the distance between home and school were estimated using ArcGIS 10.3 (ESRI Canada, Ottawa, ON) (55) Weather data were collected from Environment Canada

Measures

Dependent Variables

Physical activity: PA was measured with sealed SC-StepRx pedometers, which can estimate time spent in MVPA using step count frequency thresholds (110 steps/min for moderate- and 130 steps/min for vigorous-intensity PA) (56). When compared to other pedometers and accelerometers, SC-StepRx pedometers were found to be superior in detecting MVPA during treadmill walking and running (56) while using indirect calorimetry as a criterion measure. This pedometer demonstrated the highest sensitivity (92.9%) and specificity (96.5%) for accurate detecting of MVPA (56).

Outdoor Time: To measure children's outdoor time on weekdays and weekends, the question "*On a typical weekday [or weekend day], how much time your child spends playing outdoors at the moment*?" was used. Response options were "none", "< 1 h," "1 to 2 h," "2 to 3 h," and "> 3 h". The midpoints were calculated as 0.5, 1.5, 2.5, and 3.5 h. The average outdoor time per day was calculated using the formula: (5 × outdoor time on weekdays + 2 × outdoor time on weekend days)/ 7 (17,34).

Independent Variables

Individual-level variables:

Assessment of independent mobility (IM) was based on Hillman's (26) six mobility license questions. It assessed the permission to do the following activities alone (or with friends): cross main roads, travel to and from school, cycle on main roads, travel to places other than school, travel on buses other than the school bus, and go out after dark. Answers were dichotomized as 1 = yes and 0 = no, and added to generate an IM index which ranges from 0 to 6. The IM index was found to have a high test-retest reliability and convergent validity between parent and child responses for both French and English surveys (57) (intraclass correlation coefficients (ICC) range = 0.61-0.80).

Children were asked to draw their route to/from school on a map and we estimated the distance between home and school from that information (17). We multiplied distance by the child-reported number of active trips to/from school to obtain the volume of active transportation (AT). In a previous study, the volume of AT had high test-retest reliability (ICC range = 0.81-0.97) (20).

Child's age, mobile phone ownership (yes or no response), and bike ownership (yes or no response) were also collected. The child's long-term health was assessed with the question "*Does your child have a long-term illness or disability?*" Response options were yes or no with an option to specify the condition if yes. The question "*How safe do you feel on your own in your local neighborhood*?" was used to assess children's perception of neighborhood safety. Response options included "*not at all safe", "not very*

safe", "fairly safe", and "very safe". They were dichotomized to "not very safe/not at all safe/not allowed" and "fairly/very safe".

Family-level variables:

The parent questionnaire collected household socio-demographic measures like parents' age, parent education (the highest level of education of both parents), ownership of cars (0, 1 car, 2 or more cars), work status (full-time, part-time, not working), and house ownership (yes, no). Parents reported their travel mode to work; response options were walk, bike, car, transit, or others. Since multiple options were allowed, all travel modes were coded as yes or no. The parental questionnaire was based on the questions used in a 16-country study done in 2015 (58).

Social-environmental variables:

Parent-perceived neighborhood safety was assessed with "*Some young people and adults in the area make you afraid to let your children play outdoors*" and the neighborhood social cohesion was evaluated with the question "*Most adults who live in the neighborhood lookout for other people's children in the area*". For both questions, a 5-point Likert scale ranging from strongly disagree to strongly agree was used. Before analysis responses were dichotomized as "neither/disagree/strongly disagree" and "strongly agree/agree". The question "How worried are you about the risk of your child being injured in a traffic accident when crossing a road?" was used to assess traffic safety. Response options were: "very, quite, not very, not at all, and don't know/not sure". Responses were dichotomized into "very/quite" and "not very/not at all/don't know" before the analysis.

Physical-environmental variables:

Weather data were collected on total daily precipitation and 7.00 am temperature from the closest Environment Canada weather station, for each day when the children wore the pedometer. The morning temperature was collected based on the assumption that it could influence whether children engaged in AT to school (60). Total precipitation and temperature collected were averaged across the week. We collected data throughout the school year to minimize bias due to seasonal changes.

Data management and quality control

The questionnaires and other data from this study were kept in a secure file cabinet in a locked room at the data collection site (e.g., CHEO Research Institute, Université du Québec à Trois-Rivières, and the University of British Colombia). Electronic data were stored in a private folder on a secure server at the data collection site and were subsequently securely transferred to the CHEO Research Institute (i.e., files were password-protected and encrypted), to conduct statistical analyses with the full dataset. Only members of the research team and representatives from the Research Ethics Boards have access to the data. The research data will be kept for 7 years after the last publication of this study, and then will be destroyed.

Participants will not be identified in any publication or presentation of this study. A copy of the signed consent form was provided to all the participants. The participants can receive a copy of the study results at the end of the study at their request. Participants' personal information will be kept strictly confidential except as required or permitted by law. For this study, gender, age, and home address were collected for the research purposes described above and in consent forms. Representatives from the Research Ethics

Boards can check participants' records at the site where these records are held, to see that the study is following the proper laws and guidelines.

For quality control, standard data entry spreadsheets (with a detailed data dictionary) were developed and used at all sites. Verification of a random sample of 10% of questionnaires and range checks were performed for all variables. We used accepted data treatment procedures for the pedometer data which are described below.

Statistical Analysis

Data treatment: Based on previous research, pedometer data was considered "valid" if a minimum of 3 days including one weekend day where steps recorded were between 1000-29999" (61). Data was considered "invalid" when outside this range. MVPA was defined as more than 110 steps per minute. As suggested by Rowe et al. missing days were replaced by the average "valid" week/weekend days (61). Then average step count per day and average MVPA per day were calculated by summing the number and dividing it by the number of days. To address missing data, multiple imputations were performed using the mice package of R Studio software (R Studio, Inc., Boston, MA), prior to analysis (62). A total of 20 imputed data sets were computed with a maximum of 25 iterations per imputation (17). Continuous variables were assessed with the predictive mean matching while ordered categorical data were assessed using the proportional odds model and unordered categorical data were assessed using polytomous logistic regression (17,28). Prior to analysis, continuous variables were grand-mean centered and categorical variables with more than two responses were dummy-coded (63).

Descriptive statistics: All analyses were done using RStudio statistical software (version 1.3.1093) (64). Initially, descriptive statistics were performed on all the variables. For continuous variables (e.g., age, IM, AT, outdoor time, etc.), means and standard deviations were calculated, and for categorical data (e.g., gender, SES, urbanization, parent education, etc.) counts and percentages were calculated. Data visualization was done using "ggplot" (65) and "ggpubr" (66) packages in RStudio.

Multivariable analysis: Since the outcomes (PA and outdoor time) were measured as continuous variables and the recruitment of participants involved children nested within a school, analyses were performed using linear mixed models (54) while controlling for confounders. Initially, within-school intra-class correlations (ICC) were determined by running models including the only school as a random variable. Then a series of regression models were used to test each variable individually while controlling only for school. Inclusion of variables in the regression model was done using a linear cut-off point (e.g., $p < 0.2$) to avoid excluding variables that may become significant when controlling for confounders (17). Next, a backward selection approach was used to withdraw non-significant variables ($p < 0.05$) from the multivariable model, unless their removal led to a significantly worse fitting model (67). The sampling variables (site, type of urbanization, and school SES) and child age were considered mandatory variables. The Akaike information criterion (AIC) was used to assess model fit with lower values indicating better fit (68). As a post-hoc analysis, we examined age and area-level SES as potential moderators of the association between PA and outdoor time by fitting multiplicative interaction terms in the models and plotting the interactions to facilitate interpretation. These two variables were chosen based on previous literature, as well as

their statistically significant and theoretically relevant associations with PA and outdoor time. (69, 70, 71). Variance inflation factor (VIF) was examined to identify potential collinearity issues. Finally, a comparison of multiply imputed models with a complete case analysis was done to examine the consistency of our findings. (17,28). For all statistical inferences, $p < 0.05$ was used as the threshold for statistical significance.

Research ethics approval

The study protocol was approved by the Research Ethics Boards at Children's Hospital of Eastern Ontario (15/103X), University of British Columbia (H15-02710), and Université du Québec à Trois-Rivières (CER-15-218-07.05) along with relevant school boards and participating schools. For the secondary analysis, ethics approval was obtained from the University of Lethbridge Human Participant Research Committee (HPRC-2020-050).

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CHAPTER 2
MANUSCRIPT 1

Correlates of physical activity in children from families speaking non-official languages at home: A multi-site Canadian study

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ABSTRACT

Introduction: Previous research suggests that, in Canada, girls from families who speak a non-official language at home are less physically active. Using data collected in three regions of Canada, we investigated the correlates of physical activity (PA) among children from families speaking non-official languages at home.

Methods: The sample included 1,699 children recruited in 37 elementary schools and was stratified by area-level socioeconomic status (SES) and type of urbanization (urban, suburban, rural). Among these children, 478 spoke a non-official language at home. Steps/day and moderate- to vigorous-intensity physical activity (MVPA) were measured using pedometers for 7 consecutive days. Data on potential correlates were collected via child and parent surveys and weather data from Environment Canada. Gender-stratified linear mixed models were used to examine correlates of PA.

Results: The strongest correlate of increased PA among boys and girls from non-official language homes was outdoor time. Younger children were generally more active. Girls who had less independent mobility and whose parents reported driving to work accumulated more MVPA. Having a long-standing illness/disability and lower SES was associated with less PA among boys. The strength of the association between outdoor time and PA decreased with age in boys and increased with age in girls. The differences in PA between boys attending schools in low-vs. high-SES areas decreased with outdoor time.

Conclusions: Outdoor time was the most consistent correlate of PA. Future interventions in this population should aim to increase opportunities to be active outdoors and address socio-economic disparities.

Keywords: Physical activity, Children, Correlates, Social-ecological model, Acculturation, Socioeconomic status

Highlight's box

- Research has shown girls from families speaking non-official languages at home are less physically active, underscoring a need to understand factors associated with physical activity in this subpopulation.
- Outdoor time was the most consistent correlate of physical activity for girls and boys speaking a non-official language at home.
- Age moderated the association between outdoor time and physical activity for girls and boys.
- The differences in PA between boys attending schools in low-vs. High-SES areas decreased with outdoor time.
- Future interventions in this subpopulation should aim to increase opportunities for children to be active outdoors and address socio-economic disparities.

INTRODUCTION

For children and adolescents aged 5 to 17-years, the recommended level of physical activity (PA) is at least 60 minutes of moderate-to-vigorous-intensity PA (MVPA) per day.[1] Based on the 2007-2015 Canadian Health Measures Survey, only 35% of 5-17-year-olds met this guideline.[1] Insufficient PA is associated with increased obesity,[2] increased cardiometabolic risk factors,[3] lower cognitive abilities,[4] and decreased academic performance[5] during childhood and adolescence. Many interventions have been implemented to address insufficient PA among children in school, community, and family settings.[6] However, a meta-analysis of 30 randomized controlled trials found that the pooled intervention effect was trivial to small for increasing total PA.[7] A better understanding of the correlates of PA among children may help develop more successful interventions.

The correlates of PA span all levels of the social-ecological model, including individual, family, social, environmental, and policy factors.[8,9] According to Sallis and colleagues, PA intervention programs should focus on the strongest correlates of PA in target populations.[8] So, it is important to explore whether correlates of PA are consistent across different population groups to determine whether generic or tailored interventions are more appropriate.

International migration has accelerated over the last few decades.[10] Statistics Canada estimates that over 20% of Canadians are foreign-born and projects that this proportion will reach between 24.5 and 30.0% by 2036.[11] Population-based studies have found that immigrant adults were less active than non-immigrants and that PA varied with ethnicity and time since immigration.[12,13] Additionally, Kukaswadia and colleagues found

that only 11% of immigrant youth in Canada reported engaging in 60 min of MVPA on 7 days/week compared to 15% among Canadian-born peers.[14] This difference was significantly greater for recent immigrants.[14] Yet, a 2020 systematic review reported that immigrant children and adolescents are underrepresented in the current PA literature, and there is limited information about how their PA varies with age and gender.[15]

Immigrants can face cultural and linguistic barriers in adapting to life in a foreign country. Acculturation can be defined as psychological and behavioral changes that happen as a person adopts the values and norms of the host culture while trying to harmonize with the customs and cultural norms of their original country.[16-18] Understanding acculturation as a potential determinant of PA among immigrant children is important given that migration and the process of acculturation can influence health-related outcomes and determinants such as stress, coping strategies, dietary practices, and PA.[19] A 2012 systematic review found that time since immigration, immigration generation (e.g., first/second-generation), and language spoken at home are commonly used as proxy measures of acculturation.[19] The majority of the studies found that greater acculturation was associated with higher leisure-time PA.[19]

A Canadian multi-site study found that girls from families who speak non-official languages (non-English/French) at home accumulated less daily MVPA, but this association was not significant in boys.[20] Building on this work[20], the purpose of this study is to examine the correlates of PA among children from families speaking non-official languages at home. Using language spoken at home as a proxy measure of acculturation we aim to explore individual, family, social, and environmental correlates and how they vary by gender.

METHODS

Recruitment

This cross-sectional study used data from the Active Transportation and Independent Mobility Study.[20] A total of 1,951 children were recruited from three regions of Canada: Ottawa, Ontario, Trois-Rivières, Québec, and Vancouver, British Columbia. The pooled response rate was 54.2%. In each region, the schools' sample was stratified by level of urbanization: urban, suburban, and rural.[21] It was further stratified by area-level socioeconomic status (SES), using 2006 Census Canada data on the median household income within their census tract.

Data Collection

All students in grades 4 to 6 from selected classrooms were eligible. Between May 2016 and June 2017, data were collected from all students who returned signed parental consent and child assent forms. The subsample examined in the present study were children who spoke a non-official language at home (n = 478) as reported by their parent or guardian. Separate child and parent questionnaires were used for data collection. The parent questionnaire was based on questions used in a 16-country study.[22]

Measures

Dependent Variable

Physical activity: PA was measured with sealed SC-StepRx pedometers (Steps Count, Deep River, ON) which can estimate time spent in MVPA using step count frequency thresholds (110 steps/min for moderate- and 130 steps/min for vigorous-intensity PA).[23] When compared to other pedometers and accelerometers, SC-StepRx pedometers

demonstrated the highest sensitivity (92.9%) and specificity (96.5%) for accurate detection of MVPA during treadmill walking and running in a sample of children and youth[23]. Data were collected for 7 consecutive days, except when sleeping and doing water-based activities.

Independent Variables

Individual-level variables:

Children's independent mobility (IM) was operationalized using Hillman's[24] six mobility license questions which assess permission to do each of the following activities alone (or with peers): travel to and from school, cross main roads, cycle on main roads, travel on public buses, travel to places other than school, and go out after dark. Answers were dichotomized as 1 = yes and 0 = no and added to create an IM index ranging from 0 to 6. A previous study found the IM index to have a high test-retest reliability and convergent validity between child and parent responses for both English and French surveys (intraclass correlation coefficients (ICC) range = 0.61–0.80).[25] Parents reported the number of active trips to/from school that their child did in the previous week. This number was multiplied by the distance between home and school to compute the volume of AT. A previous study has shown high test-retest reliability (ICC range=0.81–0.97) for the volume of AT to and from school.[25]

Children's outdoor time on weekdays and weekend days were assessed using the question "*On a typical weekday [or weekend day], how much time does your child spends playing outdoors at the moment?*" Response options were "none", "< 1 h," "1 to 2 h," "2 to 3 h," and "> 3 h". Midpoints were then calculated as 0.5, 1.5, 2.5, and 3.5 h. Consistent with previous research, average outdoor time per day was calculated using the following

formula: (5 *outdoor time on weekdays + 2 * outdoor time on weekend days)/7.[20,26] Child's age, mobile phone ownership (yes/no response), and bike ownership (yes/no response) were also collected. The child's long-term health was assessed with the question "*Does your child have a long-term illness or disability?*" Response options were yes or no with an option to specify the condition. Child perceived neighborhood safety was assessed using the question "*How safe do you feel on your own in your local neighborhood?"* Response options were "very safe", "fairly safe", "not very safe", "not at all safe", "not allowed out on my own". They were dichotomized to "not very safe/not at all safe/not allowed" and "fairly/very safe".

Family-level variables:

Parents were asked to report their mode of transport to work: walk, bike, transit, car, and/or other. Since multiple options were allowed, all travel modes were coded as yes or no. Household socio-demographic measures like parent education (the highest level of education of both parents), parents' age, house ownership (yes, no), work status (full-time, part-time, not working), car ownership (0, 1 car, 2 or more cars) were also gathered in the parent questionnaire.

Social-environmental variables:

Traffic safety was assessed with the question "*How worried are you about the risk of your child being injured in a traffic accident when crossing a road*?" Response options included: very, quite, not very, not at all, and don't know/not sure. They were dichotomized into "very/quite" and "no" before analysis. Parent-perceived neighborhood social cohesion was assessed with "*Most adults who live in the neighborhood lookout for other people's children in the area*" and neighborhood safety was assessed with "*Some*

young people and adults in the area make you afraid to let your children play outdoors". For both items, a 5-point scale ranging from strongly agree to strongly disagree was used. These responses were dichotomized as "agree" and "neither/disagree" before analysis.

Physical-environmental variables:

Data on total daily precipitation and 7:00 am temperature were collected from the closest Environment Canada weather station for each day when the children wore the pedometer. Total precipitation and temperature collected were averaged across the week.

Analysis

Data treatment:

Based on previous research, pedometer data were considered "valid" if a minimum of 3 days including one weekend day where steps recorded were between 1,000-29,999.[27] Data were considered "invalid" when outside this range. MVPA was defined as at least 110 steps per minute.[23] As suggested by Rowe et al., missing days were replaced by the average "valid" week/weekend days.[27] Then average daily step count and MVPA were calculated. To address missing data, multiple imputations were performed using the mice package of R Studio software (R Studio, Inc., Boston, MA) before analysis.[28] Data were assumed to be missing at random (MAR) and all variables of interest were included in our analyses in addition to several auxiliary variables that may improve the prediction of missing values.[29] Twenty imputed data sets were computed with a maximum of 25 iterations per imputation.[20, 30] The predictive mean matching, proportional odds model, and polytomous logistic regression methods were used respectively for continuous variables, ordered categorical, and unordered categorical

variables.[20,30] Prior to analysis, continuous variables were grand-mean centered and categorical variables with more than two responses were dummy-coded.[31]

Statistical analysis: All analyses were conducted using RStudio version 1.3.1093.[32] First, descriptive statistics were computed for all variables. Means and standard deviations were reported for continuous variables while counts and percentages were reported for categorical variables. Data visualization was conducted using "ggplot"[33] and "ggpubr"[34] packages in RStudio. Gender-stratified linear mixed models were used to examine the correlates of MVPA and steps per day. [35] Initially, within-school intra-class correlations (ICC) were determined by running a model including only the school as a random variable. Then a series of regression models were used to test each variable individually while controlling only for school. Variables with $p<0.20$ were included in multivariable regression models, to reduce the likelihood of excluding variables that may achieve statistical significance at $p<0.05$ after adjustment for covariates.[20] Next, a backward selection approach was used to withdraw non-significant variables ($p < 0.05$) from the multivariable model[36], unless their removal resulted in a worse model fit as assessed with the Akaike information criterion (AIC).[37] The sampling variables (site, type of urbanization, and school SES) and child age were considered mandatory variables.[20]

As a post-hoc analysis, we examined age and area-level SES as potential moderators of the association between PA and outdoor time by fitting multiplicative interaction terms in the models and plotting the interactions to facilitate interpretation. These two variables were chosen based on previous literature, as well as their statistically significant and theoretically relevant associations with PA and outdoor time.[38-40] Non-significant interaction terms were removed from the final models. Variance inflation

factor (VIF) was examined to identify potential collinearity issues. Finally, a comparison of multiply-imputed and complete case models was done to examine the consistency of our findings.

RESULTS

Table 2.1 provides sample characteristics stratified by gender. The majority of participants who spoke a non-official language at home were from the Vancouver site. The boys were marginally younger than girls (10.0 vs. 10.2 years, p=0.014). More than 80% owned a bike and 78-80% of children reported they feel safe in their neighborhood. Most parents were above 30 years of age, 90-95% had college or university degrees, and the majority were employed at least part-time. Compared with girls, boys accumulated approximately 2,000 more steps per day (p<0.001), 11.4 more minutes of MVPA (p<0.001), and spent 12 more minutes outdoors (p=0.028).

Table 2.1. Descriptive characteristics of the sample stratified by gender (N=478).

Variables	Boys (n=228)		Girls (n=250)		*p*-value
	Count (Percentage)	Mean (SD)	Count (Percentage)	Mean (SD)	
Sampling variables					
Site-Ottawa	51 (22.4)	N/A	74 (29.6)	N/A	0.132
Site-Vancouver	165 (72.4)	N/A	168 (67.2)	N/A	N/A
Site-Trois-Rivières	12 (5.2)	N/A	8 (3.2)	N/A	N/A
Type of urbanization-urban	142 (62.3)	N/A	141 (56.4)	N/A	0.388

Type of urbanization-suburban	73 (32.0)	N/A	90 (36.0)	N/A	N/A
Type of urbanization-rural	13 (5.7)	N/A	19 (7.6)	N/A	N/A
School SES-high	129 (56.6)	N/A	137 (54.8)	N/A	0.765
School SES-low	99 (43.4)	N/A	113 (45.2)	N/A	N/A
Individual-level variables					
Age (years)	N/A	10.0 (0.9)	N/A	10.2 (0.9)	0.014
Bike ownership (yes)	193 (86.2)	N/A	215 (87.0)	N/A	0.884
Phone ownership (yes)	39 (17.3)	N/A	47 (19.2)	N/A	0.673
Child illness (yes)	10 (4.4)	N/A	6 (2.4)	N/A	0.349
Child perceived neighborhood safety (very safe/fairly safe)	166 (78.7)	N/A	192 (80.0)	N/A	0.800
IM index	N/A	1.66 (1.49)	N/A	1.45 (1.41)	0.114
AT volume (km/week)	N/A	0.69 (3.80)	N/A	0.29 (3.19)	0.238
Outdoor time (h/day)	N/A	1.56 (1.0)	N/A	1.36 (1.0)	0.028
MVPA/day (min)	N/A	71.2 (26.1)	N/A	59.8 (19.4)	<0.001
Steps/day	N/A	13,259 (4.265)	N/A	11,198 (3,167)	<0.001
Family-level variables					
Parent age <30 years	3 (1.3)	N/A	4 (1.6)	N/A	0.966
Parent age 30-44 years	131 (58.3)	N/A	144 (58.3)	N/A	N/A
Parent age >45 years	91 (40.4)	N/A	99 (40.1)	N/A	N/A
Parent work-not working	58 (25.7)	N/A	73 (29.6)	N/A	0.374
Parent work-full-time	112 (49.6)	N/A	125 (50.6)	N/A	N/A

Parent work-part-time	56 (24.7)	N/A	49 (19.8)	N/A	N/A
Parent walks to work (yes)	46 (20.3)	N/A	47 (19.0)	N/A	0.807
Parent bikes to work (yes)	20 (8.8)	N/A	10 (4.0)	N/A	0.051
Parent drives to work (yes)	128 (56.4)	N/A	157 (63.3)	N/A	0.149
Parent takes public transit to work (yes)	46 (20.3)	N/A	54 (21.8)	N/A	0.771
Homeownership (yes)	130 (57.8)	N/A	139 (55.8)	N/A	0.737
Car ownership (1 or more vs. 2 or more)	196 (95.6)	N/A	216 (93.5)	N/A	0.453
Parent education-high school or less	10 (4.4)	N/A	18 (7.3)	N/A	0.611
Parent education-college	40 (17.8)	N/A	41 (16.7)	N/A	N/A
Parent education-university	171 (76.0)	N/A	182 (74.0)	N/A	N/A
Social environmental variables					
Parent worry about traffic (very/quite)	141 (68.8)	N/A	158 (68.7)	N/A	0.161
Adults look out for children (agree)	104 (52.8)	N/A	123 (54.7)	N/A	0.774
Some people make you afraid (agree)	40 (20.4)	N/A	43 (19.4)	N/A	0.886
Physical environmental variables					
Mean temp (Celsius)	N/A	2.90 (6.0)	N/A	2.81 (6.9)	0.880
Mean precipitation (mm)	N/A	4.7 (3.4)	N/A	4.8 (3.7)	0.695

Note: Significance was calculated using the Tabelone package in RStudio. The hypothesis test functions used by default are chisq.test () for categorical variables (with continuity correction) and oneway.test () for continuous variables (with equal variance assumption, i.e., regular ANOVA). AT- Active Transportation, IM index- Independent mobility index, MVPA- moderate to vigorous physical activity, School SES – School area-level socioeconomic status

Boys MVPA and steps counts

Correlates of boys' MVPA and steps/day are shown in Tables 2.2 and 2.3, respectively. At the individual level, each additional hour/day spent outdoors was associated with an average of 10.3 more min of MVPA (95%CI = 2.6, 18.0) and 1,843 more steps per day (95%CI = 578, 3108). Boys who had an illness/disability accumulated less MVPA, but no differences were observed for step counts. Each additional year of age was associated with an average of 2.2 minutes less MVPA (95%CI = -3.6, -1.0). The association between outdoor time and PA was stronger in younger boys (Figure 2.1&2.2).

At the social-environmental level, lower school SES was associated with lower MVPA and steps counts. As outdoor time increased, the difference in PA between children attending school in a low-vs. high-SES area was attenuated (Figure 2.3&2.4).

Table 2.2. Correlates of average minutes of MVPA per day in boys in bivariate and multivariable models.

Variable	Bivariate			Multivariable		
	B	CI	*p*-value	B	CI	*p*-value
Sampling variables						
Site-Vancouver (ref = Ottawa)	0.9	-9.4, 11.1	0.866	-4.0	-15.3, 7.3	0.489
Site-Trois-Rivières (ref = Ottawa)	6.7	-9.0, 22.4	0.404	6.8	-6.1, 19.7	0.303
Suburban (ref = urban)	4.1	-6.6, 14.8	0.453	5.9	-4.8, 16.7	0.279
Rural (ref = urban)	-10.1	-24.9, 4.8	0.184	-8.3	-19.7, 3.1	0.152
School SES (low vs high)	-9.7	-18.0, -1.4	0.022	**-17.8**	**-26.5, -9.1**	**<0.001**
Individual-level variables						
Age (years)	-3.0	-6.3, 0.4	0.085	**-2.2**	**-3.6, -1.0**	**0.001**
Bike ownership (yes)	0.7	-7.9, 9.2	0.879	N/A	N/A	N/A
Phone ownership (yes)	5.7	-2.54, 14.0	0.175	N/A	N/A	N/A
Child illness (yes)	-12.1	-26.8, 2.5	0.105	**-12.5**	**-15.5, -9.5**	**<0.001**
Child perceived neighborhood safety (very/fairly safe vs not safe)	-3.2	-10.3, 4.0	0.389	N/A	N/A	N/A

Independent mobility index	1.1	-1.0, 3.2	0.303	N/A	N/A	N/A
AT volume (km/week)	0.8	-0.1, 1.7	0.071	N/A	N/A	N/A
Outdoor time (h/day)	3.4	0.4, 6.4	0.025	**10.3**	**2.6, 18.0**	**0.008**
Family-level variables						
Parent age (30-44 vs <30)	-0.4	-29.3, 28.4	0.976	N/A	N/A	N/A
Parent age (>45 vs <30)	2.2	-26.9, 31.2	0.884	N/A	N/A	N/A
Parent work (full time vs no)	3.2	-4.2, 10.6	0.400	N/A	N/A	N/A
Parent walks to work (yes)	3.5	-4.0, 10.9	0.363	N/A	N/A	N/A
Parent bikes to work (yes)	6.3	-4.8, 17.4	0.264	N/A	N/A	N/A
Parent drives to work (yes)	-1.1	-6.8, 4.7	0.724	N/A	N/A	N/A
Parent takes public transit to work (yes)	-4.7	-12.2, 2.8	0.218	N/A	N/A	N/A
Home ownership (yes vs no)	-0.8	-7.2, 5.7	0.813	N/A	N/A	N/A
Car ownership (1or more vs 0)	-0.2	-12.1, 11.8	0.976	N/A	N/A	N/A
Parent education-high school or less (ref = university)	-5.8	-16.3, 4.8	0.283	N/A	N/A	N/A
Parent education-college (ref = university)	4.1	-3.8, 11.9	0.311	N/A	N/A	N/A
Social environmental variables						
Parent worry about traffic (not very vs very/quite)	1.5	-5.4, 8.5	0.662	N/A	N/A	N/A
Adults look out for children (neither/disagree vs agree)	-3.0	-8.9, 3.0	0.332	N/A	N/A	N/A
Some people make you afraid	2.5	-4.7, 9.7	0.494	N/A	N/A	N/A
Physical environmental variables						
Mean temp (^{0}C)	0.5	-0.1, 1.1	0.128	N/A	N/A	N/A
Mean precipitation (mm)	0.2	-1.1,1.4	0.794	N/A	N/A	N/A
Interaction terms						
Age* Outdoor time	N/A	N/A	N/A	**-0.8**	**-1.6, -0.1**	**0.032**
SES* Outdoor time	N/A	N/A	N/A	**3.3**	**2.0, 4.6**	**<0.001**

Note: AT- Active transportation, School SES – School area-level socioeconomic status

Figure 2.1. Association between MVPA and outdoor time in boys stratified by age.

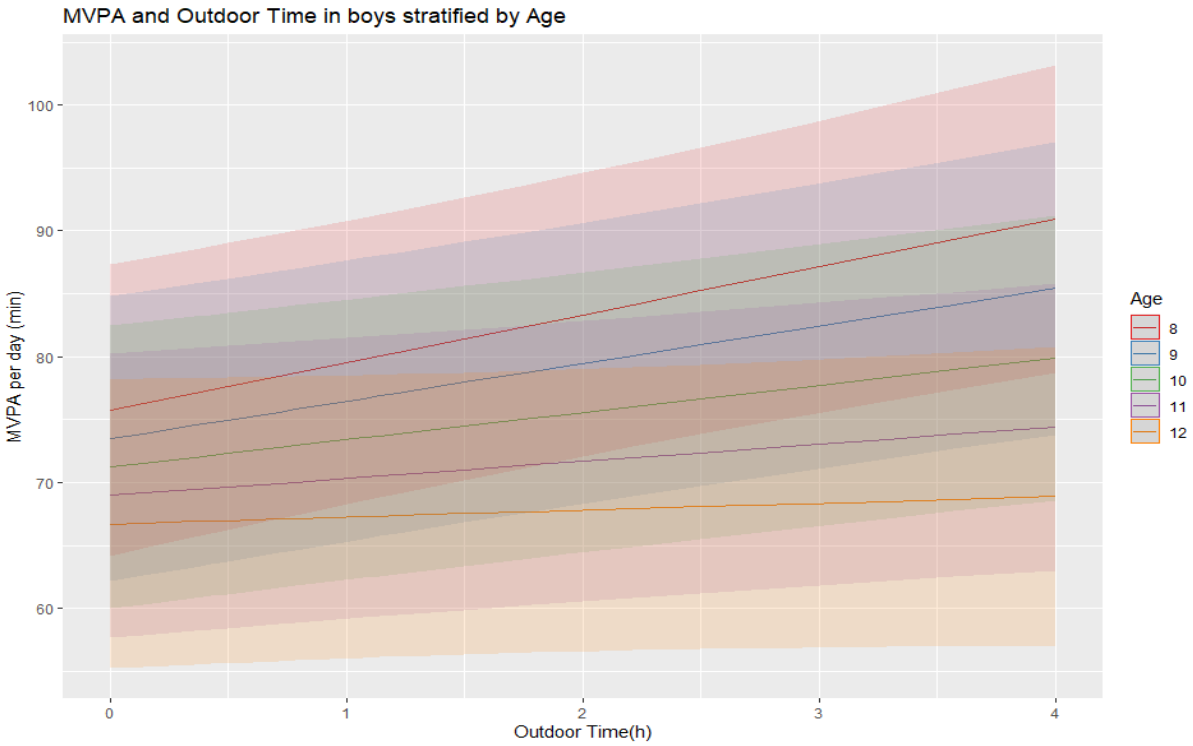


Table 2.3. Correlates of average steps per day in boys in bivariate and multivariable models.

Variable	Bivariate			Multivariable		
	B	CI	*p*-value	B	CI	*p*-value
Sampling variables						
Site-Vancouver (ref = Ottawa)	-772	-2577, 1033	0.402	-978	-3064, 1108	0.358
Site-Trois-Rivières (ref = Ottawa)	1094	-1554, 3743	0.418	1438	-929, 3804	0.234
Suburban (ref = urban)	593	-1299, 2485	0.539	608	-1367, 2583	0.546
Rural (ref = urban)	-2406	-5128, 316	0.083	-1230	-3308, 848	0.246
School SES (low vs high)	-1919	-3389, -449	0.011	**-2752**	**-4323, -1180**	**0.001**
Individual-level variables						
Age (years)	-398	-944, 148	0.153	-210	-426, 5	0.055
Bike ownership (yes)	-348	-1662, 965	0.603	N/A	N/A	N/A
Phone ownership (yes)	953	-365, 2272	0.156	N/A	N/A	N/A

Child illness (yes)	403	-2267, 3073	0.767	N/A	N/A	N/A
Child perceived neighborhood safety (very/fairly safe vs not safe)	-121	-1285, 1043	0.839	N/A	N/A	N/A
Independent mobility index	185	-153, 523	0.284	N/A	N/A	N/A
AT volume (km/week)	247	114, 379	<0.001	N/A	N/A	N/A
Outdoor time (h/day)	691	217, 1166	0.004	**1843**	**578, 3108**	**0.004**
Family-level variables						
Parent age (30-44 vs <30)	-661	-4667, 3345	0.747	N/A	N/A	N/A
Parent age (>45 vs <30)	-578	-4606, 3451	0.779	N/A	N/A	N/A
Parent work (full time vs no)	440	-713, 1593	0.454	N/A	N/A	N/A
Parent walks to work (yes)	302	-871, 1474	0.614	N/A	N/A	N/A
Parent bikes to work (yes)	1160	-614, 2932	0.200	N/A	N/A	N/A
Parent drives to work (yes)	-117	-1104, 870	0.816	N/A	N/A	N/A
Parent takes public transit to work (yes)	-861	-2012, 290	0.143	N/A	N/A	N/A
Home ownership (yes vs no)	-477	-1715, 761	0.450	N/A	N/A	N/A
Car ownership (1or more vs 0)	630	-1308, 2569	0.524	N/A	N/A	N/A
Parent education-high school or less (ref = university)	-1001	-2702, 700	0.249	N/A	N/A	N/A
Parent education-college (ref = university)	55	-1158, 1268	0.929	N/A	N/A	N/A
Social environmental variables						
Parent worry about traffic (not very vs very/quite)	-234	-1344, 877	0.680	N/A	N/A	N/A
Adults look out for children (neither/disagree vs agree)	-194	-1169, 780	0.696	N/A	N/A	N/A
Some people make you afraid	1147	-52, 2346	0.061	N/A	N/A	N/A
Physical environmental variables						
Mean temp (^{0}C)	53	-59, 166	0.354	N/A	N/A	N/A
Mean precipitation (mm)	-64	-293, 166	0.586	N/A	N/A	N/A
Interaction terms						
Age* Outdoor time	N/A	N/A	N/A	**-130**	**-253, -8**	**0.037**
SES* Outdoor time	N/A	N/A	N/A	**225**	**6, 445**	**0.045**

Note: AT- Active transportation, School SES – School area-level socioeconomic status

Figure 2.2. Association between steps counts and outdoor time in boys stratified by age.

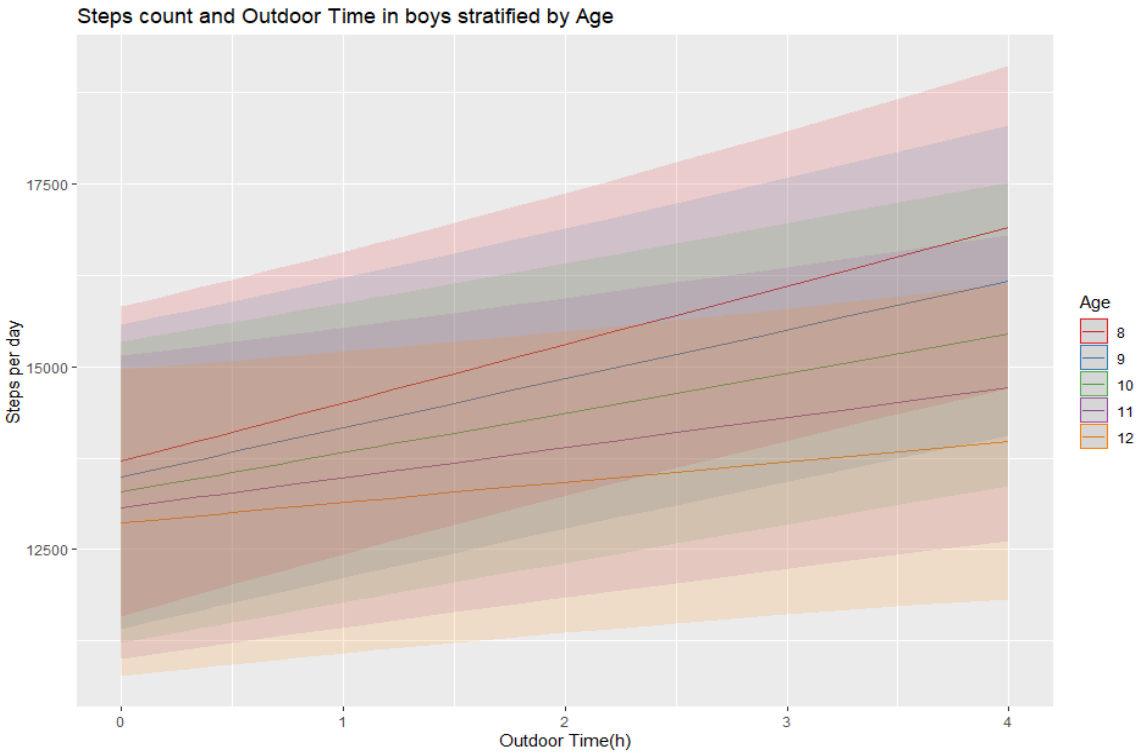


Figure 2.3. Association between MVPA and outdoor time in boys stratified by area-level school SES.

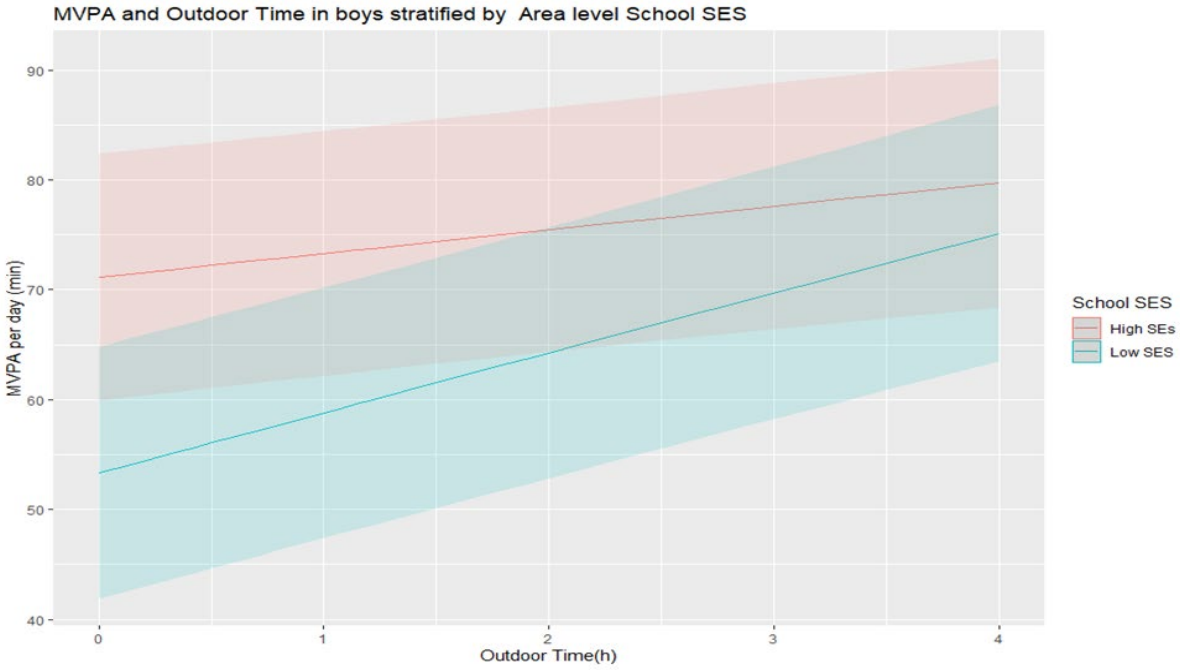
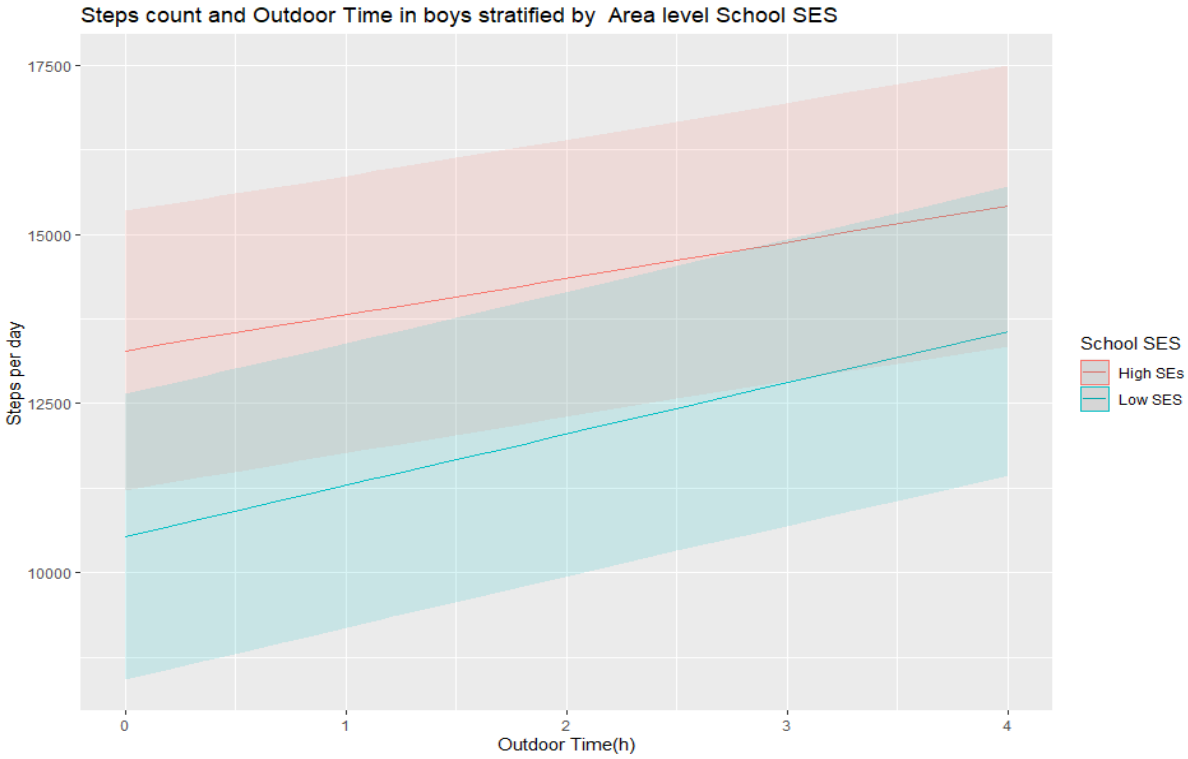


Figure 2.4. Association between steps counts and outdoor time in boys stratified by area-level school SES.



Girls' MVPA and steps counts

Correlates of girls' MVPA and steps/day are shown in Tables 2.4 and 2.5, respectively. At the individual level, each additional hour/day spent outdoors was associated with an average of 3.6 more min of MVPA (95%CI = 3.1, 4.0) and 557 more steps per day (95%CI = 474, 640). The association between outdoor time and PA became stronger with age (Figure 2.5&2.6). Each unit increase in the IM index was associated with an average of 1.5 fewer minutes of MVPA. At the family level, girls whose parents drove to work accumulated more MVPA.

Table 2.4. Correlates of average minutes of MVPA per day in girls in bivariate and multivariable models.

Variable	Bivariate			Multivariable		
	B	CI	*p*-value	B	CI	*p*-value
Sampling variables						
Site-Vancouver (ref = Ottawa)	2.3	-6.1, 10.7	0.593	0.4	-7.5, 8.3	0.922
Site-Trois-Rivières (ref = Ottawa)	0.2	-14.4, 14.8	0.980	1.4	-9.2, 12.1	0.795
Suburban (ref = urban)	-1.0	-10.2, 8.2	0.827	-0.2	-8.7, 8.3	0.958
Rural (ref = urban)	-1.4	-13.1, 10.4	0.820	2.4	-6.7, 11.4	0.609
School SES (low vs high)	-7.2	-14.9, 0.4	0.064	-3.5	-10.7, 3.7	0.343
Individual-level variables						
Age (years)	-3.3	-5.7, -0.8	0.009	**-5.1**	**-6.0, – 4.2**	**<0.001**
Bike ownership (yes)	-1.6	-7.8, 4.6	0.611	N/A	N/A	N/A
Phone ownership (yes)	-0.5	-6.0, 5.0	0.863	N/A	N/A	N/A
Child illness (yes)	-12.1	-26.9, 2.6	0.106	N/A	N/A	N/A
Child perceived neighborhood safety (very/fairly safe vs not safe)	0.1	-5.52, 5.8	0.964	N/A	N/A	N/A
Independent mobility index	-1.8	-3.4, -0.2	0.028	**-1.5**	**-1.9, -1.2**	**<0.001**
AT volume (km/week)	0.4	-0.3, 1.2	0.219	N/A	N/A	N/A
Outdoor time (h/day)	3.9	1.7, 6.1	<0.001	**3.6**	**3.1, 4.0**	**<0.001**
Family-level variables						
Parent age (30-44 vs <30)	11.1	-5.6, 27.8	0.193	N/A	N/A	N/A
Parent age (>45 vs <30)	9.3	-7.5, 26.0	0.279	N/A	N/A	N/A
Parent work (full time vs no)	3.5	-1.9, 9.0	0.204	N/A	N/A	N/A
Parent walks to work (yes)	0.3	-5.1, 5.6	0.925	N/A	N/A	N/A
Parent bikes to work (yes)	-0.7	-11.4, 10.0	0.901	N/A	N/A	N/A
Parent drives to work (yes)	5.3	0.8, 9.7	0.021	**4.7**	**3.7, 5.7**	**<0.001**
Parent takes public transit to work (yes)	-2.4	-7.5, 2.7	0.351	N/A	N/A	N/A
Home ownership (yes vs no)	1.7	-2.8, 6.2	0.466	N/A	N/A	N/A
Car ownership (1or more vs 0)	-0.3	-8.3, 7.8	0.945	N/A	N/A	N/A
Parent education-high school or less (ref = university)	-6.3	-14.5, 1.9	0.130	N/A	N/A	N/A
Parent education-college (ref = university)	2.4	-3.0, 7.8	0.378	N/A	N/A	N/A
Social environmental variables						
Parent worry about traffic (not very vs very/quite)	2.0	-2.7, 6.8	0.403	N/A	N/A	N/A
Adults look out for children (neither/disagree vs agree)	1.1	-3.4, 5.7	0.624	N/A	N/A	N/A
Some people make you afraid	-4.2	-9.7, 1.3	0.132	N/A	N/A	N/A

Physical environmental variables						
Mean temp (^{0}C)	0.2	-0.2, 0.7	0.330	N/A	N/A	N/A
Mean precipitation (mm)	-0.01	-1.0, 0.9	0.976	N/A	N/A	N/A
Interaction terms						
Age* Outdoor time	N/A	N/A	N/A	**2.0**	**1.5, 2.5**	**<0.001**

Note: AT- Active transportation, School SES – School area-level socioeconomic status

Figure 2.5. Association between MVPA and outdoor time in girls stratified by age.

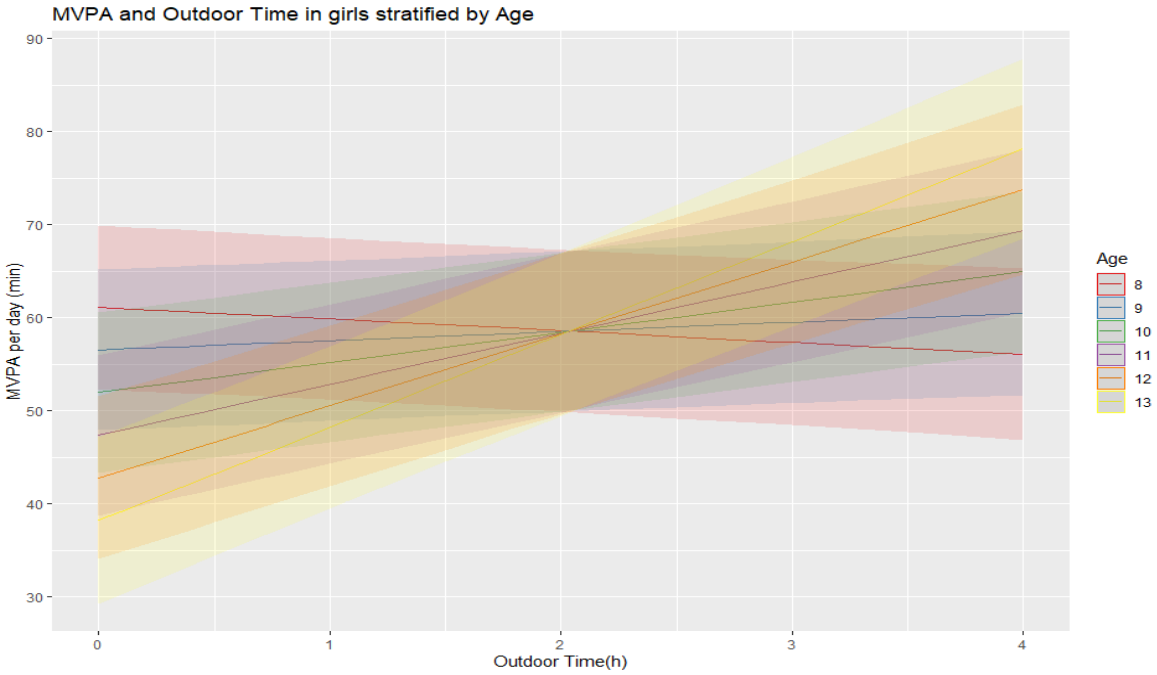


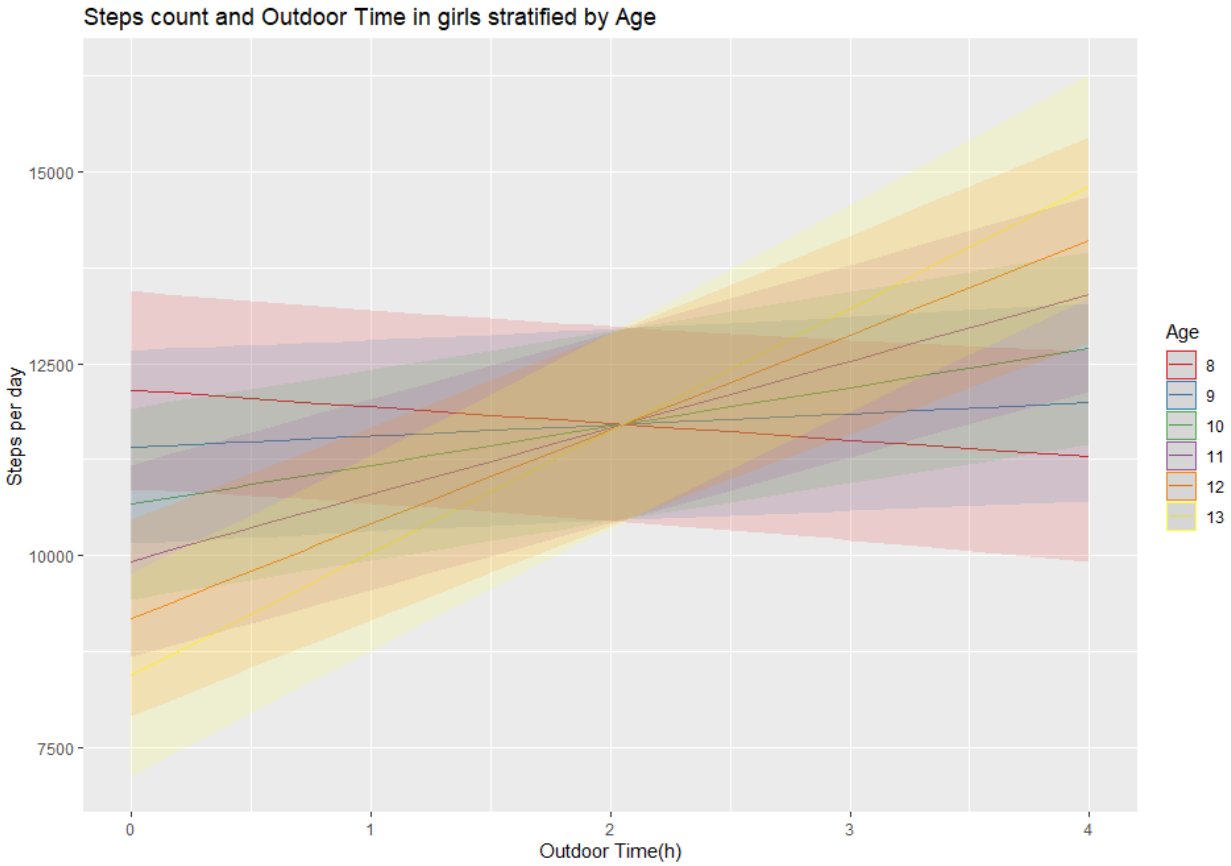
Table 2.5. Correlates of average steps per day in girls in bivariate and multivariable models.

Variable	Bivariate			Multivariable		
	B	CI	*p*-value	B	CI	*p*-value
Sampling variables						
Site-Vancouver (ref = Ottawa)	75	-1339, 1490	0.917	-140	-1325, 1045	0.817
Site-Trois-Rivières (ref = Ottawa)	216	-2163, 2595	0.859	239	-1378, 1856	0.772
Suburban (ref = urban)	-240	-1629, 1149	0.735	-45	-1315, 1226	0.945
Rural (ref = urban)	-237	-2043, 1569	0.797	407	-958, 1772	0.559
School SES (low vs high)	-975	-2179, 230	0.113	-667	-1748, 413	0.226
Individual-level variables						
Age (years)	-195	-595, 205	0.339	**-843**	**-994, -692**	**<0.001**
Bike ownership (yes)	-248	-1194, 699	0.608	N/A	N/A	N/A

Phone ownership (yes)	68	-831, 966	0.883	N/A	N/A	N/A
Child illness (yes)	-1670	-3870, 530	0.137	N/A	N/A	N/A
Child perceived neighborhood safety (very/fairly safe vs not safe)	186	-975, 1346	0.754	N/A	N/A	N/A
Independent mobility index	-206	-546, 133	0.234	N/A	N/A	N/A
AT volume (km/week)	114	-5, 234	0.061	N/A	N/A	N/A
Outdoor time (h/day)	799	446, 1152	<0.001	**557**	**474, 640**	**<0.001**
Family-level variables						
Parent age (30-44 vs <30)	1311	-1401, 4023	0.343	N/A	N/A	N/A
Parent age (>45 vs <30)	784	-1939, 3506	0.573	N/A	N/A	N/A
Parent work (full time vs no)	741	-106, 1588	0.087	N/A	N/A	N/A
Parent walks to work (yes)	-109	-1008, 791	0.813	N/A	N/A	N/A
Parent bikes to work (yes)	-1	-1709, 1707	0.999	N/A	N/A	N/A
Parent drives to work (yes)	623	-112, 1358	0.097	N/A	N/A	N/A
Parent takes public transit to work (yes)	-144	-1053, 766	0.757	N/A	N/A	N/A
Home ownership (yes vs no)	2	-727, 732	0.995	N/A	N/A	N/A
Car ownership (1or more vs 0)	140	-1406, 1686	0.859	N/A	N/A	N/A
Parent education-high school or less (ref = university)	-778	-1956, 400	0.196	N/A	N/A	N/A
Parent education-college (ref = university)	411	-498, 1320	0.375	N/A	N/A	N/A
Social environmental variables						
Parent worry about traffic (not very vs very/quite)	388	-381, 1157	0.322	N/A	N/A	N/A
Adults look out for children (neither/disagree vs agree)	148	-572, 867	0.687	N/A	N/A	N/A
Some people make you afraid	-152	-1260, 955	0.788	N/A	N/A	N/A
Physical environmental variables						
Mean temp (^{0}C)	26	-54, 106	0.530	N/A	N/A	N/A
Mean precipitation (mm)	-24	-180, 132	0.765	N/A	N/A	N/A
Interaction terms						
Age* Outdoor time	N/A	N/A	N/A	**326**	**238, 414**	**<0.001**

Note: AT- Active transportation, School SES – School area-level socioeconomic status

Figure 2.6. Association between steps counts and outdoor time in girls stratified by age.



There was no collinearity between the variables included in the multivariable models. The complete case analysis was consistent with multiply imputed models for the direction and magnitude of all associations; the only difference was that girls' IM index was not significantly associated with MVPA (data not shown).

DISCUSSION

This study explored correlates of device-measured PA in children from Canadian families speaking a non-official language at home. At the individual level, greater time spent outdoors was associated with higher PA in both genders. In boys, having a long-standing illness/disability was associated with lower PA, while in girls, a higher IM index

was associated with less MVPA. The association between outdoor time and PA decreased with age in boys and increased with age in girls. At the family level, girls whose parent/guardian drove to work accumulated more MVPA. At the social-environmental level, lower school-level SES was associated with lower PA in boys. Further, the difference in PA between schools in low- and high-SES areas diminished with outdoor time. Consistent with previous studies we observed that boys were significantly more active than girls,[8, 9, 20,] and the correlates of PA varied by gender.[8,20] In this context, girls from less acculturated families may be a particularly vulnerable group for low PA, underscoring a need for future research and gender-sensitized PA interventions.

Individual-level: For both genders, the most consistent correlate of PA was outdoor time. This finding is consistent with a systematic review in which all included studies found that children who spent more time outdoors were more physically active.[41] The consistency of these findings emphasizes the need for increasing children's outdoor time as a strategy to increase PA regardless of children's gender and ethnicity. As recommended in the Position Statement on Active Outdoor Play,[42] many stakeholders including parents, educators, urban planners, and policymakers should increase opportunities for children to be active outdoors. In a separate analysis, we found that outdoor time was significantly lower in this sample compared to children who spoke English or French at home (1.45 vs. 1.68 hours/day, $p<0.001$; data not shown). Interventions focusing specifically on non-official language-speaking families may also alleviate barriers to participation in outdoor activities.[43]

Interestingly, girls and boys demonstrated two different patterns of interaction between age and outdoor time. The association between PA and outdoor time was

stronger in younger boys and older girls. An age-related decrease in the strength of association between outdoor time and PA could suggest that children increasingly engage in sedentary activities while outside.[44] The opposite pattern for girls may suggest that, with increasing age, more active children are more likely to spend time outdoors.

The IM index and AT volume were not associated with PA in the multivariable model for boys. It is worth noting that children in our subsample had lower IM index (boys: 1.66 vs 2.3, girls: 1.45 vs 2.1) and AT (km/week) (boys: 0.69 vs 2.8, girls: 0.29 vs 2.5) compared to those who spoke English or French at home.[20,30] Furthermore, because both IM and AT usually occur outdoors, the inclusion of outdoor time in the model may have controlled for these variables. Surprisingly, IM was negatively associated with girls' MVPA, but not with steps/day. This finding needs to be interpreted with caution given that a systematic review found that IM was generally associated with more MVPA.[45] Our IM questions assess permission to do certain activities (e.g., travel to and from school alone, cross main roads alone, etc.), not how often children do them, which can introduce measurement error when examining associationswith PA. These findings call for qualitative studies exploring the context in which IM and MVPA occur in this population.

Having an illness/disability was associated with lower MVPA in boys. This finding is consistent with a previous study by Larouche et al.[20] Only 2-4% of children had a long-term illness or disability, so this may have reduced our ability to detect a similar association in girls. There were a variety of conditions reported such as asthma, autism spectrum disorders, allergies, heart conditions, hearing loss, etc.[20] Thus, interventions to address the disparity in PA should not adopt a one-size-fits-all approach. Decision-makers

and parents should ensure that children with long-standing disabilities/illnesses have sufficient opportunities to engage in appropriate PA.

Family-level: Girls whose parents drove to work accumulated more MVPA. This finding differs from Larouche et al, who found that boys whose parents drove to work accumulated less MVPA.[20] Previous research also suggested that parents who drive to work may escort their children along the way, which can reduce their PA.[46] Unfortunately, parents were not asked if they escorted their child to school. Although driving children to school on the way to work can reduce one source of PA, parents may also provide transportation to/from organized physical activity/sports. In our sample, these activities may have made a larger contribution to PA compared to AT. There is evidence that providing transportation to leisure activities can facilitate girls' PA.[47]

Social-environmental level: Boys from areas with lower area-level SES accumulated less MVPA and step counts. Two studies conducted in Australia had similar findings.[48,49] Children from less acculturated families may have access to fewer culturally relevant opportunities for PA when living in low-SES areas. In girls, the association between area-level SES and PA was in the same direction, but not statistically significant. Our findings emphasize the need for interventions to increase opportunities for PA among children in schools located in low-SES neighborhoods. Schools may play a particularly important role in providing accessible PA opportunities for young children from newcomer families.[50] We also observed that the difference in PA between children attending low-vs. high-SES schools were lower in boys who spent more time outdoors. From a public health perspective, this finding suggests that outdoor time may help reduce the impact of SES inequalities on children's PA.

Limitations and strengths

One should interpret the results with caution given the exploratory nature of our study cannot establish causal relationships or temporal sequence. Thus, results should be replicated and further explored using longitudinal designs. There was a large amount of missing data, which we addressed by using multiple imputations. Social desirability and recall bias can occur when using questionnaires to collect data. Efforts were taken to minimize recall bias by asking children to complete the AT questions each day. To reduce the bias occurring from measurement reactivity, sealed pedometers were used and the first day of measurement was not included in the analysis. Underestimation of some activities (swimming, cycling) by using pedometers is another limitation. Thus, we used surveys concurrently to gain insight into the context in which PA occurred. Healthy volunteer bias can occur if families who consent to participate are different from those who did not. To reduce the risk that families did not participate due to insufficient knowledge of English or French, researchers at the Vancouver site offered translations of the parent and child surveys in Mandarin and Punjabi[26]. Another limitation is using only the language spoken at home as a proxy measure of acculturation. Future studies should consider using more than one measure of acculturation. Finally, the use of multiple comparisons increases the risk of type 1 error, so our exploratory findings should be interpreted cautiously.

The recruitment of a stratified sample and the collection of data in 3 diverse regions of Canada is a strength of this study as it increases generalizability. Using surveys along with pedometers can provide insight into the context in which PA occurs. Another

strength is collecting data on a large number of potential correlates that span multiple levels of the social-ecological model.

CONCLUSIONS

Outdoor time was the most consistent correlate of PA in a sample of children who spoke neither of Canada's official languages at home, emphasizing the need for interventions to increase the time this subpopulation of children spends outdoors. Gender-sensitized interventions are recommended given the observed gender differences in correlates of PA. Results also highlight the need for addressing disparities in PA based on disability/illness status and area-level SES. Overall, this study suggests that to increase PA among children living in non-official language-speaking homes, multilevel interventions targeting individual, family as well as social environmental-level correlates are needed.

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Conflicts of interest

RL receives royalties from Elsevier for his book, which is not cited in the present manuscript.

Ethics Approval

The primary study was approved by relevant research ethic boards [Children's Hospital of Eastern Ontario (15/103X), University of British Columbia (H15-02710), and Université du Québec à Trois-Rivières (CER-15-218-07.05)], and school boards at each site. Ethics approval for this secondary analysis was obtained from the University of Lethbridge Human Participant Research Committee (2020-050).

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CHAPTER 3
MANUSCRIPT 2

Correlates of outdoor time in children from families speaking non-official languages at home: A multi-site Canadian study

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ABSTRACT

Introduction: Increasing outdoor time could be an effective strategy for increasing the level of physical activity in children. Using data collected in three regions of Canada, we investigated the correlates of outdoor time among schoolchildren who spoke a non-official language at home.

Methods: A total of 1,699 children were recruited in 37 schools. Sample was stratified by area-level socioeconomic status and type of urbanization. This analysis included 478 children who spoke a non-official language at home. Children's outdoor time and data on potential correlates were collected via child and parent surveys and weather data from Environment Canada. Gender-stratified linear multiple regression was used to examine the correlates of outdoor time.

Results: In boys, higher independent mobility (IM index) was associated with more outdoor time. Boys who owned a phone spent more time outdoors. Boys whose parents were younger, and whose parents biked to work accumulated more outdoor time. Boys accumulated more outdoor time when temperature was high and less outdoor time when they were from sub-urban areas. Age moderated the association between IM index and outdoor time in boys. Girls spent less time outdoors when parents had high school or less education and when parental perception on neighborhood safety and neighborhood cohesion were low.

Conclusions: Correlates of outdoor time differ according to gender, and span through the ecological model underscoring the need for gender-sensitized interventions targeted at

individual, family, and social-environmental level correlates to increase children's outdoor time.

Keywords: Outdoor time, Children, Correlates, Social-ecological model, Acculturation

INTRODUCTION

The Position Statement on Active Outdoor Play states that spending more time outdoors is associated with several physical (body composition, blood pressure, cholesterol levels, bone density, cardiorespiratory and musculoskeletal fitness), mental, social and environmental benefits (1). All articles included in a 2015 systematic review found that children who spent more time outdoors were more physically active overall. Using data from the 2012–2013 Canadian Health Measures Survey, researchers found that each additional hour/day spent outdoors was associated with an extra 7 minutes of moderate- to vigorous-intensity physical activity (PA) and decreased odds of negative psychosocial outcomes in 7-14 years-old children (3). Collectively, these studies underscore the importance of investigating the correlates of outdoor time to plan new PA promotion interventions in the future (1, 3). This is particularly important since researchers have found that today's children go and spend less time outdoors compared to their parents at the same age (4).

According to Bronfenbrenner's social-ecological theory, human behaviors are influenced by various correlates embedded within several level of influence (e.g., individual, family, social, environmental) that interact to shape behaviour (5). Building on this theory, a recent systematic review identified 33 common correlates of outdoor time that span all levels of influences of the ecological model (6). A 2019 systematic review of parental correlates of outdoor play in 0 to 12-year-olds identified 5 main correlates which include the ethnicity of the mother, employment status of the mother, parents' education level, the importance parents assign to outdoor play, and perceived social cohesion in the

neighborhood (7). This paper also stated that only four studies have discussed gender-stratified results, emphasizing the need for future research to address this gap (7).

According to a 2012 study, 28% of Canadian children were from immigrant families (8). These numbers are steadily increasing according to 2016 census data (9). When an individual immigrate from one country to another, many aspects of self-identity are changed to accommodate information about and experiences within the new culture. This complex process is referred to as acculturation, and involves changes in attitudes, behaviors, values, and sense of cultural identity (10-12). Immigration and the related process of acculturation can impact health-related behaviours such as PA and outdoor time. Thus, understanding the concept of acculturation as a possible determinant of outdoor time among immigrants is important (13). According to a systematic review, commonly used proxy measures of acculturation are immigration generation (e.g., first and second-generation), time since immigration, and language spoken at home (13).

A recent national study in Canada found greenspaces where people can spend time outdoors are lesser in areas where immigrants and visible minorities reside (14). Studies also suggest that minority populations more often live-in neighbourhoods that are less favourable for outdoor exercise due to neighborhood safety concerns (15, 16). Such disparities could partly explain why children from mothers of ethnic minorities spend less time outdoors compared to children from mothers of the ethnic majority (7). Nevertheless, in a previous analysis we found that outdoor time was the most consistent corelate of PA in Canadian children from families speaking non-official languages at home (submitted).

Given the lack of previous studies that examined gender and cultural differences in correlates of outdoor time, there remains a need for more research to inform future PA promotion interventions in this population. Therefore, using language spoken at home as a proxy measure, this study aimed to explore the individual, family, social, and environmental level correlates of outdoor time in children speaking non-official languages at home.

METHODS

Recruitment

For this study, we used data from the Active Transportation and Independent Mobility Study, a multi-site cross-sectional study. A total of 1951 children aged 8-12 were recruited from 37 schools in 3 regions of Canada: i) Ottawa, Ontario, ii) Trois-Rivières, Québec, and iii) Vancouver, British Columbia (pooled response rate = 54.2%). First, schools were stratified into urban, suburban, and rural areas (17). Next, schools were further stratified by area-level socio-economic status (SES) based on the median household income within the census tract according to the 2006 Canadian Census. Written parent consent and child assent were obtained for all participants.

Data collection

The data were collected using child and parent questionnaires administered between May 2016 and June 2017. The parent questionnaire was based on questions used in a 16-country study (18). To reduce the risk that parents decide not to participate due to language barriers, parent and child surveys were offered in Mandarin and Punjabi at the

Vancouver site (19). For this paper, we focused on a subsample of students who spoke a non-official language at home (n=478)

Measures

Dependent Variable

Outdoor Time: To measure children's outdoor time on weekdays and weekends, the question "*On a typical weekday [or weekend day], how much time your child spends playing outdoors at the moment*?" was used. Response options were "none", "< 1 h," "1 to 2 h," "2 to 3 h," and "> 3 h". The midpoints were calculated as 0.5, 1.5, 2.5, and 3.5 h. The average outdoor time per day was calculated using the formula: (5 × outdoor time on weekdays + 2 × outdoor time on weekend days)/ 7 (3, 20).

Independent Variables

Individual-level variables:

Assessment of independent mobility (IM) was based on Hillman's (21) six mobility license questions. It assessed the permission to do the following activities alone (or with friends): cross main roads, travel to and from school, cycle on main roads, travel to places other than school, travel on buses other than the school bus, and go out after dark. Answers were dichotomized as 1 = yes and 0 = no, and added to generate an IM index which ranges from 0 to 6. The IM index was found to have a high test-retest reliability and convergent validity between parent and child responses for both French and English surveys (22) (intraclass correlation coefficients (ICC) range = 0.61-0.80).

Children were asked to draw their route to/from school on a map and we estimated the distance between home and school from that information (22). We multiplied distance by

the child-reported number of active trips to/from school to obtain the volume of active transportation (AT). In a previous study, the volume of AT had high test-retest reliability (ICC range = 0.81-0.97) (22).

Child's age, mobile phone ownership (yes or no response), and bike ownership (yes or no response) were also collected. The child's long-term health was assessed with the question "*Does your child have a long-term illness or disability?*" Response options were yes or no with an option to specify the condition if yes. The question "*How safe do you feel on your own in your local neighborhood*?" was used to assess children's perception of neighborhood safety. Response options included "*not at all safe", "not very safe", "fairly safe", and "very safe*". They were dichotomized to "not very safe/not at all safe/not allowed" and "fairly/very safe".

Family-level variables:

The parent questionnaire collected household socio-demographic measures like parents' age, parent education (the highest level of education of both parents), ownership of cars (0, 1 car, 2 or more cars), work status (full-time, part-time, not working), and house ownership (yes, no). Parents reported their travel mode to work; response options were walk, bike, car, transit, or others. Since multiple options were allowed, all travel modes were coded as yes or no.

Social-environmental variables:

Parent-perceived neighborhood safety was assessed with "*Some young people and adults in the area make you afraid to let your children play outdoors*" and the neighborhood social cohesion was evaluated with the question "*Most adults who live in*

the neighborhood lookout for other people's children in the area". For both questions, a 5-point Likert scale ranging from strongly disagree to strongly agree was used. Before analysis responses were dichotomized as "neither/disagree/strongly disagree" and "strongly agree/agree". The question "How worried are you about the risk of your child being injured in a traffic accident when crossing a road?" was used to assess traffic safety. Response options were: "very, quite, not very, not at all, and don't know/not sure". Responses were dichotomized into "very/quite" and "not very/not at all/don't know" before the analysis.

Physical-environmental variables:

Weather data were collected for each day children were wearing the pedometer. 07:00 am temperature (°C) and total daily precipitation (mm) from the closest Environment Canada weather station were obtained and were averaged across the week. We collected data throughout the school year to minimize bias due to seasonal changes.

ANALYSIS

All analyses were performed using RStudio version 1.3.1093 (23). Using multiple imputations methods (mice package of R Studio software - R Studio, Inc., Boston, MA), a total of 20 imputed datasets were computed to address missing data prior to analysis (24). Data were assumed to be missing at random (MAR) and the variables of interest were included in our analyses in addition to several auxiliary variables that may improve the prediction of missing values (25). A maximum of 25 iterations per imputation was used (3). The predictive mean matching, proportional odds model and polytomous logistic regression methods were used respectively for continuous variables, ordered categorical

and unordered categorical variables (3, 19). Grand-mean centering of continuous variables and dummy-coding of categorical variables with more than two responses were done prior to analysis (26).

Means and standard deviations were reported for continuous data while counts and percentages were reported for categorical data. The "ggplot2" (27) and "ggpubr" (28) packages in RStudio were used for data visualization. To examine the correlates of outdoor time, gender stratified multiple linear regression models were used. First, bivariate regression models were performed to test the association between each potential correlate and outdoor time only. Variables with $p < 0.20$ were selected for the multiple regression model, to reduce the possibility of excluding variables that might reach statistical significance at $p < 0.05$ after controlling for covariates (3). Then, a backward selection was performed to remove nonsignificant variables ($p < 0.05$) from the multiple regression model (29). Model fit was assessed using Akaike information criterion (AIC) (30). The sampling variables (site, school SES, type of urbanization, school ID, and child age) were considered as mandatory variables for the models (3).

As a post-hoc analysis, we examined age as a potential moderator of the association between outdoor time and other significant variables by fitting multiplicative interaction terms in the final regression models and plotting the interactions to facilitate interpretation. These interaction terms were based on previous evidence that correlates of outdoor time differ by age group (31). Non-significant interaction terms were removed from the final models. Variation inflation factor (VIF) was used to examine collinearity in multivariable models. Finally, a comparison of complete case and multiple imputed models was performed to assess the consistency of our results.

RESULTS

Table 3.1 provides descriptive characteristics of the sample stratified by gender. The majority of participants who spoke a different language than English or French at home were from Vancouver site. Girls were marginally older than boys (10.2 vs. 10.0 years, $p = 0.01$). 17-19% children owned a mobile phone and approximately 80% children reported that they feel safe in their neighbourhood. Girls spent 12 less minutes outdoors ($p = 0.03$) compared to boys. 90-95% of parents had either a college or university degree, and majority were above 30 years of age. 70-75% parents were employed (full-time or part-time).

Table 3.1. Descriptive characteristics of the sample stratified by gender (N=478).

Variables	Boys (n=228)		Girls (n=250)		*p*-value
	Count (%)	Mean (SD)	Count (%)	Mean (SD)	
Sampling variables					
Site-Ottawa	51 (22.4)		74 (29.6)		0.132
Site-Vancouver	165 (72.4)		168 (67.2)		
Site-Trois-Rivières	12 (5.2)		8 (3.2)		
Type of urbanization-urban	142 (62.3)		141 (56.4)		0.388
Type of urbanization-suburban	73 (32.0)		90 (36.0)		
Type of urbanization-rural	13 (5.7)		19 (7.6)		
School SES-high	129 (56.6)		137 (54.8)		0.765
School SES-low	99 (43.4)		113 (45.2)		
Individual-level variables					
Age (years)		10.0 (0.9)		10.2 (0.9)	**0.014**

Bike ownership (yes)	193 (86.2)		215 (87.0)		0.884
Phone ownership (yes)	39 (17.3)		47 (19.2)		0.673
Child illness (yes)	10 (4.4)		6 (2.4)		0.349
Child perceived neighborhood safety (very safe/fairly safe)	166 (78.7)		192 (80.0)		0.800
IM index		1.66 (1.49)		1.45 (1.41)	0.114
AT volume (km/week)		0.69 (3.80)		0.29 (3.19)	0.238
Outdoor time (h/day)		1.56 (1.0)		1.36 (1.0)	**0.028**
MVPA/day (min)		71.2 (26.1)		59.8 (19.4)	**<0.001**
Steps/day		13,259 (4.265)		11,198 (3,167)	**<0.001**
Family-level variables					
Parent age <30 years	3 (1.3)		4 (1.6)		0.966
Parent age 30-44 years	131 (58.3)		144 (58.3)		
Parent age ≥45 years	91 (40.4)		99 (40.1)		
Parent work-not working	58 (25.7)		73 (29.6)		0.374
Parent work-full time	112 (49.6)		125 (50.6)		
Parent work-part-time	56 (24.7)		49 (19.8)		
Parent-walks to work (yes)	46 (20.3)		47 (19.0)		0.807
Parent-bikes to work (yes)	20 (8.8)		10 (4.0)		0.051
Parent-drives to work (yes)	128 (56.4)		157 (63.3)		0.149
Parent-takes public transit to work (yes)	46 (20.3)		54 (21.8)		0.771
Homeownership (yes)	130 (57.8)		139 (55.8)		0.737
Car ownership (1 or more vs 0)	196 (95.6)		216 (93.5)		0.453

Parent education-high school or less	10 (4.4)		18 (7.3)		0.611
Parent-education-college	40 (17.8)		41 (16.7)		
Parent education-university	171 (76.0)		182 (74.0)		
Parent education-unspecified	4 (1.8)		5 (2.0)		
Social environmental variables					
Parent worry about traffic (very/quite)	141 (68.8)		158 (68.7)		0.161
Adults look out for children (agree)	104 (52.8)		123 (54.7)		0.774
Some people make you afraid (agree)	40 (20.4)		43 (19.4)		0.886
Physical environmental variables					
Mean temperature (°Celsius)		2.90 (6.0)		2.81 (6.9)	0.880
Mean precipitation (mm)		4.7 (3.4)		4.8 (3.7)	0.695

Note: Significance was calculated using the Tableone package in RStudio. The hypothesis test functions used by default are chisq.test () for categorical variables (with continuity correction) and oneway.test () for continuous variables (with equal variance assumption, i.e., regular ANOVA). AT- Active Transportation, IM index- Independent mobility index, MVPA- moderate to vigorous physical activity, School SES – School area-level socioeconomic status

Correlates of boys' outdoor time

Correlates of boys' outdoor time are shown in Table 3.2. At the individual level, each additional unit of IM index was associated with an average 0.7 hours/day more outdoor time (95% CI = 0.51, 0.92). Phone ownership was associated with spending more time outdoors (B= 0.23, 95% CI = 0.16, 0.31). As shown in Figure 3.1, the association between IM index and outdoor time became weaker with age.

At the family level, boys with younger (<45 years) parents accumulated more outdoor time than boys of older parents (≥45 years). Boys whose parents biked to work also accumulated more outdoor time (B= 0.42, 95% CI = 0.32, 0.51). At the built-

environmental level, boys from suburban areas spent less time outdoors compared to boys from urban areas. At the physical-environmental level each °C increase in temperature was associated with an average 0.03 hours more outdoor time (95% CI = 0.02, 0.03).

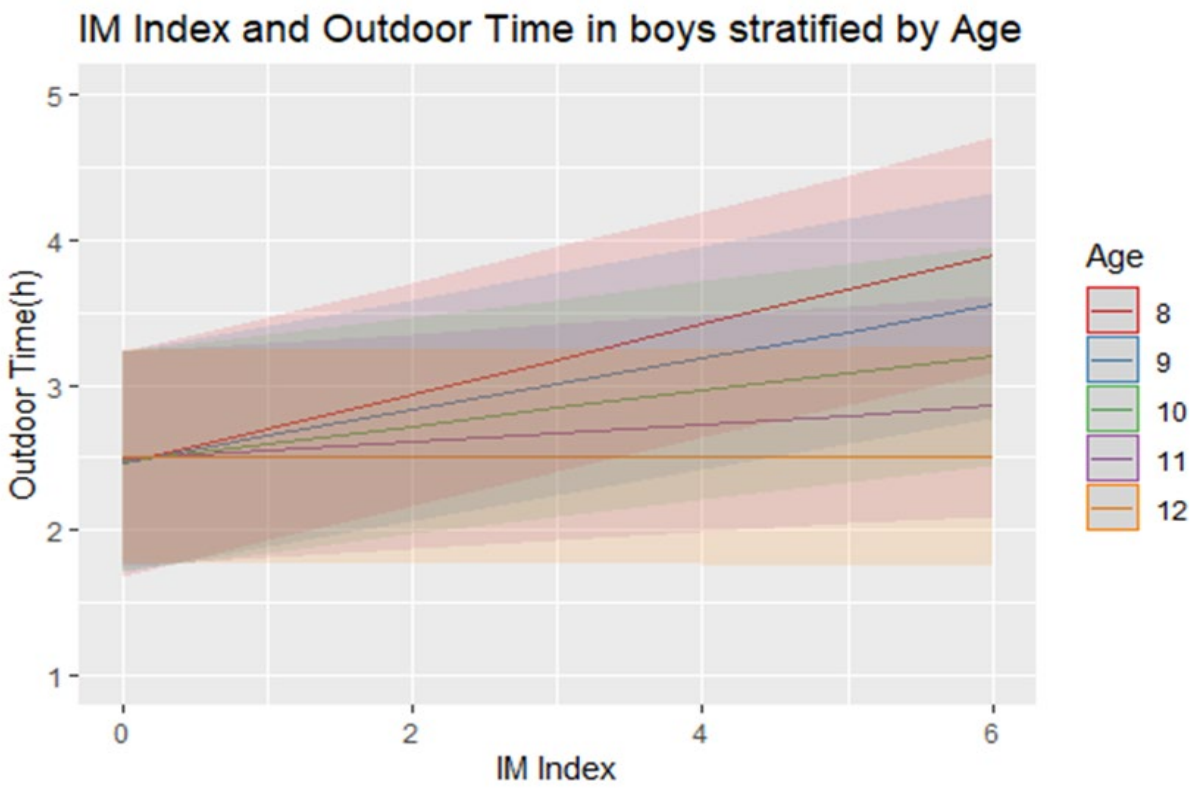
Table 3.2. Correlates of average hours of outdoor time per day in boys in bivariate and multivariable models.

Variables	**Bivariate**			**Multivariable**		
	B	**95% CI**	***p* Value**	**B**	**95% CI**	***p* value**
Sampling variables						
Site-Vancouver (ref = Ottawa)	0.08	-0.21, 0.37	0.583	-0.07	-0.97, 0.83	0.884
Site-Trois-Rivières (ref = Ottawa)	-0.59	-1.14, -0.04	0.037	-0.42	-2.25, 1.41	0.650
Suburban (ref = urban)	0.06	-0.21, 0.32	0.672	**-0.13**	**-0.20, -0.06**	**<0.001**
Rural (ref = urban)	0.40	-0.13, 0.93	0.139	0.08	-0.04, 0.19	0.201
School SES (low vs high)	-0.01	-0.26, 0.24	0.949	-0.02	-0.08, 0.04	0.523
School ID	-0.00	-0.00, 0.00	0.297	-0.00	-0.01, 0.01	0.938
Individual-level						
Age (yrs.)	-0.03	-0.16, 0.11	0.709	0.01	-0.04, 0.06	0.643
Bike ownership (yes)	0.21	-0.14, 0.57	0.239			
Phone ownership (yes)	0.29	-0.04, 0.63	0.087	**0.23**	**0.16, 0.31**	**<0.001**
Child illness (yes)	0.06	-0.47, 0.59	0.836			
Child perceived neighbourhood safety (very/ fairly safe vs not safe)	0.19	-0.10, 0.48	0.196			
Independent mobility index	**0.09**	**0.01, 0.18**	**0.027**	**0.71**	**0.51, 0.92**	**<0.001**
AT volume (km/week)	0.03	-0.01, 0.06	0.125			
Family-level						
Parent age (<30 vs ≥45)	0.83	-0.18, 1.84	0.108	**-1.06**	**-1.29, -0.82**	**<0.001**
Parent age (30-44 vs ≥45)	-0.02	-0.28, 0.23	0.867	**-1.09**	**-1.33, -0.85**	**<0.001**
Parent work (full time vs no)	-0.03	-0.33, 0.27	0.866			
Parent-walks to work (yes)	0.05	-0.26, 0.37	0.737			
Parent-bikes to work (yes)	0.39	-0.06, 0.84	0.090	**0.42**	**0.32, 0.51**	**<0.001**
Parent-drives to work (yes)	-0.04	-0.29, 0.22	0.777			
Parent-takes public transit to work (yes)	-0.16	-0.47, 0.15	0.314			
Home ownership (yes vs no)	0.13	-0.12, 0.38	0.321			
Car ownership (1 or more vs 0)	-0.20	-0.66, 0.27	0.404			

High school or less (ref = university)	0.10	-0.33, 0.53	0.639			
College (ref = university)	-0.08	-0.39, 0.23	0.626			
Social-environmental variables						
Parent worry about traffic (not very vs very/quite)	0.04	-0.24, 0.31	0.796			
Adults look out for children (neither/disagree vs agree)	0.00	-0.25, 0.25	0.983			
Some people make you afraid (neither/disagree vs agree)	-0.08	-0.38, 0.22	0.596			
Physical-environmental variables						
Mean temperature (°C)	0.02	-0.00, 0.04	0.065	**0.03**	**0.02, 0.03**	**<0.001**
Mean precipitation (mm)	-0.02	-0.05, 0.02	0.391			
Interaction Terms						
Age* IM Index				**-0.06**	**-0.08, -0.04**	**<0.001**

Note: AT- Active transportation, B- unstandardized regression coefficients, IM Index- Independent mobility index, School SES- School area-level socioeconomic status.

Figure 3.1: Association between IM index and outdoor time in boys stratified by age.



Correlates of girls' outdoor time

Correlates of girls' outdoor time are shown in Table 3.3. At the family level, girls whose parents' highest level of education was high school or less spent less time outdoors compared to girls whose parents had a university degree (B = -0.53, 95% CI = -0.91, -0.16). At the social environment level, girls whose parents perceived lower social cohesion (B= -0.24, 95% CI = -0.47, -0.01) or had greater concerns about neighborhood safety (B= -0.36, 95% CI = -0.63, -0.09) spent less time outdoors. We did not observe any interactions between age and any correlates of girls' outdoor time.

Table 3.3. Correlates of average hours of outdoor time per day in girls in bivariate and multivariable models.

Variables	Bivariate			Multivariable		
	B	95% CI	*p* value	B	95% CI	*p* value
Sampling variables						
Site-Vancouver (ref = Ottawa)	-0.02	-0.28, 0.23	0.848	-0.66	-4.40, 3.08	0.727
Site-Trois-Rivières (ref = Ottawa)	-0.23	-0.84, 0.39	0.468	-1.29	-8.73, 6.14	0.732
Suburban (ref = urban)	0.21	-0.03, 0.45	0.087	0.17	-0.09, 0.43	0.193
Rural (re = urban)	0.33	-0.07, 0.73	0.110	0.38	-0.06, 0.83	0.090
School SES (low vs high)	-0.02	-0.24, 0.21	0.888	-0.20	-0.45, 0.04	0.104
School ID	0.00	-0.00, 0.00	0.820	0.01	-0.03, 0.04	0.755
Individual-level						
Age (yrs.)	**1.35**	**1.23, 1.46**	**<0.001**	-0.06	-0.18, 0.07	0.348
Bike ownership (yes)	0.16	-0.16, 0.48	0.332			
Phone ownership (yes)	0.05	-0.25, 0.34	0.759			
Child illness (yes)	-0.06	-0.68, 0.55	0.838			
Child perceived neighbourhood safety (very/ fairly safe vs not safe)	-0.02	-0.30, 0.26	0.890			
Independent mobility index	0.02	-0.07, 0.10	0.704			
AT volume (km/week)	0.01	-0.02, 0.05	0.404			
Family-level						
Parent age (<30 vs ≥45)	0.85	-0.02, 1.71	0.055			
Parent age (30-44 vs ≥45)	0.08	-0.15, 0.31	0.506			
Parent work (full time vs no)	0.05	-0.22, 0.32	0.706			
Parent-walks to work (yes)	**-0.28**	**-0.55, -0.00**	**0.047**			

Parent-bikes to work (yes)	-0.13	-0.69, 0.43	0.639			
Parent-drives to work (yes)	0.01	-0.22, 0.24	0.923			
Parent-takes public transit to work (yes)	-0.16	-0.44, 0.11	0.231			
Home ownership (yes vs no)	-0.00	-0.23, 0.23	0.999			
Car ownership (1 or more vs 0)	0.20	-0.26, 0.65	0.397			
High school or less (ref = university)	-0.33	-0.71, 0.06	0.101	**-0.53**	**-0.91, -0.16**	**0.005**
College (ref = university)	-0.08	-0.35, 0.20	0.573	-0.05	-0.36, 0.26	0.736
Social-environmental variables						
Parent worry about traffic (not very vs very/quite)	0.21	-0.04, 0.46	0.101			
Adults look out for children (neither disagree vs agree)	-0.15	-0.38, 0.08	0.197	**-0.24**	**-0.47, -0.01**	**0.037**
Some people make you afraid (neither/disagree vs agree)	**-0.54**	**-0.81, -0.27**	**<0.001**	**-0.36**	**-0.63, -0.09**	**0.010**
Physical-environmental variables						
Mean temperature (ºCelsius)	**0.02**	**0.00, 0.03**	**0.023**			
Mean precipitation (mm)	-0.01	-0.04, 0.02	0.628			

Note: AT- Active transportation, B- unstandardized regression coefficients, IM Index- Independent mobility index, School SES - School area-level socioeconomic status, .

There was no collinearity between variables included in the multivariable models. Apart from higher IM index and higher mean temperatures been the only significant associations with the higher outdoor time in boys, we found no difference in the significance, direction, and magnitude of interactions between imputed and complete case analyses.

DISCUSSION

This study aimed to explore the correlates of outdoor time in children from families speaking a non-official language at home in Canada. We used language spoken at home as a proxy measure for acculturation, assuming that families speaking non-official languages are less acculturated (13). In boys, higher IM index, and phone ownership were associated with more outdoor time. Interactions showed that IM index

was more strongly associated with younger boys' outdoor time. Boys whose parents were younger (<45 years) or biked to work accumulated more outdoor time. Boys from suburban versus urban areas spent less time outdoors. Higher morning temperature was associated with spending more time outdoors. In girls, lower parental education and parental perceptions of neighborhood safety and social cohesion were associated with less outdoor time.

Individual-level (boys): The finding that boys who reported higher IM index spent more time outdoors is intuitive and consistent with previous studies (32, 33). Our results show that with each unit increase in IM index outdoor time increased by ~ 42 minutes/day. An age-related decrease in the strength of association between IM index and outdoor time could suggest that older children increasingly engage in sedentary activities even when they are outside. The US National Kids Survey indicated that using media devices outside is one of the most common outdoor activities among children (34). We found that boys owning a mobile phone spent more time outdoors. A study done in UK in 2019 reported that parents thought that ownership of phones would keep children safe (35). These findings suggest that, although parents may provide a mobile phone to their child for safety reasons (e.g., in case of an emergency), children may spend more and more time playing on it as they get older.

At the family-level, we found that boys who had younger parents (<45 vs. ≥45 years) spent about 1 more hour/day outdoors. Previous studies have reported that parent encouragement plays a positive role in supporting children's outdoor time while lack of parent supervision plays a negative role (36, 37). Our finding may suggest that younger parents encourage and accompany children for outdoor activities to a greater extent than

older parents. Boys whose parents biked to work reported ~ 25 more minutes/day outdoor time. These parents may encourage outdoor time more (37) and/or engage in AT with their children, which may in turn increase children's outdoor time. It is also worth noting that only 20 (~ 9%) parents of boys biked to work in our sample.

At the built-environmental level, we found that boys from suburban areas spend ~8 minutes/day less outdoors than boys from urban areas. A previous analysis of the full study sample that included children from families speaking English or French at home and fewer variables in the model found no association between outdoor time and type of urbanization in boys (25). Our findings suggest that children from less acculturated families living in suburban areas may have fewer opportunities for culturally relevant outdoor activities than in urban areas. In a separate analysis, we found that participants speaking a non-official language at home spent less time outdoors compared to children speaking English or French at home (1.4 vs. 1.7 hours/day, $p<0.001$; data not shown). A national study reported that the amount of greenness was lower in areas where immigrants and people of visible minority live in Canada (14). Future interventions should address disparities in access to nature and, potentially other barriers to outdoor play among children from less acculturated families (38).

At the physical-environmental level, we found that a 10° Celsius increase in morning temperature is associated with an average 18 minutes/day increase in boys' outdoor time. For girls, in the bivariate model this association was significant, but it disappeared when controlling for other variables. Previous research has generally reported significant changes in PA with weather (39, 40). A 2011 study reported that changes in weather, weather-related policies for outdoor play and weather-related clothes

can be barriers for children's outdoor time (41). Advice on appropriate clothing for weather conditions and introducing weather appropriate outdoor activities could be a few options to minimize seasonal differences.

At the family-level, girls whose parents reported high school or less education spent ~30 less minutes/day outdoors compared to girls whose parents had university degrees. It is documented in previous literature that parents tend to spend more time with their children if they are better educated (42). Parents with higher education may be more knowledgeable about the benefits of spending more time outdoors and encourage or accompany their children for outdoor activities. Also, the parents with less education might have to work more with less flexible conditions and this could reduce their ability to accompany children outdoors.

At the social-environmental level, the two strongest predictors of girls' outdoor time were parent's perception about neighbourhood cohesion and safety. Girls spent ~ 15 min/day less outdoors if their parents thought that adults in the neighbourhood do not look after the children in the area. And they spent ~ 20min/day less outdoors when some people in the neighbourhood made parents afraid. Consistent with our results, many previous studies have identified "stranger danger" and parental concerns about neighbourhood safety as barriers to outdoor play and PA (43-46). However, we found that perceived safety and social cohesion were not associated with boys' outdoor time. Previous research suggests that parents are more protective towards their daughters than their sons (47), and such gender differences may be even greater in immigrants (38). These findings emphasize the importance of educating parents about the benefits of

spending more time outdoors and also to address their concerns about neighborhood and personal safety.

Limitations and strengths

Given the cross-sectional study design, we cannot establish causal relationships or temporality. We addressed the issue of missing data by using the multiple imputation method prior to analysis. The use of questionnaires for data collection can result in social desirability and recall bias. For example, participants could overreport their outdoor time and level of education. Recall bias was minimized by asking children to complete the AT questions each day. Healthy volunteer bias can occur if families who consent to participate are different from those who did not. For example, we observed that the majority of parents were highly educated. Another limitation is using only the language spoken at home as a proxy measure of acculturation. Future studies should consider using more than one measure of acculturation. Finally, given the number of potential correlates examined in our exploratory analyses, the risk of type 1 error is considerable.

The main strengths of this study are the recruitment of a stratified sample and the collection of data in 3 diverse regions of Canada, which increase the generalizability. We performed gender-stratified analyses, which extends previous literature that generally did not take gender into account. Another strength is collecting data on a large number of potential correlates of outdoor time that span multiple levels of the social-ecological model.

CONCLUSIONS

Correlates of outdoor time differ according to gender, suggesting that gender-sensitized interventions should be considered to increase children's outdoor time. Our findings suggest the importance of addressing parental concerns about neighborhood safety and cohesion, especially for girls. Because parents may overestimate the risks associated with outdoor activities (1), interventions may aim to raise awareness about the benefits of outdoor play and realign the balance between risks and benefits (48). Conversely, our results suggest that IM may be an important enabler of outdoor time, especially in boys. Overall, this study suggests that, to increase outdoor time in this subpopulation, multilevel interventions targeting individual, family and social environmental correlates may be needed.

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CHAPTER 4
DISCUSSION & CONCLUSIONS

Purpose

In this study we used language spoken at home as a proxy measure of acculturation, assuming that children from families speaking a non-official language at home are less accultured (1). Our first objective was to explore correlates of PA (MVPA and step/day) in Canadian school children from families speaking a non-official language at home. Following the recommendations provided by Atkin et al. (2) to advance the field of correlates of PA in children and youth, we used appropriate terminology, applied multilevel behavioral sciences theories and frameworks to capture the complex context and timing, of children's PA, and used rigorous analytical methods with mixed model multivariable regressions while controlling for confounding. We also stratified the correlates of PA by gender and tried to examine effect modifications where possible.

Our initial analysis identified outdoor time as the most consistent correlate of physical activity (PA) for both girls and boys from families speaking non-official languages at home. Thus, our second objective was to explore the individual, family, social and environmental correlates of outdoor time in Canadian children from families speaking a non-official language at home to help inform novel PA interventions for this population.

In the following sections, the correlates of PA and outdoor time are summarized and discussed by levels of influence. Table 4.1 provides a visual overview of the direction of associations between significant correlates and the three outcome variables (step counts, MVPA and outdoor time) by gender. The table clearly illustrates that many associations are gender-specific.

Table 4.1. Direction of associations between statistically significant correlates and the out come variables by gender.

Independent variables	Boys' steps	Boys' MVPA	Boys' outdoor time	Girls' steps	Girls' MVPA	Girls' outdoor time
Age (years)						
IM index (licenses)						
School SES (low vs. high)						
Suburban (ref=urban)						
Child illness (yes)						
Phone ownership (yes)						
Parent age (<45 vs.≥45)						
Parent bike to work (yes)						
Parent drives to work (yes)						
Mean temperature (°C)						
Parent education (highschool or less) ref = university						
Adults look out for children (neither disagree vs agree)						
Some people make you afraid (neither/disagree vs agree)						

Note: variables that were not associated with any of the 3 outcomes for any gender were excluded from the table. Significance was conducted at 0.05 alpha level.

	Negative association(the outcome variable decreases with increases in the exposure)
	Positive association(the outcome variable increases with increases in the exposure)
	No association

Gender differences

Consistent with previous studies we observed that boys were significantly more active than girls, (1, 3-5) and many associations in our study were gender specific (1,4,5) as illustrated by Table 4.1. Lane et al reported in their mixed-method study that new immigrants experienced difficulties when trying to involve their children in organized sports when they have limited English language skills and strong rules and traditions regarding gender (3). The same study identified other barriers to immigrant children's PA participation such as limited financial and transportation resources, unfamiliarity and lack of knowledge on recreational sports as a PA opportunity, safety concerns, adopting to weather, and children's preference for screen time. They observed that visible minority immigrants were more likely to report these challenges (3). According to a 2006 study, some females from specific cultural and traditional backgrounds avoid participating in sports as it is considered as challenging their cultural boundaries and not seen as respectable femininity (6). Another focus group interview with Arab American college students reported that parents try to regulate children's, and especially girls', activities to preserve Arab identity (7). Immigrant females from Middle East countries experience difficulties when participating in sports such as swimming because they are not allowed to wear short swimwear or to swim in public pools (7). A 2007 British study observed that that Asian and Black girls were less active than white girls (8). Similarly, Kirchengast et al stated that Turkish girls from families who immigrated to Australia are at higher risk of developing overweight and obesity conditions due to strong ethnic and religious rules regarding gender and PA (9).

In this context, girls from less acculturated families may be a particularly vulnerable group for low PA due to cultural and or religious barriers, underscoring a need for future research and gender-sensitized PA interventions in this population in Canada. It has been observed that strong family and peer support could reverse the negative effects of gender rules on PA (10).

Individual-level correlates of PA

For both genders, the most consistent correlate of PA was outdoor time. For boys, each additional hour/day spent outdoors was associated with an average of 10.3 more minutes of MVPA and 1,843 more steps per day. For girls, each additional hour/day spent outdoors was associated with an average of 3.6 more minutes of MVPA and 557 more steps per day. The effect size of 10.3 for boys is almost $1/6^{th}$ of the recommended daily MVPA for the age range, which is considerable. These findings are consistent with a systematic review in which all included studies found that children who spent more time outdoors were more physically active (11). The consistency of these findings emphasizes the need for increasing children's outdoor time as a strategy to increase PA regardless of children's gender and ethnicity. As recommended in the Position Statement on Active Outdoor Play (12) many stakeholders including parents, educators, urban planners, and policymakers should increase opportunities for children to be active outdoors. In a separate analysis, we found that outdoor time was significantly lower in this sample compared to children who spoke official language(s) at home (1.45 vs. 1.68 hours/day, p <0.001). Also, a systematic review reported that children from mothers of ethnic minorities spent less time outdoors compared to children from mothers of the ethnic majority (13). A Canadian study found lower access to greenspaces in areas where

immigrants and some groups designated as visible minorities reside (14). These findings underscore the importance of future studies on correlates of outdoor time in this population to help identify key correlates that should be addressed in future interventions.

With each additional year of age, MVPA decreased by 2.2 minutes for boys and by 5 minutes for girls. Interestingly, girls and boys demonstrated two different patterns of interaction between age and outdoor time. In boys, the association between PA and outdoor time became weaker with age while in girls the association got stronger with age. An age-related decrease in the strength of association between outdoor time and PA in boys could suggest that they increasingly engage in sedentary activities while outside. Previous research shows that media device ownership is associated with increased sedentary time (15) and the US National Kids Survey found that using media devices outside is one of the most common outdoor activities among children (16). The opposite pattern for girls may suggest that, with increasing age, more active children are more likely to spend time outdoors, suggesting a self-selection effect.

Even though higher IM index and AT volume are generally associated with increased PA in literature, (17-21) they were not associated with PA in our multivariable model for boys. It is worth noting that children in our subsample had lower IM index (boys: 1.66 vs 2.3, girls: 1.45 vs 2.1) and AT (km/week) (boys: 0.69 vs 2.8, girls: 0.29 vs. 2.5) compared to those who spoke English or French at home (1, 22). Qualitative studies with new immigrants in Canada and the United States found that while they used AT in their home country, they did not continue this habit in North America (3, 23) Thus, these studies suggest that immigrants accumulate a very small amount of PA by engaging in AT.

Furthermore, because both IM and AT usually occur outdoors, the inclusion of outdoor time in the model may have controlled for these variables. Surprisingly, IM was negatively associated with girls' MVPA, but not with steps/day. This finding needs to be interpreted with caution given that a systematic review found that IM was generally associated with more MVPA (19). Our IM questions assessed permission to do certain activities (e.g., travel to and from school alone, cross main roads alone, etc.), not how often children do them, which can introduce measurement error when examining associations with PA. These findings call for qualitative studies exploring the context in which IM and MVPA occur in this population.

Having an illness/disability was associated with an average of 18 less minutes of MVPA in boys, which represents 30% of the recommended amount of daily MVPA. This finding is consistent with a previous study by Larouche et al. (1). Only 2-4% of children had a long-term illness or disability, so this may have reduced our ability to detect a similar association in girls. A previous study reported that serious illness and physical disability in childhood and adolescents are negative predictors for high sports involvement in adult life (24). Another qualitative study reported that PA promotion is a normalizing experience for children and adolescents living with long-standing disabilities because it enables them to extend their social network with peers and thereby helps them to form a social identity (25). A 2021 mixed-method systematic review found that fostering social connections and support, and ensuring a suitable physical environment are vital to supporting PA in these children (26). Rimmer and Rowland reported in their study, that there is a lack of interventions for youth living with disabilities in community settings (27). They further stated that most of the previous studies were done in clinical

settings where they did not consider barriers these children face such as transportation, adaptation programs, and facilities they need and availability of knowledgeable staff, etc. (27). Some of the other barriers identified are fear, parental behavior, lack of knowledge and skills, negative attitude to disabilities, etc. (28).

In our study sample, there were a variety of conditions reported such as asthma, autism spectrum disorders, allergies, heart conditions, hearing loss, etc. (1). Thus, interventions to address the disparity in PA should not adopt a one-size-fits-all approach.

Individual-level correlates of outdoor time

In contrast with previous research (29-32), we did not observe an age-related decline in outdoor time in multivariable models. Increased use of entertainment devices (e.g., television, computer, phone) indoors is considered a key reason for this decline with age (12, 15). A 2017 cross-sectional study reported that the presence of bedroom electronic devices, parental rules regarding electronic use, and home and neighborhood-built environment (type of house, yard space, street type etc.) could significantly predict the sedentary behavior of children (33). Another cross-sectional study found that immigrant children spent more time using electronic screen media compared to non-immigrant children (34). A 2015 study observed that peer network characteristics such as time/location of interaction with friends and friends PA behavior play a major role in PA and sedentary/screen time in late childhood and early adolescence (35).

The finding that boys who reported higher IM index spent more time outdoors is intuitive and consistent with previous studies (29, 36). Each additional unit increase of IM index was associated with an average 43 minutes more outdoor time in boys. Given this high effect size, this might be an promising area for future research and PA interventions

in this subpopulation. An age-related decrease in the strength of association between IM index and outdoor time could suggest that older children increasingly engage in sedentary activities even when they are outside. As mentioned above, the US National Kids Survey found that using media devices outside is one of the most common outdoor activities among children (16). On average, boys owning mobile phones spent 14 more minutes outdoors. A study done in the UK in 2019 reported that parents thought that ownership of phones would keep children safe (37). Also as mentioned previously, a study done in England reported that media device ownership is associated with increased sedentary time (15). These findings suggest that, although parents may provide a mobile phone to their child for safety reasons (e.g., in case of an emergency), children may spend more and more time playing on it while outdoors.

Family-level correlates of PA

Girls whose parents drove to work accumulated 4.7 minutes more MVPA on average. This finding differs from Larouche et al, who found that boys whose parents drove to work accumulated less MVPA (1). Previous research also suggested that parents who drive to work may escort their children along the way, which can reduce their PA (38). Unfortunately, parents were not asked if they escorted their child to school. Although driving children to school on the way to work can reduce one source of PA, parents may also provide transportation to/from organized physical activity/sports. In our sample, these activities may have made a larger contribution to PA compared to AT. There is evidence that providing transportation to leisure activities can facilitate girls' PA. (39) Also, a qualitative study examining parents' decision-making process regarding

children's transport mode(s) to and from school reported, that some parents drove the children to and from schools to save time for sporting activities (40)

Family-level correlates of Outdoor time

We found that boys who had younger parents (<45 vs. ≥45 years) spent on average 60 more minutes outdoors. Previous studies have reported that parent encouragement plays a positive role in supporting children's outdoor time while lack of parent supervision plays a negative role (30, 41). Our finding may suggest that younger parents in our sample encourage and accompany children for outdoor activities to a greater extent than older parents. Boys whose parents biked to work reported 25 more minutes outdoors. These parents may encourage outdoor time more (41) and/or engage in AT with their children, which may, in turn, can increase children's outdoor time. It is also worth noting that only 20 (~ 9%) parents of boys biked to work in our sample. A previous study reported that children from carless households have higher IM (42) which in turn can increase outdoor time.

Girls whose parents reported high school or less education spent on average 32 less minutes outdoors compared to girls whose parents had university degrees. It is documented in previous literature that parents tend to spend more time with their children if they are better educated (43). Parents with higher education may be more knowledgeable about the benefits of spending more time outdoors and encourage or accompany their children for outdoor activities. A qualitative study done with recent immigrants to Saskatchewan, Canada reported that among female participants, the only predictor of PA was parent's education level (3). Crompton and colleagues stated that higher education can expand the perspectives of individuals towards more equal gender

roles and thereby increasing girls' participation in PA (44). Also, the Canadian Fitness and Lifestyle Research institute observed that the majority of Canadian children participating in organized sports are from families where parents have a higher level of education and income (45). Another aspect could be that the parents with less education might have to work more with less flexible conditions and this could reduce their ability to support their children's PA through encouragement, transportation, and accompaniment.

Social-environmental level correlates of PA

Boys attending schools with lower area-level SES accumulated an average of 17.8 less minutes of MVPA and 2752 less step/day. This corresponds to 30% of the daily MVPA recommendation, highlighting the importance of PA interventions catering specifically to children attending schools located in lower SES areas. A study done in Germany found that compared to German-born children and children from high SES families, immigrant school children from lower SES families were less physically active (46). Also, two studies conducted in Australia have reported similar findings (47, 48). Children from less acculturated families may have access to less culturally relevant opportunities for PA when living in low-SES areas. In girls, the association between area-level SES and PA was in the same direction, but not statistically significant. Nobari and colleagues (49) examined the association between children's body mass index (BMI) and the percentage of neighbors speaking the same language. They found that when a greater proportion of neighbors spoke their mother's language 2–5-year-old children from low-income families had lower BMI z-scores. This suggests that social networks and support

received from the neighbors who speak the same language might facilitate engagement in energy-balance related behaviours, including PA.

Our findings emphasize the need for interventions to increase opportunities for PA among children in schools located in low-SES neighborhoods. Schools may play a particularly important role in providing accessible PA opportunities for young children from newcomer families (3). We also observed that the difference in PA between children attending low- versus high-SES schools was lower in boys who spent more time outdoors. From a public health perspective, this finding suggests that outdoor time may help reduce the impact of SES inequalities on children's PA and warrants future research.

Social-environmental level correlates of outdoor time

At the social-environmental level, the two strongest predictors of girls' outdoor time were parents' perceptions about neighborhood cohesion and safety. Girls spent 14 minutes less outsideif their parents thought that adults in the neighborhood do not look after the children in the area, and 21 minutes less if some people in the neighborhood made them afraid. Consistent with our results, many previous studies have identified "stranger danger" and parental concerns about neighborhood safety as barriers to outdoor play and PA (50-53). According to the 2015 ParticipACTION Report Card on PA for children and youth, parents tend to keep their children indoors to keep them safe (54). Lee et al reported that parents are concerned about their children's safety, bullies, and traffic while outside (50). But in keeping them indoors, they may overlook the benefits of outdoor play and underestimate the risks associated with screen time and inadequate PA. However, we found that perceived safety and social cohesion were not associated with boys' outdoor time. Previous research suggests that parents are more protective towards

their daughters than sons, (55) and such gender differences may be even greater in immigrants (3). These findings emphasize the importance of educating parents about the benefits of spending more time outdoors and also addressing their concerns about the neighborhood and personal safety.

Built-environmental level correlates of outdoor time

We found that boys from suburban areas spent 8 minutes less outdoors than boys from urban areas. A previous analysis of the full study sample that included children from families speaking English or French at home and fewer variables in the model found no association between outdoor time and type of urbanization in boys (56). Our finding suggests that children from families speaking a non-official language at home who reside in suburban areas may have less opportunities for culturally relevant outdoor activities than in urban areas. Also, a national study reported that the amount of greenness was lower in areas where immigrants and people of visible minorities live in Canada (14).

Physical-environmental level correlates of outdoor time

We found that a 10° Celsius increase in morning temperature is associated with an average 18 minutes/day increase in boys' outdoor time. For girls, in the bivariate model, this association was significant, but it disappeared when controlling for other variables. Previous research has generally reported significant changes in PA with the weather (57, 58). A 2011 study reported that changes in weather, weather-related policies for outdoor play, and weather-related clothes can be barriers for children's outdoor time (59).

Limitations and strengths

One should interpret the results with caution given the exploratory nature of our study which cannot establish causal relationships or temporality. Thus, results should be replicated and further explored using longitudinal designs. Also, since our sample size was just over the sufficient number from the sample size calculation, power could be insufficient to detect associations between some potential correlates and measures of PA and outdoor time particularly when we further stratify the data. There was a large amount of missing data, which we addressed by using multiple imputations. Social desirability and recall bias can occur when using questionnaires to collect data. For example, participants could overreport their outdoor time and level of education. Efforts were taken to minimize recall bias by asking children to complete the AT questions each day. To reduce the bias occurring from measurement reactivity, sealed pedometers were used and the first day of measurement was not included in the analysis. Underestimation of some activities (swimming, cycling) by using pedometers is another limitation. Thus, we used surveys concurrently to gain insight into the context in which PA occurred.

Healthy volunteer bias can occur if families who consent to participate are different from those who did not. For example, we observed that the majority of parents were highly educated. To reduce the risk that families did not participate due to insufficient knowledge of English or French, researchers at the Vancouver site offered translations of the parent and child surveys in Mandarin and Punjabi (22). Another limitation is using only the language spoken at home as a proxy measure of acculturation. Future studies should consider using more than one measure of acculturation. We used weather data from the Environment Canada website and we collected data throughout the

school year to minimize the bias due to seasonal variations in PA and outdoor time. Finally, the use of multiple comparisons increases the risk of type 1 error, so our exploratory findings should be interpreted cautiously.

The recruitment of a stratified sample and the collection of data in 3 diverse regions of Canada is a strength of this study as it increases the generalizability. Using surveys along with pedometers can provide insight into the context in which PA occurs. We performed gender-stratified analyses, which extends previous literature that generally did not take gender differences in correlates of PA and outdoor time into account. Another strength is collecting data on a large number of potential correlates that span multiple levels of the social-ecological model.

Recommendations for future research, practice, and policy

Future research: We used only the language spoken at home as a proxy measure of acculturation. Since acculturation involves a complex change in behavioral and psychosocial processes, future studies should consider using more than one measure of acculturation to comprehensively grasp the context of acculturation. Our study had 478 participants which deemed sufficient for the analytical purpose based on sample size calculation (427 needed). Nevertheless, power could be insufficient to detect associations between some of the correlates that we investigated with PA and outdoor time. So, studies with larger sample sizes may be needed. Also, we suggest conducting longitudinal studies to establish temporality, which could provide stronger evidence for future interventions. Finally, some of our findings are difficult to explain without understanding the context in

which the behavior occurs. For example, we found that girls who had a higher IM index were less physically active and this finding is inconsistent with previous evidence (19). Without information about the context in which IM occurs in this population, it is difficult to interpret this finding. Qualitative studies could be conducted to explore the context of IM and PA in children from less acculturated families.

Practice and Policy: Since our study was exploratory in nature results should be interpreted with caution. Nevertheless, most of our findings are comparable with studies conducted with other minority populations in different countries. Future interventions aimed at educating parents and families on the benefits of PA and outdoor time, consequences of inadequate PA, should target all parents, regardless of their child's gender in this population. However, consistent with previous literature, we found that girls were less active and spend less time outdoors than boys, and the correlates of PA and outdoor time differed by gender (3-5). So, it is also important to focus on parents of girls to encourage them to support girls' involvement in sports while addressing cultural and religious barriers.

Outdoor time was the most consistent correlate of PA for both girls and boys in our study. Stakeholders including parents, educators, urban planners, and policymakers should increase opportunities for children to be active outdoors. Our findings emphasize that apart from educating parents about the benefits of spending more time outdoors, future interventions should also address their concerns about neighborhood cohesion and safety. Because parents may overestimate the risks associated with outdoor activities (12), interventions may aim to realign the balance between risks and benefits as well (60). Future interventions should address socio-demographic disparities in access to nature (14)

and other barriers (recreational PA being an unfamiliar concept, gender restrictions, financial resources, and safety concerns) to PA and outdoor play among children from families speaking non-official languages at home (3).

A previous study has reported that friends play a major role in PA and outdoor time in older children and adolescents (35). In this context, interventions aiming to increase the positive influence of active peers may be an area to explore to increase outdoor time and PA and potentially reduce the age-related decline in PA.

The finding that children with different types of disabilities/illnesses accumulate lesser PA is consistent with previous studies (1, 24). Our results highlight the importance of involving decision-makers and parents to ensure that children with long-standing disabilities/illnesses have sufficient opportunities to engage in disease-appropriate PA while addressing the barriers they face.

Our findings highlight the need for interventions to increase opportunities for PA among children attending schools located in low-SES neighborhoods. Schools may play a particularly important role in providing accessible PA opportunities for young children from newcomer families (3). Alberta Project Promoting active Living and healthy Eating (APPLE) Schools is one such effective school based comprehensive health intervention program in low SES areas (61).

Finally, advice on dressing up for cold conditions and introducing weather-appropriate outdoor activities with proper clothing could be a few options to minimize seasonal differences.

Conclusions

Outdoor time was the most consistent correlate of physical activity in a sample of children who spoke neither of Canada's official languages at home, emphasizing the need for interventions to increase children's outdoor time. Gender-sensitized interventions may also be recommended given the observed gender differences in correlates of PA and outdoor time as evident by Table 4.1. Results also highlight the need for addressing disparities in PA based on disability/illness status and area-level SES. Our findings suggest the importance of addressing parental concerns about neighborhood safety and cohesion, especially for girls. Conversely, our results suggest that IM may be an important enabler of outdoor time, especially in boys. Overall, this study suggests that to increase PA participation and outdoor time in this subpopulation, multilevel interventions targeting individual, family, social and environmental correlates may be needed.

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APPENDICES

Appendix 1- Children's Mobility and Physical Activity Study – informed consent

Appendix 2- Children's Mobility and Physical Activity Study – Child Assent Form

Appendix 3- Children Mobility Questionnaire

Appendix 4- Parent Questionnaire on Children's Mobility

APPENDIX 1 - Children's Mobility and Physical Activity Study – Informed Consent

Investigators:

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Background and rationale:

We are inviting about 1080 children in grades 4 through 6 to participate in a voluntary research study and your child is invited to participate. The purpose of the study is to learn more about children's mobility and how it relates to how active they are. "Children's mobility" means how children travel to and from places such as school, parks, shops, sports fields, and friends and family members' houses. We will invite children in 3 regions across Canada: Ottawa (Ontario), Trois-Rivières (Québec), and Vancouver (British Columbia). Within each region, children from urban, suburban, and rural areas can participate in the study.

Why is this work important?

We know that only 5% of Canadian children and youth aged 6-19 years are active enough. Increasing children's physical activity may help prevent diseases such as diabetes, heart disease, and some types of cancer later in life. Children who walk or bike to school are generally more active than those who get there by car or bus. However, the majority of Canadian children are now driven to and from school. In addition, little is known about children's mobility to and from other places. This may represent an overlooked way for children to be active without the need for expensive equipment. Walking and cycling to and from places may also be good for children's mental health and for the environment. Thus, we aim to provide a detailed picture of children's mobility in 3 diverse regions of Canada. Funding for this study is provided by the Heart and Stroke Foundation of Canada.

Study procedures:

This study includes different tasks as detailed below.

1. **Physical activity**: we will measure how active your child is with a pedometer. This small device is worn clipped to a belt or pant waistband. We will ask your child to wear it for 8 consecutive days. The pedometer should be worn for all activities except while sleeping or participating in activities that involve water (i.e. swimming or bathing). It does not measure where your child is or what your child is doing. While wearing the pedometer, your child should be as active as he/she normally is. In other words, we are not asking your child to be more active than usual.
2. **Child survey**: We will ask your child to complete a survey which should take about 15 minutes to complete. In the survey, your child will be asked a series of questions on:
    1. How he/she traveled to and from school and other places during the week in which he/she wore the pedometer.
    2. His/her level of agreement with the presence of different barriers to walking or biking (e.g., sidewalks, road safety issues, etc.).
    3. How he/she feels they are allowed to use different travel modes (e.g., walking, biking, and public transit) when traveling to and from different places.
3. **Parent survey**: We will ask you to complete a survey about your child's mobility which should take about 15 minutes to complete. While the parent survey covers similar themes as the child survey, we want to know your perspective on these topics. The parent survey also contains questions about:
    1. How you traveled to and from school as a child
    2. Your household in general.
4. **Mapping exercise**: We will give you a map of the area in which you live. The map will indicate the location of your child's school. We will ask you and your child to draw on this map the route that your child usually takes to get to and from school. We will use this information to calculate the distance between your home and your child's school. The mapping exercise should take you about 5minutes to complete.

Please note that if your child participates in this study, he/she may miss class for a brief period (about 10 minutes) while he/she will be given the pedometer, the surveys, and the map. Data collection will be scheduled at the teachers' (or school principal's) convenience to minimize interference with class routines.

Risk and benefits:

Your child's participation in this study does not pose any risk that differs from those normally encountered in daily life. We do not require that your child walk or bike to and from school in order to participate in the study. The pedometer should not be left unattended in the presence of young children (i.e. under 3 years old) and it should not be worn for

activities that involve water (i.e. swimming and bathing). A potential discomfort may include you feeling uncomfortable with some of the questions being asked. If you feel uncomfortable, you may choose not to answer a question.

The physical activity associated with walking or biking to and from school has been shown to be good for health. This study aims to improve our understanding of the factors associated with children's mobility. This will help guide future efforts to make it easier for children to walk or bike to and from different places. The Healthy Active Living and Obesity Research Group will provide a donation to your child's school for their cooperation.

Confidentiality:

Your personal information will be kept strictly confidential except as required or permitted by law. For this study, we will be collecting gender, age, and postal code for the research purposes described in this consent form. Representatives from the CHEO Research Ethics Board may look at your records at the site where these records are held, to check that the study is following the proper laws and guidelines. The customized maps will be produced by representatives from the Department of Geography at the University of Ottawa. To produce the maps, they will need to know your home address. However, they will not have access to any other personal information.

Data conservation:

The surveys and maps and other data from this study will be stored in a locked file cabinet in a locked office at the CHEO Research Institute. Electronic data will be stored in a private folder on a secure computer at CHEO. Only members of the research team and the individuals described above will have access to the data. Following completion of the research study, the data will be kept for 7 years after the last publication of this study. They will then be destroyed.

You will not be identified in any publication or presentation of this study. A copy of the signed consent form will be provided to you. You can also receive a copy of the study results at the end of the study.

Questions about the study:

If you have questions about this study, please contact Dr. Richard Larouche at 613-737-7600, ext. 4191. More information about the Healthy Active Living and Obesity Research Group (HALO) can be found at: http://www.haloresearch.ca/. This study has been reviewed and approved by the CHEO Research Ethics Board, as well as by the Upper Canada District School Board. The CHEO Research Ethics Board is a committee of the hospital that includes individuals from different professional backgrounds. The Board reviews all human research that takes place at the hospital. Its goal is to ensure the protection of the rights and welfare of people participating in research. The Board's work is not intended to replace a parent or child's judgment about what decisions and choices are best for them. You may contact the Chair of the Research Ethics Board for information regarding patient's rights in research studies at (613) 737-7600 (ext. 3272), although this person cannot provide

any specific, detailed, or health-related information about the study itself. The Board could review your child's study records in fulfilling its roles and responsibilities.

Children's Mobility and Physical Activity Study – informed consent

I, ...,

(Your Name)

the parent/guardian of .....:

(Your Child's Name)

☐ **Give consent** to my child's participation in the study.

☐ **Consent** to complete the parent survey.

I have read and understood the attached information sheet / had the attached information sheet verbally explained to me. I have been fully informed of the details of the study. I have had the opportunity to discuss my concerns. I understand that I am free to withdraw my child at any time or not answer questions that make us uncomfortable. I have received a copy of the information sheet and consent form.

Please indicate your street address on the line below. This will allow us to provide you with a customized map of your neighborhood. This information will be kept strictly confidential.

Address: _____

_____

Name of child

_____

Name of Parent/Guardian

_____ _____

Signature of Parent/Guardian Date

_____ _____ _____

Name of Researcher Signature of Researcher Date

APPENDIX 2 - Children's Mobility and Physical Activity Study – Child Assent Form

You are invited to take part in a research study. The goal of this study is to help us to understand better how kids like you travel to and from places like schools, parks, and shops.

The study will involve the following measures.

1. **Physical activity**: We will ask you to wear a pedometer, which is a small square device worn on your belt or on your pant waistband, for 8 days. The pedometer cannot tell us where you are or what you are doing. It only counts the number of steps you are taking. You should wear the pedometer throughout the day, except when swimming or bathing. While wearing the pedometer, you should be as active as you normally are. In other words, we are not asking you to be me more active than usual.
2. **Questionnaire**: We will ask you to fill a questionnaire which should take you about 15 minutes to complete. It contains questions on the following topics:
    1. How you travel to and from school and other places.
    2. Your opinion on things that may make walking and biking difficult for you
    3. How free you are to go to different places by walking, biking, or riding the bus.
3. **Mapping exercise**: We will provide you a map of the area where you live. With help from your parent or guardian, we will ask you to draw the route that you take to get to and from school on this map. Drawing the route should take you about 5-10 minutes.

To participate in the study, you need to sign this form, and your parents need to complete the consent form. If you choose to join the study, there may be no direct benefits to you. You don't have to participate if you don't want to. The information we get from you won't be shared with anyone except you and your parents. You can decide to stop the study at any time. All of your written information will be stored safely, and your personal information will stay private.

Children's Mobility and Physical Activity Study – Child Assent Form

I ..... consent to participate in the above study.

(your name)

I have read and understood the attached information sheet or had the attached information sheet verbally explained to me. I have been fully informed of the details of the study and have had the chance to ask questions to further understand what I have to do. I understand that I am free to withdraw from the study at any time, or not answer questions that make me feel uncomfortable. I have received a copy of the information sheet and consent form.

_____

Name of Participant

_____ _____

Signature of Participant Date

_____

Name of Person Obtaining Consent

_____ _____

Signature of Person Obtaining Consent Date

APPENDIX 3 - Children's Mobility Questionnaire

Children Mobility Questionnaire

Please answer the questions as best you can.
There are no right or wrong answers.

1) You are a: □ girl □ boy

2) a) How old are you? _____ years
b) What grade are you in? □ 4th- grade □ 5th- grade □ 6th grade

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YOUR TRAVELLING JOURNAL

3) Please draw an X in the table below to indicate <u>how you traveled to school</u> on each day of the week. (If you missed school, please don't put an X)

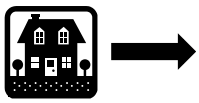

	Monday	Tuesday	Wednesday	Thursday	Friday
Walk					
Bike					
Skateboard					
Rollerblade					
Car					
Bus					
Other: _____					

4) Please draw an X in the table below to indicate <u>how you traveled back home</u> on each day of the week. (If you missed school, please don't put an X)


	Monday	Tuesday	Wednesday	Thursday	Friday
Walk					
Bike					
Skateboard					
Rollerblade					
Car					

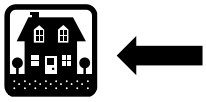
Bus					
Other: _____					

5) How many times did you go <u>from home to the following places</u> using active modes of travel (such as walking, running, biking)?
Please respond for each day of the week.



Places	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
School							
Friend's home							
Relative's home							
Parks or playgrounds							
Shops, markets, or restaurants							
Sports venues (e.g., soccer field, swimming pool)							
Faith places (e.g., church, mosque)							
Other: _____							

6) How many times did you go <u>to home from the following places</u> using active modes of travel (such as walking, running, biking)?
Please respond for each day of the week**.**



Places	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
School							
Friend's home							
Relative's home							
Parks or playgrounds							

Shops, markets, or restaurants							
Sports venues (e.g., soccer field, swimming pool)							
Faith places (e.g., church, mosque)							
Other: _____							

7) For each day of the week, please write "yes" if you have worn the activity monitor (pedometer) for most of the day or "no" if you did not.

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Did you wear the pedometer for most of the day?							

QUESTIONNAIRE

8) Are you allowed to walk or bike to school on your own?

□ Yes □ No

9) How long does it <u>usually</u> take you to travel to school? (Only tick <u>one box</u>)

□ Less than 5 minutes □ 5 to 15 minutes □16 to 30 minutes

□ 31 to 45 minutes □ 46 minutes or more

10) Are you allowed to walk or bike to go back home after school on your own?

□ Yes □ No

11) How would you like to be able to travel to and from school? (Only tick <u>one box</u>)

□ Walk most or all the way
□ Cycle
□ School bus
□ Local bus or train or underground
□ Car
□ Other, please write in: _____

12) How many times a week do you usually go home for lunch during school days?

□ 0 time (Please go to Question 14) □ 1 time □ 2 times

□ 3 times □ 4 times □ 5 times

13) How do you usually go home for lunch? (Please tick only one box)

□ I walk □ I bike □ I run
□ By car or van □ By bus or train □ By motorcycle
□ By another way. Please write it down: _____
□ I do not go home for lunch

WALKING

14) a) Are you allowed to cross main roads on your own?

□ YES (Please go to Question **14c**)
□ NO

b) If you are not allowed to cross main roads on your own, would you like to be allowed to?

□ YES □ NO

c) How old were you when you first crossed main roads on your own?
(Please estimate if you are not sure)

☐ Age
□ Not allowed to crossroads on my own

d) When going to places other than school that are within walking distance, are you allowed to go on your own?

□ I usually go on my own □ I am usually taken □ Varies

CYCLING

15) a) Do you have a bicycle?

□ YES □ NO (Please go to Question **16**)

b) Are you allowed to cycle on main roads on your own?

□ YES; At what age were you first allowed? _____ years
□ NO
□ Don't have a bicycle

c) If you have a bicycle, are you allowed to ride it to go to places (like the park or friend's houses) on your own?

□ YES □ NO □ Don't have a bicycle

d) **How many times do you cycle in a typical week (both <u>with and without parents</u>) including the weekend?** (Please answer for the current season)

□ Less than once a week □ One or two days a week

□ Three or more days a week □ Don't have a bicycle

BUSES

16) Are you allowed to go on local buses on your own (other than a school bus)?

□ YES □ NO

AFTER DARK

17) Are you usually allowed to go out on your own after dark?

□ YES □ NO

ON THE WEEKEND

18) Which of these activities did you do this weekend?

Tick the 1st column if you did these things <u>on your own or with another young person</u>.
Tick the 2nd column if you did them <u>with a parent or other adult</u>.

		On your own or with another young person	With a parent or other adult
	Visited a friend's home		
	Visited relatives or grown-ups		
	Went to a youth club (including Scouts, Guides, Cadets, Sunday school, etc.)		
	Went to the shops		
	Went to a library		
	Went to a cinema		
	Spent time with friends outside after dark		
	Went to a playground, park or playing fields		
	Played sport or went swimming (individual or team sports or lessons)		
	Went for a walk or cycled around		
	Went to a concert or nightclub		
	Visited a place of worship		
	Other *(please write in):*		

WHERE YOU LIVE

19) a) How safe do you feel <u>on your own</u> in your local neighborhood? (Only tick <u>one box</u>)

□ Very safe □ Fairly safe □ Not very safe
□ Not at all safe □ Not allowed out on my own

b) When you are outside <u>on your own or with friends</u> are you worried by any of the following?

	Yes	No	Don't know
Traffic			
Getting lost			
Bullying			
Strangers			
Do not feel that I am old enough to go about on my own			
Not knowing what to do if someone speaks to me			

c) Is there anything else you are worried about when you are outside <u>on your own or with friends</u>?

Please write in:……..

20) How far from home are you allowed to roam on your own? (Only tick <u>one box</u>)

□ I am not allowed out on my own
□ Within my street
□ Within 2-3 streets away from home
□ Within a 15 minute walk from home
□ More than a 15-minute walk from home

21) How far from home are you allowed to roam on your own with friends? (Only tick <u>one box</u>)

□ I am not allowed out on my own with friends
□ Within my street
□ Within 2-3 streets away from home
□ Within a 15 minute walk from home
□ More than a 15-minute walk from home

22) Please indicate your level of agreement with the statements written in the first column of the table. Please check (√) one number only.

STATEMENTS It is **difficult** for me to walk or bike to school because…	1 Strongly disagree	2 Somewhat disagree	3 Somewhat agree	4 Strongly agree
• there are too many hills along the way				
• there are no sidewalks or bike lanes				
• the route is boring				
• the route does not have good lighting				
• there is too much traffic *along the route*				
• there is too much traffic *around our home*				
• there is too much traffic *around the school*				
• there is one or more dangerous crossing				
• I get too hot and sweaty				
• no other children walk or bike to school				
• it's not considered cool to walk or bike				
• I have too much stuff to carry				
• it is easier for my parents to drive me on the way to something else				
• it involves too much planning ahead				
• it is unsafe because of crime (strangers, gangs, drugs)				
• I get bullied, teased, harassed				
• there is nowhere to leave a bike safely				
• there are stray dogs				
• it is too far				

Data Entry Staff Initials: _____ Date: _____ /_____

APPENDIX 4. Parent Questionnaire on Children's Mobility

The following questions are about your child:

- This questionnaire should take about 15 minutes to complete.
- Please only answer in relation to the child who gave you this form – do not answer about any other children in your household.
- Please answer the questions as accurately as possible to the best of your knowledge.
- Your answers will be made anonymous and will be kept confidential.

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1. Is your child allowed to walk or bike home from school on their own?

□ Yes – When did you first allow your child to walk or bike home from school on their own?

[ ] years old

□ No – At what age will you be likely to allow your child to walk or bike home from school on their own?

[ ] years old

2. How many days a week is your child typically collected from school by an adult?

(Please insert number)

[ ] times each week

3. What are your *main* reasons for picking your child up from school (even if you no longer do)?

(Please tick no more than three boxes)

□	**1.** Opportunity to spend time with my child	□	**6.** Fear of bullying by other children
□	**2.** Opportunity for exercise or to get out of the house	□	**7.** Opportunity to meet people (teachers, other parents, etc.)
□	**3.** Concern about traffic danger	□	**8.** On the way to an activity for you or the child (e.g. shopping, visiting a relative, after school club, etc.)
□	**4.** Child unreliable or too young	□	**9.** School too far away
□	**5.** Danger from adults	□	**10.** Other, please write in:

4. How long would it typically take <u>you</u> to get to your child's school?

(Insert a time however large or small, or tick "Don't know / Not applicable")

On foot	*minutes*	or □ Don't know / Not applicable
By car	*minutes*	or □ Don't know / Not applicable
Public transport	*minutes*	or □ Don't know / Not applicable

5. Is the school the nearest one your child can attend?

□ YES *(Please go to Question 7)*

□ NO

6. What is the main reason for your child attending this school?

(Tick as many as you need)

□	1. No places available at the nearest school
□	2. Did not want to send the child to a local school or preferred a specific school elsewhere
□	3. Wanted a specific type of school (faith school, private, performing arts, etc.)
□	4. Moved home after the child started at school
□	5. Travel is easier
□	6. Other, *please write in:*

7. Please draw an **<u>X</u>** in the table below to indicate how your child traveled **<u>to school</u> on each day** of the week when wearing the pedometer. (*If your child missed school, please don't put an X*)

	Walk	Bike	Skateboard	Roller-blade	Car	Bus	Other
Monday							
Tuesday							
Wednesday							
Thursday							
Friday							

8. Please draw an **X** in the table below to indicate how your child traveled **back home on each day** of the week when wearing the pedometer. (*If your child missed school, please don't put an X*)

	Walk	Bike	Skateboard	Roller-blade	Car	Bus	Other
Monday							
Tuesday							
Wednesday							
Thursday							
Friday							

9. Does your child go home for lunch during school days?
□ Yes □ No *(Please go to Question 12)*

10. How many times during the week?
□ 0 time *(Please go to Question 12)* □ 1 time □ 2 times
□ 3 times □ 4 times □ 5 times or more

11. How does your child usually go home for lunch? Please tick only one box.
□ He/she walks □ He/she bike s □ He/she runs
□ By car or van □ By bus or train □ By motorcycle
□ By another way. Please write it down: _____
□ He/she does not go home for lunch

12. When going to places other than school that are *within walking distance*, is your child taken there or allowed to go on their own?
□ Usually goes on their own
□ Usually taken
□ Varies

13. What is the approximate number of round trips made *each week* to accompany your child, *excluding the journey to school?*
(For example, traveling to the swimming pool and then home again would count as one round trip)

☐ Round trips each week

14. What is the method of travel most frequently used on these trips?
(Tick as many as you need)

□ Walk most or all the way 

□ Cycle

□ Local bus or train or underground

□ Car

□ Other methods, *please write in*:
……

15. When wearing the pedometer, how many times did your child go **from home to the following destinations** using active modes of travel (for example, walking, running, biking)? Please respond for each day of the week.

Destination	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
School							
Friend's home							
Relative's home							
Parks or playgrounds							
Shops or markets, or restaurants							
Sports venues (e.g., soccer field, swimming pool)							
Faith places (e.g., church, mosque)							
Other							

** If you have written "other", please specify which destination it is:

_____

16. When wearing the pedometer, how many times did your child go **to home from the following destinations** using active modes of travel (for example, walking, running, biking)? Please respond for each day of the week.

Destinations	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
School							
Friend's home							
Relative's home							
Parks or playgrounds							
Shops or markets, or restaurants							
Sports venues (e.g., soccer field, swimming pool)							
Faith places (e.g., church, mosque)							
Other							

** If you have written "other", please specify which destination it is:

_____

17. Please indicate your level of agreement with the statements written in the table below.

Please CHECK (√) ONE number only.

Statements (It is difficult for my child to walk or bike to school because…)	1 Strongly disagree	2 Somewhat disagree	3 Somewhat agree	4 Strongly agree

There are too many hills along the way				
There are no sidewalks or bike lanes				
The route is boring				
The route does not have good lighting				
There is too much traffic *along the route*				
There is too much traffic *around our home*				
There is too much traffic *around the school*				
There is one or more dangerous crossing				
My child gets too hot and sweaty				
No other children walk or bike to school				
It's not considered cool to walk or bike				
My child has too much stuff to carry				
It is easier for me to drive my child here on the way to something else				
It involves too much planning ahead				
It is unsafe because of crime (strangers, gangs, drugs)				
My child gets bullied, teased, harassed				
There is nowhere to leave a bike safely				

There are stray dogs				
It is too far				

18. Is your child allowed to cross main roads on their own?

***Please note**: This question is included for all parents of children aged between 7 and 15 years old. Please answer even if the answer seems obvious.*

□ YES At what age was your child first allowed to do so?

☐ years old

□ NO At what age do you think you will allow your child to do so?

☐ years old

19. Is your child usually allowed to go out *on their own* after dark?

□ YES *(Please go to Question* 21)

□ NO

20. If NO, what is the main reason your child is not allowed to go out *on their own* after dark?

Please write in:……

……..

21. Is your child allowed to cycle on main roads on their own?

□ Does not own a bicycle

□ YES - At what age was your child first allowed to cycle on main roads on their own?

☐ years old

□ NO - At what age do you think you will allow your child to cycle on main roads on their own?

☐ years old

22. Is your child usually allowed to travel on local buses on their own (other than a school bus)?

□ YES At what age was your child first allowed to travel on buses

on their own?

☐ years old

□ NO At what age do you think you will allow your child to travel on buses on their own?

☐ years old

23. Does your child have a mobile phone?

□ YES

□ NO (*Please go to Question **25***)

24. If YES, does this give you more confidence about letting your child go out on their own?

□ YES

□ NO

□ The child does not go out on their own

25. How worried are you about the risk of your child being injured in a traffic accident when crossing a road?

□ Very

□ Quite

□ Not very

□ Not at all

□ Don't know / not sure

26. How far from home is your child allowed to roam on their own? *(Only tick <u>one box</u>)*

□ He/she is not allowed out on their own

□ Within my street

□ Within 2-3 streets away from home

□ Within a 15 minute walk from home

□ More than a 15-minute walk from home

27. How far from home is your child allowed to roam on their own with friends (unaccompanied by an adult)? *(Only tick <u>one box</u>)*

□ He/she is not allowed out on their own with friends

□ Within my street

□ Within 2-3 streets away from home

□ Within a 15 minute walk from home

□ More than a 15-minute walk from home

28. On a typical **<u>weekday</u>**, how much time does your child spend playing outdoors at the moment (choose <u>only one</u> answer):

□ None at all

□ Less than 1 hour

□ 1 to 2 hours

□ 2 to 3 hours

□ More than 3 hours

29. On a typical **<u>weekend day</u>**, how much time does your child spend playing outdoors at the moment (choose <u>only one</u> answer):

□ None at all

□ Less than 1 hour

□ 1 to 2 hours

□ 2 to 3 hours

□ More than 3 hours

30. Does your child have a long-standing illness, disability, or infirmity?

□ YES - *Please give brief details (optional)*……

□ NO

The following questions are about you:

31. When you were a child aged 10 to 12, how did you usually travel to school?

(Only tick one box)

□  Walked most or all the way

□  Cycled

□  School bus

□  Local bus or train or underground

□  Car

□ Other. *Please write in:* ……

32. At about what age were you allowed to get about on your own?

☐ years old

33. Was **your** primary school closer or further away from your home than your child's primary school?

Much closer	Closer	About the same	Further	Much further
□	□	□	□	□

34. How do **you** usually travel to and from work? (*Tick as many as you need*)

□ I walk

□ I bike

□ I use public transit (i.e., bus, train)

□ I drive (i.e., car, van, motorcycle)

□ By another way. Please write it down: _____

□ I work at home (or don't work)

35. To what extent do you agree or disagree with the following two statements?

Tick the box which best matches your opinion.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Most adults who live in the neighborhood lookout for other people's children in the area	□	□	□	□	□
Some young people and adults in the area make you afraid to let your children play outdoors	□	□	□	□	□

36. Does your household have regular use of a car (including car share)?

□ No □ Yes, 1 car □ Yes, 2 or more cars

37. How many adults in your household, *including yourself*, have a full driving license?

	Number

38. How many people live in your home, *including yourself?*

	Children aged 10 years or less
	Children aged 11 to 15 years
	Everyone else aged 16 or more
	TOTAL

39. Does your family own your home or is it rented?

□ Own home (with or without mortgage)

□ Rented home from Council or Housing Association

□ Private rented

□ Live in a relative's home

□ Temporary accommodation

□ Other ……..

40. Do you have access to outside space(s) where your children can play?

(Please tick all the relevant boxes)

□	1. Garden
□	2. Park which you can reach without crossing a main road
□	3. Park you reach by crossing a main road
□	4. Quiet residential road

□	5. Shared communal space
□	6. Other *please write in:*
□	7. No suitable outside space available

41. Please write in your postal code

For the following questions, please tick the boxes for you and (if applicable) your partner

42. How old are you?

	You	Your husband, wife or partner (if applicable)
Under 30	□	□
30 to 44	□	□
45 or over	□	□

43. What gender are you?

	You	Your husband, wife or partner (if applicable)
Male	□	□
Female	□	□

44. Are you in paid work?

	You	Your husband, wife or partner (if applicable)
Yes, full-time	□	□
Yes, part-time	□	□
No	□	□

45. If you are in paid work, do you work at home or elsewhere?

	You	Your husband, wife or partner (if applicable)
Home	□	□
Elsewhere	□	□

46. Do you speak a language other than English or French at home?

□ Yes, please specify: _____

□ No

47. What is the highest level of education that the child's father has completed?

□ Elementary school (grade 8)

□ Secondary school (grade 12)

□ College

□ University

□ Graduate school

□ Not applicable / don't know

48. What is the highest level of education that the child's mother has completed?

□ Elementary school (grade 8)

□ Secondary school (grade 12)

□ College

□ University

□ Graduate school

□ Not applicable / don't know

Thank you very much for your help ☺

Data Entry Staff Initials: _____ Date: _____ /_____ / ___