EXAMINING HOW PHYSICAL ACTIVITY PATTERNS RELATE TO PSYCHOSOCIAL HEALTH AMONG CHILDREN (AGES 4 – 6 YEARS) IN CANADA: NATIONAL LONGITUDINAL SURVEY OF CHILDREN AND YOUTH (NLSCY) 1996-2008.

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Abstract:

Background: Declining rates of total physical activity (PA) among children and youth are disconcerting; however, research on PA and sport participation among 4- to 6-year-olds is still in the early stages. As a result, there is a pressing need to understand potential benefits for psychosocial development in the context of the growing popularity of early childhood sport participation and organized physical activity (OPA) programs.

Objectives: The primary purpose of this study is to estimate the prevalence and explore predictors of sport/OPA participation among 4–6-year-olds across Canada from 1996 to 2008, and ii) to evaluate psychosocial outcomes associated with their sport/OPA and unorganized physical activity (UPA).

Methods: Data from 4- to 6-year-olds in the 1996 – 2008 National Longitudinal Survey of Children and Youth (NLSCY; weighted n= ~5 572 000) were pooled and cross-classified based on self-reported PA engagement (inactivity, OPA, UPA, and combined PA). A series of logistic regressions were subsequently used to identify potential predictors of OPA participation in crude and adjusted analyses. Associations between OPA (vs no OPA) participation and psychosocial health outcomes (e.g. hyperactivity, physical aggression/conduct disorder, school performance, and social relationships with adults) were then conducted. All analyses were weighted with the master survey weights to ensure national representativeness of the data.

Results: Over half of 4–6-year-olds (53.4%) were engaged in at least some OPA. In general, the odds of OPA participation were higher in 5- and 6-year-olds, those who participated in other

extracurricular activities, and families living in an urban setting with higher parental education and household income. On the other hand, odds of OPA tended to be lower in males, those with a low *or* high BMI, and among landed immigrants. Although the patterns of predictors varied according to the outcome, better psychosocial development was generally seen amongst frequent OPA group, 5- and 6-year-olds, and those with a higher household income, whereas ineffective parenting styles and one-parent households were generally associated with poorer outcomes.

Conclusion: Results from this thesis suggests that a host of socioecological factors – most notably parental involvement and socioeconomic advantage – are central to engagement in (and psychosocial benefit from) OPA participation in the early childhood years.

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Introduction

The benefits of regular physical activity (PA) to physical and psychological health are well documented (American Academy of Pediatrics [AAP], 2006; (Mikkonen & Raphael, 2010)). By contrast, physical *in*activity is associated with poorer health (AAP, 1992; Goldfield, Harvey, Grattan, & Adamo, 2012) in both children and adults ((Pate et al., 2013; Timmons, Naylor, & Pfeiffer, 2007); Tremblay, Prince, Ham, & Barnes, 2016). Although the barriers and facilitators of physical activity engagement are complex, a growing body of research points to the pivotal role of parents and caregivers in providing children with optimal environments for safeguarding lifelong physical activity (Whitehead, 2001).

Physical literacy is the term used to describe lifelong physical activity, a concept which Whitehead (2007) contends affects multiple developmental domains (e.g. cognitive, emotional, physical, and social development). On that account, appropriate engagement in PA has been associated with a more positive self-image, regard for health and fitness behaviors, and a path to skilled performance for children with exceptional physical movements (Whitehead, 2007). Because of the link between positive self-perceptions and skill performance in relation to PA participation (Findlay, Garner, & Kohen, 2009; Tremblay, Inman, & Willms, 2000), there is an urgent need for strategies to reduce physical inactivity and sedentary behaviours, as a means to prevent or delay the development of chronic disease, and improve mental and psychological health of young Canadians. The present study intends to explore the prevalence of organized and unorganized PA, and the importance of these various forms of PA to early childhood development. Having this knowledge is fundamental to the development of policies that shape and support the long-term health and fitness behaviours of Canadian youth.

Literature Review

Physical Activity Prevalence

Early childhood is an inherently active period; as such, children need opportunities for outdoor active play (AHKC, 2010; ParticiPACTION, 2015; Pate, McIver, Dowda, Brown, & Addy, 2008; Shields, 2006; Timmons et al., 2007). According to one study on the 2004 to 2005 National Longitudinal Survey of Children and Youth (NLSCY), 36 percent of toddlers, and 44 percent of preschoolers were engaged in active play, including outdoor play (AHKC, 2010), while another study surmised that enrollment in sport and structured PA programs among preschoolers was expanding (Timmons et al., 2007). Many parents may feel enthusiastic about the role sport played in their lives while growing up; that being so, parental assumptions or their sport bias may be contributing to the popularity of sport among preschoolers (Timmons et al., 2007; Timmons et al., 2012). It is important to note that this trend is also occurring against a backdrop of declining levels of regular PA among children overall. Indeed, only four percent of girls and nine percent of boys were achieving 60 minutes of MVPA (CSEP guidelines) (Colley et al., 2011; Goldfield, Harvey, Grattan, & Adamo, 2012; Tremblay et al., 2016).

Benefits of Physical Activity

The benefits of PA are in general positive (Ahn & Fedewa, 2011; Findlay et al., 2010), particularly in relation to the protective effect of PA on cardiometabolic risk in children (Liu et al., 2010; Maggio et al., 2011). Of the more limited studies that have been conducted in other aspects of health, activities involving modest increases in PA in the early years were associated with reductions in adiposity and positive psychosocial health outcomes, including improvements

in cognitive development and self-esteem (Atlantis, Barnes, & Singh, 2006; Timmons et al., 2012; Tremblay et al., 2000).

Similar to what was seen for PA, sport has also been shown to have benefitted physical, psychological, and social skill development among children and youths (Findlay et al., 2009; Fraser-Thomas et al., 2005; Leanne C. Findlay et al., 2009). Some studies have shown that children who participate in sport have lower obesity risks and improved self-esteem compared to children who do not participate in sports (Atlantis et al., 2006; Hebert, Møller, Andersen, & Wedderkopp, 2015; Tremblay & Willms, 2003; Tremblay et al., 2000).

Predictors of Physical Activity

While family support, neighbourhoods, and schools may represent physical and social environmental barriers or enhancers of PA, Pradinuk, Chanoine, and Goldman (2011) found that among the broad determinants of PA, built environment design (e.g. access, openness, and safety), was most commonly associated with active outdoor play. Craggs, Corder, Van Sluijs, and Griffin (2011) also examined the broad determinants of *change* in PA among children and adolescents, and found that self-efficacy and perceived behavioral control among adolescents were amongst the most important correlates of change in PA. In the first systematic review of determinants of objectively measured PA among preschool-age children, using longitudinal studies, Li, Kwan, King-Dowling, and Cairney (2015) found that parental health behaviors, weather, and season were most strongly related to levels of PA. In another systematic review – the first relating to the determinants of change in PA among preschool-aged children, using longitudinal studies with objective measures of activity, Hesketh et al (2017) found that parental

monitoring was positively associated with change in PA among young children. These studies collectively aid our understanding of the strongest predictors of PA at the individual and family level.

Movement Behaviours and Health

Over the past 25 years, the study of childhood movement behaviours have become a growing public health concern (Goldfield et al., 2012; Ogden et al., 1997; Whitehead, 2001). The Canadian Society for Exercise Physiology (CSEP) advised in the recent *24-Hour Movement Guidelines for the Early Years (0–4 years)* that children should engage in at least 180 minutes of PA (including 60 minutes of moderate-to-vigorous PA (MVPA)), and are encouraged to limit sedentary behaviours (e.g. sitting periods or sedentary screen time) to one hour or less (Tremblay et al., 2017). Although these recommendations were made on the basis of a range of health benefits, the guidelines suggest that this set of balanced movement behaviours may be particularly advantageous for psychosocial health (Tremblay et al., 2017).

The early years of childhood are necessary for movement skill acquisition, overall health, fitness, and lifespan development (Goldfield et al., 2012; Whitehead 2007); however, since 2001, studies have shown that fewer Canadian children have engaged in PA, which can be detrimental to physical literacy and lifelong PA engagement (Active Healthy Kids Canada [AHKC], 2010; (Taylor et al., 2009). One common reason tends to be the lack of time. Although activity levels tend to decline as children become school-age because educators are under pressure to safeguard the academic achievement of children in their care by putting academic curriculum ahead of activities, it is clear that parents share more responsibility for safeguarding the movement

behaviours of children by scheduling time for play (Pate et al., 2008, Martin, 2010). Preschool-age children are also at risk of becoming less physically active, particularly as perceived physical, sociocultural, and socioeconomic barriers result in fewer opportunities for active outdoor play (Pate et al., 2008; White & McTeer, 2012; Wijtzes et al., 2014). Children may be prevented from playing outside due to concerns about neighbourhood safety (Bauman et al., 2012). Declines in PA are particularly pronounced among girls (Findlay et al., 2010), as well as single-parent households, and households with less than a high school education (Clark, 2014., 2015; Wijtzes et al., 2014**)**. As a result, research to reduce inactivity *and* sedentary time has grown considerably in order to safeguard childhood physical and psychosocial development (Howie, Brown, Dowda, McIver, and Patel, 2013; Saunders, Chaput, & Tremblay, 2014; Timmons et al., 2007). Some strategies involve creating settings for increasing PA, such as classroom-based PA (Calvert, Mahar, Flay, & Turner, 2018; Reznik, Wylie-Rosett, Kim, & Ozuah, 2015).

Developmental Frameworks: Positive Youth Development (PYD) and the Socio-Ecological Model (SEM)

In an effort to understand the broader societal influence in promoting PA among children, a number of theoretical frameworks have been proposed. Two of the most well accepted (and relevant to the study of sport and PA among children) are the Positive Youth Development (PYD) through Sport Model, and the Socio-Ecological Model (SEM).

Since 2005, PYD has been well studied among educators and sport psychologists (Fraser-Thomas et al., 2005; Holt et al., 2011; Holt & Neely; 2011; Holt et al., 2017; Larson, 2000;

Zarrett, Fay, Li, Carrano, Phelps, & Lerner, 2009; Wright & Li, 2009). Although no specific definition of PYD exists, researchers have conceptualized PYD as a broad term that implies the nurturing of child and adolescent development through structured activities (Holt & Neely, 2011). The key concept of PYD is its strength-based approach to positive development; as such, PYD functions as a method for nurturing social connectedness – which is advantageous for cultivating prosocial behaviours among individuals (Holt & Neely, 2011). Thus, the scope of research in this area tends to emphasize the social interactions that yield positive psychosocial development within popular contexts such as sport (Holt & Neely, 2011). In the children and youths' development discourse, PYD recognizes the complex multilayered social challenges by tailoring programs to create opportunities for youths to work to enhance their physical and social environmental; for example, being active in charities, community, cultural or faith-based programs, sport, and vocational clubs, in an effort to build resiliency and self-worth (Atkiss et al., 2011; Holt & Neely, 2011).

Family support is central to PYD. Families provide the foundation for children to flourish by creating a secure and supportive environment for children to explore and make connections (Fraser-Thomas et al., 2008; Holt & Neely, 2011; Holt, Kingsley, Tink, & Scherer, 2011). Parents also help children interpret and navigate this process of psychosocial development (Fraser-Thomas et al., 2008; Holt & Neely, 2011; Holt et al., 2017). Other adults caring for a child, such as caregivers and extended family, also have this responsibility – to ensure that the developmental needs of the child are being met. Ensuring that children develop the skills to be able to make prosocial contributions to the community is a key interest of PYD; thus, PYD should be undertaken within supportive physical and social environments (Fraser-Thomas et al., 2008; Holt & Neely, 2011; Holt et al., 2017).

To be effective, there must be an appropriate context for PYD. Sport tends to be the most popular structured activity for youth (Fraser-Thomas & Côté, 2009); as such, coaches, teachers, and parents should be aware of the vital importance of appropriate engagement to observe tangible developmental outcomes from sport/OPA participation. The effectiveness of activity engagement patterns and tangible developmental outcomes are evaluated in three parts: self-perception, physical development, and social skill development (Holt et al., 2017). Thus, appropriate sport engagements should safe guard an individual's overall psychosocial well-being, lifelong PA engagement (physical literacy), and preserve their prosocial interests over their lifecourse (Fraser-Thomas et al., 2005; Holt & Neely, 2011; Holt et al., 2017; Wright & Li, 2009).

Although activity engagements may not always safeguard positive behaviours, PYD ensures that adult custodians can foster social environments that prioritizes the interests of children (Fraser-Thomas et al., 2008; Holt & Neely, 2011). As a strength-based approach, PYD through sport cultivates prosocial interests through structure, which is contingent on coaches and parents engaged as resource stakeholders (Fraser-Thomas et al., 2008; Holt & Neely, 2011). As such, these groups have a tangible interest in the program's success. Research suggests that appropriate levels of engagement may promote behaviour change, healthy behaviours, self-efficacy, self-regulation, resiliency, social support network, better school performance, and other developmental assets (Atkiss et al., 2011; Fraser-Thomas et al., 2008; Holt & Neely, 2011; Holt et al., 2017).

PYD can also have complementary effects due to the interconnectedness among important psychosocial outcomes (e.g. social relationships, behavioural health, and academic performance). Participants with more developmental assets are more likely to be resilient and

prosocial, which has advantages over antisocial behaviours such as aggression, anxiety, or other health impairing behaviours (Holt & Neely, 2011). PYD may also be advantageous to individuals affected by sociocultural as well as socioeconomic barriers impeding the enculturation of health behaviours (Atkiss et al., 2011); for example, families experiencing adverse living conditions, recent immigrants, and single-parent households.

Studies involving school-age children have reported that parental factors (including education, financial resources, and parenting), and the social environment were important predictors of sport engagement among the young school-age children (six-to-nine-year-olds) (Basterfield et al., 2016; Holt et al., 2017; Kobel et al., 2015; Wijtzes et al., 2014). Furthermore, among older children (12-year-olds), behavioural and social maladjustments (e.g. apathy, disinterest, isolation) were important predictors of inverse associations with sport engagement (Basterfield et al., 2016). Thus, research involving preschool-age children, in the context of a societal influences, may aid our understanding of the effects of family-level factors (e.g. family functioning, parenting style, and socioeconomic status) and availability of safe outdoor play spaces as important factors for characterizing sport and PA engagement at an earlier age (Wijtzes et al., 2014).

One behavioural health study using Developmental Assets (DA) and SEM to explore the effects of a novel PYD program on youths affected by economic, health, and social disparities reported positive results in their integrated approach (Atkiss, Moyer, Desai, & Roland, 2011). They found that by the end of the study, the self-perception of youth participants had improved because of the external supports they had built through social relationships. However, a small sample size (n=11) and self-selection bias were some major limitations of the study (Atkiss et al., 2011). Furthermore, half of study participants withdrew due to competing interests (family,

school, sport, and other commitments). Thus, a representative sample is needed to enhance generalizability in future studies in order to enhance our understanding of the relationship between psychosocial developmental assets through sport.

Socio-Ecological Model (SEM)

Because childhood development involves the multilayering of biological, psychological, social, environmental, and policy-level determinants, which correlate with PA over a lifecourse (Bauman et al., 2012; Vella, Cliff, & Okely, 2014), SEM is a widespread framework that dovetails with PYD in the children and youths' development discourse. Several theoretical approaches are focused specifically on the development of internal and external assets; however, SEM accounts for health behaviours shaped by social influences (e.g. parents, peers, policies) and cultural factors in unique ways because behaviours are influenced by cultural norms and practices as well as upstream social inequities (Atkiss et al., 2011). Emphasis of this model is on the interrelatedness of multilevel factors contributing to health behaviours. Among adolescents, specific individual and family-level factors are known to correlate with PA; for example, previous PA (behavioural), family support, self-efficacy (psychosocial), and male-sex (Bauman et al., 2012). In younger children, there are fewer studies; however, behavioural (previous PA, parental smoking), biological (age, sex), and demographical (socioeconomic status, weight status) correlates of PA are often reported (Bauman et al., 2012). Thus, potential sociocultural (family/parental support, immigration, social norms,) and socioeconomic barriers are important considerations for sport given their importance as correlates of PA, which also includes neighbourhood design, location of recreation facilities, and transportation for any efforts to be engaged in sport or reduce inactivity (Bauman et al., 2012; Brasholt et al., 2013; CSEP, 2016).

At the environmental level, the social environment contributes to PA (Bauman et al., 2012). While behaviour modeling – seeing others – as well as crime and traffic, neighbourhood safety, and walkability are all important in reducing inactivity (Bauman et al., 2012); however, some of the most important findings regarding correlates of PA in children were residential density and access or proximity to recreational spaces (Ding, Sallis, Kerr, Lee, & Rosenberg, 2011). Social policies in relation to PA engagement tend to be moderated by geography (Fraser-Thomas et al., 2010). Children in low-income urban dwellings with poor land-use mix, low proximity or access to parks and recreation facilities, and low neighbourhood safety, may experience a higher risk of inactivity (Caprio et al., 2008). Thus, social inequities contribute to activity inequalities as well as behavioural and social maladjustments (Mikkonen & Raphael, 2010;).

A parent's education is also closely related to having more opportunity and resources to achieve healthier outcomes (Wijtzes et al., 2014). Children whose parents lacked post-secondary education were generally more susceptible to learning difficulties compare to their counterparts whose parents had obtained post-secondary education (Mikkonen & Raphael, 2010). Further, Statistic Canada's low-income cut-offs (LICOs) help to identify households with higher than average spending on basic needs such as housing, clothing, and food; hence, LICO has been implemented for signalling family-level factors, such as living conditions and hardship (e.g. social deprivation), thereby contextualizing socioeconomic disparities in relation to health risks (Mikkonen & Raphael, 2010).

Finally, children and youth are not insulated from the negative effects of social inequity; thus, it is important to account for interactions between individual and family-level sociodemographic factors on overall health. In particular, childcare programs are considerable

household costs (Malina, 2010), and need to be considered in any analysis of sport participation. For example, the establishment of full day kindergarten in some provinces alleviates some of the cost of childcare to working parents, but it varies by province (i.e. full day kindergarten is offered to children at the age of 5 years old in the Atlantic provinces, Quebec, Ontario [includes 4-year-olds], British Columbia, and the Northwest Territories) (Langford et al., 2016; Pelletier, 2017).

Psychosocial Health

Although psychosocial health tends to associate with positive development, it is clear that behavioural issues or disruptive behaviours such as emotional and behavioural difficulties – characterized as deviations from socially expected norms – tend to affect the health and development of children and youth (Bauermeister, So, Jensen, Krispin, & El Din, 2006; Merikangas et al., 2010). In a nationally representative sample of U.S. adolescents, Merikangas et al (2010) estimated that the median age of onset for behavioural health issues was age 13. The resulting lifetime prevalence of "any" behavioural health issue was found to be 14.3 percent among adolescents, while the lifetime prevalence of "severe" impairment was 11.2 percent (Merikangas et al., 2010). Behavioural health issues can also be difficult to recognize; however, severe impairments emerge around the adolescence and young adulthood (CMHA, 2014; Merikangas et al., 2010), and are associated with several contributing factors including family history, personality, and life events (CMHA, 2014; Merikangas et al., 2010).

The most common disruptive behaviours are anxiety, attention-deficit hyperactivity disorder, conduct and emotional problems, and physical aggression; however, extreme antisocial

behaviours such as delinquency, violence, substance abuse, and school dropout tend to occur more commonly amongst older children (Bushnik & Garner, 2008; Chang et al., 2014; Pogarsky, Lizotte, & Thornberry, 2003; Merikangas et al., 2010; Rhule, McMahon, Spieker, & Munson, 2006). Disruptive behaviours with early childhood onset are nonetheless considerable, and these include the inability to socially relate with other children and adults (Tremblay, 2000). Disruptive behaviours may also intensify in the presence of other psychosocial stressors (Fagan & Iglesias, 2000; Keenan & Wakschlag, 2000). The single most common behavioural health issue during early childhood is hyperactivity and inattentiveness, which affects 11.8 percent of children (DuPaul, McGoey, Eckert, & van Brackle, 1998; Janus, 2010; Wakschlag et al., 2007). Other disruptive behaviours such as aggression tend to lessen with age; however, anxiety rates are known to intensify as children become older (Bosquet & Egeland, 2006; Janus, 2010; Tremblay et al., 2004).

Furthermore, the prevalence of behavioral health issues among young children has nearly doubled since the 1980s to nearly 17 percent (Briggs-Gowan, Carter, Skuban, & Horwitz, 2001; Brauner & Stephens, 2006; Egger & Angold, 2006; Furniss, Beyer, & Guggenmos, 2006). Not least of all, behavioural issues affect between 20 to 33 percent of low-income preschool-age North American children (Del'Homme, Sinclair, Kasari, & Sigman, 1994; Feil, Walker, Severson, & Ball, 2000; Gross, Sambrook, & Fogg, 1999; Kaiser, Hancock, Cai, Foster, & Hester, 2000). However, differences in diagnostic criteria and respondent data collection contributes to variability in the prevalence rates (Janus, 2010).

Studies examining PA and behavioural health issues in children are uncommon (Ahn & Fedewa, 2011; McKercher et al., 2012), but tend to suggest improved behavioral health with greater activity engagement in children and adolescents (Ahn & Fedewa, 2011; Korczak,

Madigan & Colasanto., 2017; Larun et al., 2006; Wiles et al., 2008). Regular PA is also associated with better psychosocial health such as fewer emotional disruptions even 1-year later (Wiles et al., 2008). One aspect of PA and behavioural health shows that as age increases, some symptoms also increase, which may explain some of the declines in PA among school-age children, particularly adolescents (Baldursdottir, Valdimarsdottir, Krettek, Gylfason & Sigfusdottir, 2016). Indeed, Baldursdottir et al (2016) found that among adolescents aged 15 and 16, MVPA was inversely associated with depressive symptoms, regardless of gender; however, there were more positive benefits for girls who participated in sports and organized PA.

Social Relationships

Throughout the childhood years, the importance of fostering social interests is vital to PYD (Holt & Neely, 2011). The sport context is one avenue for facilitating the development of social interests; however, children with poor social relationships also tend to have emotional and behavioural difficulties as social competency constructs become more apparent and perceivable among school-age children (Atkiss, Moyer, Desai & Roland, 2011; Bauman et al., 2012; Fraser-Thomas, Côté, & Deakin, 2005). Although research shows that parents strongly influences sport engagement (Dorsch, Smith, & McDonough, 2015; Kanters, Bocarro, & Casper, 2008), it is clear that negative stressors such as frequent problems in social relationships may have underpinnings in poor parenting practices (Puhl & Latner, 2007**;** Thomas, 2004). Therefore, children affected by negative parenting styles or support, are more likely to have lower self-efficacy, which can amplify behavioral health issues (e.g. aggression, conduct disorders, and hostility), poor social relationships, and educational underachievement (Puhl & Latner, 2007**;** Thomas, 2004). Thus, these child-parent relationships are integral for experiencing positive psychosocial development

and PA engagement (Bauman et al., 2012; Fraser-Thomas et al., 2005). However, unreasonable expectations of accomplishment in sport can also result in negative experiences (Malina, 2010).

Beyond the role of parents, other social relationships can also have a positive influence on children and youths' development. Although the most integral and salient aspect of the social relationship system is the relationship with parents (Ullrich-French & Smith, 2006), familial and nonfamilial social relationships can help to moderate (or buffer) perceived deficits such as a loss in self-esteem and poor self-perception (Ullrich-French & Smith, 2006). Thus, the more positive close social relationship connections a child makes, the stronger the prerequisites to be engaged in sport (Fraser-Thomas, Côté, & Deakin, 2008; Holt & Neely, 2011).

Academic Achievement

Because childhood development is affected by brain development, early experience, growth, and maturation (McClelland et al., 2014), self-regulation – the coping mechanism to respond appropriately to perceived stress (e.g. being focused and following instructions) – tends to associate with better outcomes for behavioural health and academic achievement during childhood and adolescence (McClelland et al., 2014). Thus, the positive effect of PA in early childhood, may contribute to early academic achievement and development of self-efficacy – the intrapersonal belief in one's ability to accomplish a specific task (Bauman et al., 2012). On this basis, it is important to consider family-level psychosocial effects during the early childhood years. Studies show that early onset behavioural health issues among school-age children contributes to low academic achievement, which can have long-term negative consequences on perceptions of oneself (Petras, Chilcoat, Leaf, Ialongo, & Kellam, 2004). Thus, early

identification can predict sociocultural barriers in learning; for example, cultural background, and adversity, which affects longer term academic achievement (Espinosa, 2005).

Over the past 50 years, there has been considerable debate about the relationship between academic performance and PA in schools (Howie & Pate, 2012). Historically, school settings have fewer physical movement curricula; by contrast, academic curricula are more popular (Howie & Pate, 2012). Among youths, PA is related to better self-regulation and social relationships, and several studies have demonstrated positive effects of sport participation on academic achievement (Aumètre, François Poulin, 2018; Crosnoe, Smith, & Leventhal, 2015; Denault & Déry, 2014; Howie & Pate, 2012). While the literature is limited for younger children and toddlers, one study found that kindergarten children also tend to benefit from self-regulation in the context of structured sport (Piché, Fitzpatrick, & Pagani, 2015).

Sedentary Time

Sedentary behavior (SB), which is defined as a sitting or reclining posture needing very low levels of energy expenditure (≤1.5 Metabolic Equivalent of Task) performed during waking hours, comprises activities such as drawing, reading, playing with puzzles, watching television, or portable electronic devices (McManus & Mellecker, 2012; Sedentary Behaviour Research Network [SBRN], 2017). By contrast, the SBRN (2012) has adopted the term "inactive" (rather than "sedentary") to describe insufficient amounts of MVPA. Current guidelines suggest that children should avoid being sedentary for more than 60 minutes at a time (Timmons et al., 2007; Tremblay et al., 2017). While there are not good data on which to make broad prevalence determinations for 4- to 6-year-olds, older children and adolescents have been observed spending

at least 62 percent of their waking hours being sedentary (Pate et al., 2013; Tremblay et al., 2016). What is clear, however, is that high levels of sedentary time do not preclude PA engagement in adolescents, nor does it lead to perceived poor health in isolation (i.e. sedentary time does not directly displace time spent in PA) (Granger, Williams, Di Nardo, Harrison, & Verma, 2017).

To understand the benefits of PA in the early years, Pate et al. (2008) examined PA levels among preschoolers through direct observation and found that very light activity or sedentary activity contributed at least 80 percent of the observation time, with the physical environment as a key predictor. They estimated that children were spending less than one hour in MVPA, in a 30-hour week, while 25 hours was spent in sedentary activities. In the same study, the preschool setting accounted for 27 percent of the variation in activity levels, and 14 percent of the variation in MVPA. This suggests that optimal physical environments benefit the health of preschoolers by encouraging innate activity patterns (Pate et al., 2008). Sedentary time can therefore be considered an emerging risk factor for poor physical and psychosocial health in children and adolescents that is *distinct* from physical inactivity, and warrants separate investigation (Saunders, Chaput, & Tremblay, 2014). Despite this, the cultural emergence of sedentary tasks is one of several proposed contributors to the overall decrease in total PA, and higher risk for chronic diseases (Ellery, Weiler, & Hazell, 2014).

Screen Time

Screen time – a subset of SB – is the time spent viewing a screen such as computers, televisions, and video games (Saunders et al., 2014). It has been reported that 33 percent of

children (ages 2 – 6 years) have televisions in their bedroom (Rideout, Hamel, & Kaiser Family Foundation, 2006), and as many as 90 percent of toddlers are exposed to regular television viewing (Zimmerman, Christakis, & Meltzoff, 2007). Because of the ubiquitous nature of technology (and screen time) among children, it is critical that any analyses of PA be able to account for level of SB exposure (Hillier-Brown et al., 2014).

Indeed, the relationship between PA and screen time has been examined for over 20 years (Hills, King, & Armstrong, 2007; Leatherdale & Ahmed, 2011; Marshall, Biddle, Gorely, Cameron, & Murdey, 2004; Viner & Cole, 2005), and have generally demonstrated that higher amounts of screen time are associated with lower PA (Andersen et al., 1998; Hills, Andersen, & Byrne, 2011; Viner & Cole, 2005), poor conduct, and poor cognitive development in children (Carson, Kuhle, Spence, & Veugelers, 2010; LeBlanc et al., 2012). According to a study by Andersen et al. (1998), using the 1988–1994 National Health and Nutrition Examination Survey, when screen time increased, vigorous activity levels declined, especially in girls. Other studies found that higher amounts (over 2 hours) of screen time in children and adolescents were associated with poorer school performance (Tremblay et al., 2000; Tremblay, LeBlanc, Kho, et al., 2011). A recent study contextualized the evolution of screens and the pervasiveness of screen time behaviors since the 1980s; for example, internet use, smart phones, social media, and televisions in each household (LeBlanc et al., 2017). Between 2009 and 2015, only 24 percent of 3- to 4-year-olds in Canada were meet the screen time recommendation within the *Canadian 24-Hour Movement Guidelines* for the Early Years (Chaput et al., 2017). Current recommendations are to limit the amount of screen time among preschoolers, to less than one hour a day (Tremblay et al., 2017), and completely discourage screen time for toddlers (under age two) (Brown, Shifrin, & Hill, 2015).

Different Types of PA for Children

Sport and PA are important contexts for in childhood development (Weiss & Wiese-Bjornstal, 2009); however, the composition and type of PA has been less studied in the context of psychosocial health. Two important considerations for PA are unorganized and organized.

Unorganized Physical Activity

One of the most commonly observed PA patterns is unorganized sport/PA. Unorganized or unstructured physical activity (UPA) is broadly defined as any informal leisure time PA, especially autonomous PA, such as active play (Findlay, Garner, & Kohen, 2010; Timmons et al., 2007). Active play is any energetic activity – a definite advantage for promotion of PA – because children have a natural affinity for intermittent and intrinsic forms of activity (Timmons et al., 2007). Active play is more likely to occur as a subset of UPA, and as such, they are used interchangeably to be representative patterns of children's PA and are more likely to occur daily than formal or structured PA (Findlay et al., 2009; Findlay et al., 2010).

Children who have more opportunities for active play have the autonomy to learn from a range of self-directed physical movements (Fraser-Thomas et al., 2008). Thus, children should be engaged in active play for at least 60 minutes and up to several hours, daily (Timmons et al., 2007). Current estimates suggest that 62 percent of 3- to 4-year-olds are engaged in active play (Chaput et al., 2017). Parents, caregivers, teachers, and coaches have a role in facilitating children's PA engagement by being aware of their part as social influences as well as the broader environmental influences on psychosocial health (Bauman et al., 2012; Fraser-Thomas et al., 2008; Weiss & Wiese-Bjornstal, 2009).

Children should also have access to safe outdoor spaces which allow for activities involving large muscle groups (Timmons et al., 2007). The physical environment is known to contribute to activity inequality among children; however, increasing access to outdoor activities reduced the activity inequality between children who were highly active and their lower-active counterparts who were less likely to be active *indoors* (Howie, Brown, Dowda, McIver, & Pate, 2013). For this reason, including more outdoor play also encourages more PA, and only by capturing *both* types of activity, will accurate estimates of PA be provided in this age group (Bornstein, Beets, Byun, & McIver, 2011; Hnatiuk, Salmon, Hinkley, Okely, & Trost, 2014; Howie et al., 2013; Pate et al., 2008).

Despite the noted physical environment challenges, children should be encouraged to spend more time in active play settings. More specifically, children age six and older should be allowed to experience different types of sport in an effort to compare the outcomes of multiple sport engagements (Fraser-Thomas et al., 2008). Sampling a range of sports encourages children to experience different coach and peer relationships, which includes them in the decision-making processes that affects their long-term development (Fraser-Thomas et al., 2008).

Organized Physical Activity

The other most commonly observed PA pattern is structured or organized physical activity (OPA), which is broadly defined as any formal PA in a structured setting involving adult supervision, scheduling, and peer groupings (Aumètre, François Poulin, 2018; Findlay et al., 2009). Sport/OPA is a development vehicle for building physical literacy – the building blocks for more complex movements – and social skills; however, the support of parents, coaches, and

broader sport systems are important prerequisites (Fraser-Thomas et al., 2005; Timmons et al., 2007).

Children should spend at least 60 minutes in structured PA, daily (Timmons et al., 2007). According to the Canadian Fitness and Lifestyle Research Institute (CFLRI), 75 percent of children and youth participated in sport between 2011 and 2014, a rate relatively unchanged since 2005 (CFLRI, 2011; CFLRI, 2014). Between 2012 and 2015, 46 percent of 3- to 4-year-olds were participating in organized sports or OPA (Participaction, 2018). Participation rates in early specialization programs, however, have risen from nine percent to 12 percent, between 1997 and 2008 (Malina, 2010). While there are many positive effects of sport on psychosocial development, there are also some potential negative psychosocial effects, which may develop as a consequence to such early specialization (Fraser-Thomas et al., 2008).

While the overall participation rates remain high, over one-third of children tend to drop out of sport and OPA between childhood and adolescence (Findlay et al., 2009). One study found that dropouts were more common when parents had a history of being high-performing athletes themselves (Fraser-Thomas et al., 2008). Drop out was also a factor among individuals who were youngest in their training cohort or engaged in sport at an earlier age (Fraser-Thomas et al., 2008). Thus, there has been considerable attention to the growing popularity of early childhood sport programs in order to understand the contributing factors (Timmons et al., 2007). To this end, the earlier age group may provide even stronger associations shaped by socioecological factors. In terms of early sport interventions, research has begun to focus on upstream social inequalities and midstream physical environment health predictors (Wijtzes et al., 2014). One recent randomized study identified opportunities for multiple sessions of outdoor play, which led to increased engagement in MVPA among children in childcare centres (Razak et al., 2018).

However, some major limitations in this area of research include selection bias, and homogeneous sampling (non-probability), which limits national representativeness. Other limitations in the literature include cross-sectional designs, recall bias, and information bias, which contributed to social desirability. Lastly, there is typically an over-reliance on one parent (usually mothers) in the parental-reports, which cannot be ignored.

Conceptual Frameworks

In an effort to conceptualize the health of children (ages 4 – 6 years), the psychological and social development of children are understood better through the lens of the PYD (Holt & Neely, 2011), and the SEM framework (Bauman et al., 2012). Many chronic health problems take many years before symptoms are diagnosed in adulthood; by contrast, chronic health problems are usually rare among young children (Akinbami, 2006; Gortmaker et al., 2015; Lochte et al., 2016; O'Connor et al., 2017). However, a growing number of psychological and social problems may become apparent much sooner than the physical symptoms. Upstream social inequities, which affect living conditions and quality of life – for example, housing, land use, and schooling – are often shaped by social policies that affect physical and social environmental conditions; thus, contributing to health outcomes that can be immediate, delayed, and lasting (Mikkonen & Raphael, 2010; Puhl & Latner, 2007; Tremblay et al., 2000). Thus, psychosocial risks or stressors are those adverse conditions that impair self-control, self-regulation, and development; thereby contributing to social and behavioural maladjustments (Huang, Lanza, Wright-Volel, & Anglin, 2013; McKercher, Schmidt, Sanderson, Dwyer, & Venn, 2012; Mustillo et al., 2003; McClelland et al., 2014; Puhl & Heuer, 2010; Puhl & Latner, 2007; Sanderson, Patton, McKercher, Dwyer, & Venn, 2011). However, PA in a safe and

supportive environment facilitates positive psychosocial development (Weiss & Wiese-Bjornstal, 2009).

Developmental and sport psychology constructs such as self-efficacy (an intrapersonal belief or a sense of control) and self-esteem, help to characterize the resiliency-building aspects of psychosocial health in the context of PYD through organized activities (e.g. clubs, community centers, and sport) in an effort to cope with the demands of psychosocial stresses (Mikkonen & Raphael, 2010; Puhl & Latner, 2007; Tremblay et al., 2000; Ullrich-French & Smith, 2006). Developmental frameworks help to interpret the behavioural aspects of psychological constructs characterizing prosocial values, self-regulation, and resiliency in early childhood.

Study Rationale

Summary of current knowledge on the benefits / concerns of PA, organized, and unstructured physical activity for children:

It is important to explore the different patterns of PA, including *inactivity*, among younger children in order to gain a better understanding of their health trajectories. Regular PA as well as sport engagement are known to support healthy physical, psychological, and social development (Tremblay et al., 2017; Whitehead, 2007). Research suggests that children who are involved in the appropriate engagement of sport are better prepared for lifelong sport engagement or physical literacy (Whitehead, 2007). Sport fosters social relationships through interpersonal interactions, friendships, and team play; however, early specialization programs may be too vigorous for preschoolers due to the impractical demands that coaches and parents may impose (Malina, 2010). The American Academy of Pediatrics (AAP) (1992) has

maintained, for nearly three decades, that children under the age of six are less likely to be developmentally prepared for sport. For this reason, sport and OPA readiness should be considered along with the child's maturity and experience (Canadian Sport for Life [CS4L], 2011; Timmons et al., 2007; Tremblay et al., 2012). One of the reasons for early sport programs becoming popular is the belief that training in a sport could enhance the likelihood of child participants becoming successful in later life and sport career (Brenner, 2016; Jayanthi, Pinkham, Dugas, Patrick, & LaBella, 2013).

Given the issues about cost and suitability of sport and OPA programs for young children, encouraging outdoor active play is the most pragmatic way for most children to achieve the health benefits of PA (Findlay et al., 2010); however, the benefits of sport cannot be discounted (Timmons et al., 2007; Timmons et al., 2012). Because far less is known about the characteristics of early sport and OPA programs, and the actual or perceived barriers to PA (White & McTeer, 2012), this study is informed by the SEM – to account for the broad determinants of PA shaped by multilevel factors across a lifecourse (Bauman et al., 2012), and; the PYD framework – a broad child and youth developmental approach and an alternative to conventional deficit reduction strategies (Holt et al., 2017).

What do we need to know about PA among young children?

Explorative studies using nationally representative Canadian childhood population to examine psychosocial health in the context of sport are rare, which creates critical gaps in the literature. Most studies tend to be limited to samples obtained from small geographical areas, particularly during school days; thus, lacking representativeness. It remains unclear how

socioeconomic barriers affect early childhood PA, especially children living in neighbourhoods with safety concerns (Andersen et al., 1998; Stodolska et al., 2013). To date, most studies have only been able to study older school-age children. This study reduces the research gap regarding the investigation of PA in the context of sport using a more representative early childhood population in the years prior to the establishment of full-day kindergarten across most provinces in Canada. This study also reduces the research gap to determine potential "risks" associated with increasing PA in the early years (Timmons et al., 2012).

Summary

Research shows that preschool-age children are at high risk for inactivity (Pate, McIver, Dowda, Brown, & Addy, 2008) and require MVPA for optimal development (Timmons et al., 2007; Tremblay et al., 2017). To this end, sport and OPA are important contexts for psychosocial development (Timmons et al., 2007; Tremblay et al., 2017; Weiss & Wiese-Bjornstal, 2009), yet parents tend to have the most influence in deciding how and where children spend their time (Fraser-Thomas et al., 2008; Holt & Neely, 2011; Holt et al., 2017). As a result, our understanding of the typical modes and context for early childhood sport remain unclear, and warrant further investigation.

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Authors Contribution

Jessica Fraser-Thomas is the Primary Investigator, and Jennine Rawana, Rebecca Basset-Gunter, and Chris I. Ardern are Co-Investigators on the grant to support this work.

Akinkunle Oye-Ṣomẹfun performed the analysis, drafted the manuscript, and designed the figures and tables with support from CIA. JFT developed the idea, assisted with the analysis plan, and provided critical feedback on the manuscript draft.

Objectives

The aim of this thesis is to examine the prevalence and characteristics of physical activity types among children (ages 4 – 6 years) in Canada. There are two specific objectives:

1. To describe the participation rates and demographic trends in sport and organized physical activity participation among 4- to 6-year-olds across Canada from 1996 to 2009.

2. To evaluate psychosocial developmental outcomes associated with sport or organized physical activity, and unstructured physical activity among 4- to 6-year-olds.

Patterns and predictors of sport and organized physical activity among 4- to 6-year-olds in Canada: Analysis of the National Longitudinal Survey of Children and Youth

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Abstract:

Background: While considerable attention has focused on declining rates of total physical activity (PA) in children and youth, the composition and *type* of early childhood PA is less studied in the context of sport and organized physical activity (OPA).

Objectives: The primary objectives of this study were to therefore: i) describe national-level patterns of children's PA, and; ii) predictors of sport/OPA to better understand their relative importance within the context of PA promotion during the period of 1996 to 2008.

Methods: A cross-sectional analysis was performed based on data of 4-to-6-year-olds from multiple cycles of the 1996 – 2008 National Longitudinal Survey of Children and Youth (NLSCY). Temporal trends in the prevalence of OPA and non-OPA were reported. Multivariable logistic regression analyses were then performed to determine how individual- and family-level characteristics relate to OPA participation. Data analysis was performed with SAS version 9.4, weighted with the master survey weights to ensure national representativeness of the data.

Results: An overall weighted sample of 5 572 000 children (ages 4 – 6 years) was analyzed. More children (53.4%) were engaged in "any" OPA, compared to the non-OPA group (46.6%). Odds of OPA were higher with age (62-81%), extracurricular activities (41-149%), parent's education (31-129%), household income (43%), and urban community (45-89%), while the odds were lower among males (23%), low BMI (22%), high BMI (20%), and landed immigrant status (25-45%), after adjusting for all other variables.

Conclusion: Results from this study suggest that an interplay of socioecological factors characterize engagement in OPA among 4- to 6-year-olds, across multiple survey years.

Introduction

In Canada, sport and organized physical activity (OPA) are ubiquitous; as such, 75 percent of children and youth engaged in sport between 2011 and 2014, a rate relatively unchanged since 2005 (Canadian Fitness and Lifestyle Research Institute [CFLRI], 2011; CFLRI, 2014). However, the levels of sport engagement do not tell a complete story about physical activity (PA) patterns in that there has been a paradoxical decline in total physical activity over the last two decades, despite the popularity of sport (Malina, 2010; Timmons et al., 2007; Timmons et al., 2012). Over the past 25 years, data has shown that the declining total physical activity patterns among children has become a growing public health concern due to the link between inactivity and the development of chronic disease in adulthood (Goldfield et al., 2012; Ogden et al., 1997; Whitehead, 2001). Since 2001, studies have also shown that fewer Canadian children have engaged in active play – a declining trend that can be detrimental to physical literacy and lifelong PA engagement (AHKC, 2010; Taylor et al., 2009; Whitehead, 2001). Active play is the most representative leisure time PA pattern (Findlay, Garner, & Kohen, 2010); however, encumbrances include a lack of access to safe outdoor spaces in order to perform vigorous activities, as well as other perceived environmental, sociocultural, and socioeconomic barriers to PA (Pate et al., 2008; White & McTeer, 2012; Wijtzes et al., 2014). Among adolescents, factors known to associate with declines in PA include being female, single-parent households, and households with less than a high school education (Findlay et al., 2010; Kobel et al., 2015; Wijtzes et al., 2014**)**. Furthermore, reduced access to neighbourhood parks and recreation facilities are also known to create barriers to PA among children (Stodolska, Shinew, Acevedo, & Roman, 2013). While non-OPA (e.g. unstructured physical activity [UPA]) tends to be on a decline, enrollment in sport/OPA tends to increase, especially among younger

children or preschoolers (Malina, 2010; Timmons et al., 2007; Timmons et al., 2012). The extent to which the increase in OPA participation is related to changing social norms remains unclear, but may be due in part to parental income, influence, and support, among other socioecological factors (AHKC, 2010; Timmons et al., 2007; Timmons et al., 2012). Given the importance of PA, parents may also have the impression that structured sports or OPA can be ideal settings for development, which has theoretical support for older children (Fraser-Thomas et al., 2008; Holt & Neely, 2011; Holt et al., 2011). Thus, parents and other adults (e.g. caregivers, coaches, and teachers) must recognize that roles as social influencers who are integral to conceptualizing and realizing the perceived benefits of sport, and preserving lifelong participation (Fraser-Thomas et al., 2008; Holt & Neely, 2011; Holt et al., 2011).

The purpose of the present study is to therefore explore the influence of upstream (e.g. gender, class, immigration status) or overarching social factors, and midstream (e.g. safe parks, community size, health behaviours) or intermediate physical and social environmental factors on sport/OPA engagement among children (ages 4 – 6 years) by applying an overarching socioecological model in order to account for the broad determinants of PA (Bauman et al., 2012; Wijtzes et al., 2014). As such, this study will use nationally representative data to estimate the prevalence, pattern, and characteristics of OPA vs non-OPA participation among 4- to 6-year-olds in Canada, using a cross-sectional analysis of the National Longitudinal Survey of Children and Youth (NLSCY; 1996 to 2008).

Methods

Database

This study performed a cross-sectional analysis of the National Longitudinal Survey of Children and Youth (NLSCY), which is a database created by a joint endeavor between Statistics Canada and Human Resources and Skills Development Canada (HRSDC), from 1994 until its final year in 2008/09. Self-reported (parent-reported) data was collected from parents/caregivers (person most knowledgeable [PMK]) about children (4–6-year-olds) in all provinces – except the territories, indigenous lands, or individuals who were institutionalized, from 1996 to 2008. Data included information on a child's behavioural, cognitive, emotional, and social development, as well as sociodemographic information on the PMK. Complete details are described elsewhere (Statistics Canada, 2010). Access to the NLSCY database was granted after permission was obtained through the Social Sciences and Humanities Research Council of Canada (SSHRC) application process. Upon approval by the SSHRC, the NLSCY database was accessed through a Research Data Centre (RDC) at York University in Toronto.

Study Sample

An overall weighted sample of ~5,626,000 children (ages 4 – 6 years) was analyzed. The analytic sample is an amalgamation of seven consecutive cycles (12/13 years) of survey data collected from years 1996 to 2008. Cycle 1 (1994/1995) was omitted due to inconsistencies in the definition of sport/OPA which did not capture dance, gymnastics, or martial arts – key sport/OPA types – until Cycle 2.Data was pooled to ensure a sufficiently large sample to allow explore a range of possible predictors. Most of the time, the biological mother was the PMK who self-reported data about the child – the unit of analysis. After applying the sample weights, the

estimated weighted analytic sample was ~5 572 000 children including ~1 863 000 children in the adjusted multivariable logistic regression model of OPA engagement, and a subsample of ~850 000 children in a sensitivity analysis.

Measurement of outcome

The outcome variable was sport/OPA, which was ascertained through PMK self-reports described elsewhere (Statistics Canada, 2010). The PMK was asked about the types of sport/OPA engagements in the past 12 months (e.g. *"outside of school hours, how often has your child taken part in sports with a coach or instructor [except dance, gymnastics or martial arts]?"*). The PMK was also asked about other types of sport/OPA in the past 12 months (e.g. *"outside of school hours, how often has your child taken lessons or instruction in other organized physical activities with a coach or instructor such as dance, gymnastics or martial arts?"*). These questions formed the basis for sport/OPA assessment. A third question was used to assess the UPA (e.g. *"outside of school hours, how often has your child taken part in unorganized sports or physical activities without a coach or instructor?"*). All items had five potential responses ranging form "most days" to "almost never". A composite "any" sport/OPA dichotomized variable was created based on the sport/OPA items and using pooled categories to show regular involvement or "OPA" (e.g. *"about once a week, or a few times a week, or most days"*), in contrast to non-regular involvement or "non-OPA" (e.g. *"about once a month/almost never"*).

Predictors of OPA and non-OPA

The independent variables were extracurricular activity and screen time. Extracurricular activity was measured based on the question *"In the past 12 months, outside of school hours, how often*

has this child taken lessons or instruction in music, art or other non-sport activities?" and its five responses ranging form "most days" to "almost never", which was recoded to show three responses (e.g. *"almost never or about once a month, about once a week, a few times a week"*). Screen time, based on responses to the average time per day the child watches T.V or videos (e.g. DVDs or video games), was measured in two ways: as a continuous variable in the earlier cycles until Cycle 6, and as a categorical variable, after Cycle 6, using six responses ranging from "none" to "3 hours or more". Due to changes between cycles, screen time was recoded to show only four responses (e.g. *"less than 1 hour, 1 hour to less than 2 hours, 2 hours to less than 3 hours, and 3 hours or more"*).

Covariates

In all multivariable analyses, this study controlled for child's age, sex, body mass index (BMI) based on the cut-offs set by the International Obesity Task Force (IOTF), childcare (e.g. "*hours per week spent in primary care arrangement [to allow PMK and spouse to work or study]"*), as well as several PMK reported family level factors: biological parent status, single parent status, immigration status, education, income status (ratio of household income to the related Low-Income Cut-off [LICO] level), alcohol status, smoking status, survey collection year, family-functioning score (a high score indicates family dysfunction), maternal depression score (a high score indicates symptoms of depression), parenting styles: positive interaction (a high score indicates positive interactions), ineffective (a high score indicates hostile/ineffective interactions), consistent (a high score indicates consistent parenting behaviour), and rational parenting (a high score indicates punitive/aversive interactions), and community size (population), which have been described elsewhere (Statistics Canada, 2010).

Statistical Analysis

Prevalence of OPA and non-OPA, as well as any subgroup variation was reported for the pooled sample, along with measures of central tendency for all proposed predictor variables. A bivariate analysis was performed to account for group variations across the non-OPA and OPA categories, as well as across survey cycles (see Appendix): T-test and ANOVA (including post hoc tests) were performed for continuous variables, and chi-square tests were performed for categorical variables. Crude or unadjusted odds ratios (OR) and 95% confidence intervals (95% CI) were reported for bivariate relationships using a multivariable logistic regression for the dichotomous outcome: OPA versus non-OPA (OR=1.00, referent). Adjusted odds ratios and 95% CI were reported for the logistic regression models, after adjusting for covariates (individual-level factors: child's age, sex, and BMI; family-level factors: hours of childcare, biological parent status, single parent status, parental immigration status, parental education, household income status, parental alcohol and smoking status, survey collection year, family-functioning score, maternal depression score, parenting styles: positive interaction, ineffective, consistent, and rational parenting, and community size). Because the barriers to PA may differ, children with self-identified reduced or differential abilities were not included in these analyses. Data analysis was performed with SAS version 9.4, weighted with the master survey weights to ensure national representativeness of the data, and statistical significance was set at alpha = 0.05. Results were aggregated in tables to summarize the distribution frequencies of all covariate and predictors according to PA types.

Results

Figure 1 shows the overall prevalence of OPA compared to non-OPA, as well as a preview of the PA patterns. Overall, 53.4% of 4- to 6-year-olds were engaged in at least some type of weekly OPA, and in the context of combined or total PA, 21.4% tend to be most inactive along with 10.9% who were most active.

Table 1 shows the sociodemographic characteristics among OPA and non-OPA groups. The two groups differed significantly ($p<0.0001$) for all individual and family level characteristics, except for ineffective parenting style. In general, the proportion of OPA participation tended to be higher among 4- to 6-year-old whose PMK reported the following: age 5 (50.27%), girls (51.03%), normal BMI weight (49.45%), rarely engaged in extracurricular activities (82.9%), spent 31-60 minutes a session being active (52.98%), spent on average 1-2 hours watching T.V. per day (41.32%), came from two-parent households (88.4%), parent did not immigrate (85.3%), parent completed college or university (62.03%), agreed that neighbourhood had safe parks (54.8%), consumed alcohol at least once a week (27.9%), never smoked (81.15%), and lived in urban areas (48.9%).

Table 2 shows the results of the unadjusted and multivariable logistic regression analyses reporting the odds of OPA engagement with individual and family level characteristics. In the unadjusted model, the odds of OPA was significant ($p<0.05$) in each bivariate relationship, and most of the effects were maintained in the adjusted model, except where the effects reversed (e.g., rational parenting, occasional smoking, and 2000-2001 survey or Cycle 4), or were not significant (e.g. single parent status, ineffective parenting style, and family functioning).

In the adjusted model, males (0.77, 0.76–0.77), and children with underweight or overweight / obesity were 6% and 22% *less* likely to be involved in OPA. The results also show that OPA was more likely among children who were older (5-year-olds: 62% greater; 6-year-olds: 81% greater), and involved in extracurricular activities (41-149% greater, depending on the type). Family level factors were also associated with a greater likelihood of OPA, such as household income above the LICO (43%), parental education – [college or university degree (129%) (2.29, 2.25–2.32])], frequent alcohol use (42%) (1.42, 1.39–1.45), and small towns (45%) (1.45, 1.43–1.46), or large urban residence (89%) (1.89, 1.87–1.91 greater). However, the likelihood of OPA was lower among children who engaged in higher screen time (46%) (0.54, 0.53–0.55), children of recent immigrants (45%) (0.55, 0.54–0.56), and children whose parents who smoked daily (40%) (0.60, 0.59–0.60) were less likely to be involved in OPA.

Sensitivity Analysis

Due to a higher than expected prevalence of childhood chronic conditions and medication use, as well as the inconsistencies across cycles in terms of measurements of other key covariates (e.g. duration of physical activity (with or without a coach), duration of sleep, access to safe neighbourhood parks, and social support of the PMK), a sensitivity analysis using a subsample of the later cycles (Cycle 5-7, or 2002/03 – 2008/09; **Table 1 Supplement**) was performed to adjust for these covariates to further account for potential residual confounding (**Table 3**). Using an expanded panel of related child and family level characteristics, most of the effects from the adjusted model in Table 2 were maintained, except where the effects were reversed (e.g., landed immigrant status), or not significant (e.g. single parent status, and maternal depression score)). Child's medication use was associated with 20% lower likelihood of OPA engagement (0.80, 0.78–0.81), and compared to non-immigrants, children of recent immigrants (< 10 years) were

12% more likely to engage in OPA (1.12, 1.09–1.15), while children of past immigrants (> 10 years) were 16% less likely to engage in OPA (0.84, 0.82–0.86). Other key predictors include social support (4% higher likelihood), PA sessions longer than 15 minutes (3-8-fold higher likelihood), and access to neighbourhood safe parks did not appear to be an encumbrance to OPA, which was found to have a 50-70% higher likelihood of OPA. Self-reported chronic conditions and sleep duration were not found to be significant predictors.

Discussion

The primary objective of this study was to provide robust, nationally representative data on the prevalence and predictors of sport participation among 4- to 6-year-olds over a 12-year period, results of which suggest that approximately half of 4-to 6-years-olds engaged in at least some OPA – with higher rates among more recent survey years – suggestive of a general shift in parental interest in both OPA and other non-sport related extracurricular activities. The secondary objective was to further our understanding of the socioecological factors, which tend to influence the sports participation.

Although this study did not find one-parent households to be a significant predictor of OPA (1.01, 1.00-1.02), parenting styles were found to have a significant but modest higher likelihood of sport/OPA (1-4%); however, the influence of other non-modifiable factors at the individual/child-level (e.g. age, gender/sex), and family-level (e.g. parental education, income, recent immigrant status, and living in an urban community), as well as BMI, screen time, and engagement in extracurricular activities were all related to OPA.

Overall, between 1996 and 2008, 53.4% of children (4- to 6-year-olds) were involved in some type of sport/OPA, compared to 46.6% of 4- to 6-year-olds who were not involved. The

OPA prevalence by survey year shows a higher prevalence of OPA from 2002-2008/09 (12.9-14.4%), compared to non-OPA (10.4-12.4%). This was consistent with previous estimates of young children's sport/OPA participation between Canada and the United States (AHKC, 2010; Malina 2010). Furthermore, between 1998 and 2008/09, there was an increasing trend in the prevalence of OPA among 4- to 6-year-olds (12.0-14.4%), compared to a decreasing trend in non-OPA (16.5-10.8%) during the same period. These findings suggest a modest growth in sport/OPA programs for young children. Since 1992, about 64-75% of children and youth have participated in sport; however, some studies report that sport participation rates, specifically among *older* children (5-14-year-olds), declined to about 51% by 2005 (Clark, 2014; Gruneau, 2010; Ifedi, 2005). Over a two-decade period, this decline appeared to be greater among boys (1992: 66%; 2005: 56%), compared to girls (1992: 49%; 2005: 45%) (Clark, 2014; Gruneau, 2010; Ifedi, 2005). Current estimates show 46% of 3- to 4-year-olds participating in sport/OPA (Participaction, 2018), and among 5- to 11-year-olds, boys tend to spend 28% more time in MVPA than girls; as such, nearly twice as many boys (47%) compared to girls (25%) (60.1 versus 47.1 minutes) were meeting the *24-hour Movement Guidelines* (Roberts et al., 2017). While the reason for these sex differences are not clear, foremost among the sociodemographic trends behind the sport participation rates are: parental involvement, parental education, immigrant status, and residential community. Thus, a comparison of the differences in sport/OPA participation helped to ascertain key individual and family level predictors of OPA among children. Notably, factors such as the child's age was associated with 62% to 81% higher likelihood of OPA engagement, whereas parental income was associated with a 43% higher likelihood. Parents play an important role in bolstering childhood PA through psychosocial support (e.g. encouragement), role modeling, and financial support (Bauman et al., 2012; Brown,

Shifrin, & Hill, 2015; Holt, Kingsley, Tink, & Scherer, 2011; Timmons et al., 2007; Tremblay et al., 2017). Similar studies have shown a 62% greater likelihood of sport participation when parental involvement is high (Clark, 2014); however, family structure (e.g. two-parent households) has also been shown to be important to sport involvement (Clark, 2014; Gruneau, 2010; Ifedi, 2005). As such, two-parent households, compared to one-parent households, tend to have more children involved in sport (Clark, 2014; Gruneau, 2010; Ifedi, 2005). The reasons for parental involvement or family structure are still unclear, and several factors related to socioeconomic status may be implicated (e.g., parental education, immigrant status, and residential community).

In terms of parental education, other studies have reported a 42% to 60% greater likelihood of sport/OPA among children whose parents had attained a high school or college diploma (Clark, 2014**;** Gruneau, 2010; Ifedi, 2005), which has been a similar finding of this study regarding parental education. In addition, sex/gender (being male (23%)) and non-normal weight status (6-22%) were factors that were inversely related to OPA engagement. Some findings were also consistent with sociocultural and socioeconomic discourse about sport engagement among this age group of young children, which takes into consideration parental immigrant status, given that one-fifth of Canada's population is naturalized (Clark, 2014).

Recently landed immigrants may experience socioeconomic barriers, such as income instability and material deprivation; thus, studies contend that children who came from recent immigrant households (i.e. < 10 years since immigrating) were less likely to engage in sports (32%) compared to children who came from Canadian-born parents (55%) (Clark, 2014; Ifedi, 2005; Gruneau, 2010). This was consistent with the findings of this study, which showed that children who came from landed immigrant households had a lower (25-45%) likelihood of

sport/OPA. The environment where the child is brought up also endures as a key determinant of sport involvement; thus, the residential community – with respect to population and access to neighbourhood safe spaces – also plays an important role in sport participation and overall PA (Cragg et al., 1999; Cragg et al., 2006).

For many children living within urban municipalities, high-density residential districts (e.g. community housing) tend to associate with a lower likelihood of sport involvement (42%), which may be the result of income disparities, compared to low-density residences (e.g. suburban areas), which have a higher likelihood (52%) of sport involvement (Clark, 2014; Gruneau, 2010). However, certain urban residential communities in this study which tended to have a higher (45-89%) likelihood of OPA, compared to rural communities, may be due to the inaccessibility of recreational facilities for sport in rural areas, compared to urban municipalities, which tend to have accessible neighbourhood recreational facilities or spaces for sport (Bauman et al., 2012). Furthermore, household lifestyle such as parent's alcohol and smoking habits, which also tend to have sociocultural or socioeconomic underpinnings, may influence sport/OPA engagement among children. This study found that parental alcohol consumption showed a higher (7-42%) likelihood of OPA; however, daily smoking showed a lower (40%) likelihood of OPA. These suggest that parental health behaviours have modest sociocultural influences on children's sport participation.

Limitations

There are a number of caveats to this study that warrant mention. First, because of the cross-sectional nature of the design, cause and effect cannot be determined. Second, where there is missing data, the power to detect a difference between OPA and non-OPA groups will be reduced – which may be particularly true for the analysis of the association between

extracurricular activities and academic achievement. Furthermore, other factors which contributed to inconsistencies and general under-reporting include BMI as well as screen time. As such, the self-reports and interviews, may be subject to errors with recall, and social-desirability, which cannot be excluded as additional sources of bias, as is often the case with large scale population surveys. Parents may not have had full knowledge of their child's activities (e.g. spontaneous bouts of play or movement – a large portion of total daily energy expenditure in children); however, it is assumed that OPA will have less reporting bias, given the structured nature of this activity. Lastly, the database is somewhat dated (e.g. 1994/95 – 2008/09), which requires cautious interpretations as the Canadian population has not been static. Nonetheless, with respect to the key study variable, the NLSCY is the only dataset with nationally representative estimates on which to assess this question.

Conclusion

The predictors of OPA have been reviewed in this study, and there is evidence to suggest that an interplay of socioecological factors tends to characterize engagement in OPA among children, an effect that was maintained over 12 years. The longitudinal design of the NLSCY makes available a next step for in-depth tracking and analyses of the long-term impact of exposure variables in subpopulations of children as they reach adolescence. The findings of this study would provide population-based insight into sport and PA participation to help inform the current discourse on sport and PA behavior in the maintenance of total PA in early childhood. Given that only ~11% of preschoolers partake in early specialization programs (Malina, 2010) and only 23% currently meet the daily recommendations for 60 minutes or more of moderate-vigorous physical activity, further longitudinal investigation is warranted.

Figure Legend:

Figure 1. Prevalence of OPA vs non-OPA among 4- to 6-year-olds.

Figure 2. Prevalence of combined PA (number of times per week) among 4- to 6-year-olds.

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Table 1. Sociodemographic characteristics of children (ages 4 – 6 years) by sport or organized physical activity (OPA) engagement and non-sport or OPA.

	Non-OPA %	OPA %	P-value
Individual-Level Characteristics			
Age			
N=5572000			
4-6 years old	46.60	53.40	<.0001
4-year-olds	50.99	39.83	
5-year-olds	41.08	50.27	
6-year-olds	7.93	9.90	
Mean (SEM)	4.57 (0.005)	4.70 (0.005)	<.0001
Sex	46.60	53.40	<.0001
Girls	46.17	51.03	
Boys	53.83	48.97	
Chronic Health Condition (child)			
N=5561000	46.55	53.45	0.0015
Yes	19.22	19.33	
No	80.78	80.67	
Regular Prescription Use (child)			
N=5571150	46.59	53.41	<.0001
Yes	9.64	8.35	
No	90.36	91.65	
BMI-category (IOTF)			
N=4269300	44.84	55.16	<.0001
Normal Weight	42.40	49.45	
Underweight	17.73	16.42	

Overweight	15.25	15.73	
Obesity	24.82	18.40	
Extracurricular activities (child)			
N=5563850	46.58	53.42	<.0001
Few times a week	1.62	3.48	
At least once a week	5.94	13.63	
About once a month or almost never	92.44	82.89	
(Childcare: hours per week)			
N=2717150	40.74	59.26	
Mean (SEM)	23.4993 (0.16)	21.0625 (0.13)	<.0001
Relations of PMK to child			
N=5572000	46.60	53.40	<.0001
Biological mother	88.39	90.32	
Biological father	9.68	8.35	
Other	1.93	1.33	
Family Structure			
N=5572000	46.60	53.40	<.0001
Two parents	79.81	88.44	
One parent	19.71	11.46	
Not living with parent	0.49	0.10	
Years since immigrating to Canada (PMK)			
N=5305750	46.19	53.81	<.0001
Did not immigrate	79.39	85.30	
≥ 10 years	12.38	10.60	
< 10 years	8.23	4.10	

Highest level of schooling (PMK)			
N=5487550	46.54	53.46	<.0001
Less than secondary	17.59	4.87	
Secondary school graduation	22.84	14.06	
Some post-secondary	21.27	18.41	
College or university degree (including trade)	37.67	62.03	
Other	0.62	0.62	
Household Low-income Ratio			
N=5506750	46.28	53.72	
Mean (SEM)	1.65 (0.008)	2.49 (0.013)	<.0001
Alcohol consumption (PMK)			
N=5448350	46.40	53.60	<.0001
Never	28.77	16.17	
Less than once a month	28.60	24.73	
At least once a month	23.11	27.68	
At least once a week	17.56	27.90	
Most days	1.96	3.51	
Smoking habit (PMK)			
N=5451700	46.41	53.59	<.0001
Never	66.93	81.15	
Occasionally	4.80	4.93	
Daily	28.27	13.92	
Community population size	46.58	53.42	<.0001
N=5549450			

Rural (< 1000)	15.09	9.43	
Urban, population < 30,000	15.48	14.39	
Urban, population 30,000 – 90,000	9.22	8.88	
Urban, population 100,000 – 499,000	15.52	18.31	
Urban, population > 500,000	44.69	48.99	
Survey year that child was included (%)			
N=5572000	46.60	53.40	<.0001
Cycle 2 (1996-1997)	23.60	20.46	
Cycle 3 (1998-1999)	16.53	12.03	
Cycle 4 (2000-2001)	14.88	13.41	
Cycle 5 (2002-2003)	12.36	12.85	
Cycle 6 (2004-2005)	11.44	12.84	
Cycle 7 (2006-2007)	10.35	14.03	
Cycle 8 (2008-2009)	10.84	14.39	

Table 1 (Supplement). Sociodemographic characteristics of children (ages 4 – 6 years) by sport or organized physical – Description of additional variables available in later survey years.

Duration of Sport or PA with or without a coach			
N=2578050	37.61	62.39	<.0001
1 – 15 minutes	17.39	2.77	
16 – 30 minutes	29.50	23.15	
31 – 60 minutes	27.51	52.98	
> 1 hour	25.61	21.10	
Sleep Duration (hours per day)			
N=3550000	43.63	56.37	
Mean (SEM)	10.37 (0.01)	10.51 (0.01)	<.0001
Screen Time (hours per day)			
N=5514650	46.44	53.56	<.0001
< 1 hour	10.26	17.14	
1-2 hours	31.14	41.32	
2-3 hours	31.76	28.14	
> 3 hours	26.83	13.40	
Safe parks			
N=3433250	43.31	56.69	<.0001
Strongly Agree	25.11	33.85	
Agree	60.46	54.82	
Disagree	11.03	9.35	
Strongly Disagree	3.40	1.98	

Table 2. Odds of Sport/OPA participation according to individual and family-level factors*.

		Unadjusted	95% Confidence Limits		Adjusted	95% Confidence Limits	
		Estimate	Lower	Upper	Estimate	Lower	Upper
Individual-Level Factors (Child)							
Sex	Female	1.00 (REF)	-	-	1.00 (REF)	-	-
	Male	0.82	0.82	0.83	0.77	0.76	0.77
Age	4-year-olds	1.00 (REF)	-	-	1.00 (REF)	-	-
	5-year-olds	1.57	1.56	1.57	1.62	1.61	1.63
	6-year-olds	1.60	1.59	1.61	1.81	1.79	1.84
BMI-category (IOTF)	Normal Weight	1.00 (REF)	-	-	1.00 (REF)	-	-
	Underweight	0.80	0.80	0.81	0.78	0.77	0.79
	Overweight	0.89	0.88	0.89	0.94	0.93	0.95
	Obesity	0.64	0.63	0.64	0.80	0.79	0.80
Extra-curricular activities	About once a month or almost never	1.00 (REF)	-	-	1.00 (REF)	-	-
	About once a week	2.56	2.55	2.58	1.41	1.39	1.42
	Few times a week	2.40	2.37	2.43	2.49	2.42	2.55
Screen Time (Hours per day watching T.V. or videos)	< 1 hour	1.00 (REF)	-	-	1.00 (REF)	-	-
	1-2 hours	0.79	0.79	0.80	0.84	0.83	0.84
	2-3 hours	0.53	0.53	0.53	0.71	0.70	0.72
	> 3 hours	0.30	0.30	0.30	0.54	0.53	0.55

Family-Level Factors (PMK)							
Primary child care arrangement		1.00 (REF)	-	-	1.00 (REF)	-	-
	Hours per week	0.99	0.99	0.99	0.99	0.99	0.99
Relationship of PMK to child	Biological mother	1.00 (REF)	-	-	1.00 (REF)	-	-
	Biological father	0.84	0.84	0.85	0.77	0.76	0.78
	Others	0.67	0.67	0.68	0.77	0.74	0.79
Single Parent Status	Two-parent	1.00 (REF)	-	-	1.00 (REF)	-	-
	One-parent (incl. Not living with a parent)	0.52	0.51	0.52	1.01	1.00	1.02
Parenting Styles	Parenting score	1.00 (REF)	-	-	1.00 (REF)	-	-
	Positive	1.04	1.04	1.04	1.02	1.02	1.02
	Ineffective	1.00	1.00	1.01	1.01	1.00	1.01
	Consistent	1.10	1.10	1.10	1.04	1.04	1.04
	Rational	0.94	0.94	0.94	1.01	1.01	1.02
Family Functioning	Family Functioning Score	1.00 (REF)	-	-	1.00 (REF)	-	-
		0.96	0.96	0.96	1.00	1.00	1.00
Maternal Depression	Depression Score	1.00 (REF)	-	-	1.00 (REF)	-	-
		0.96	0.96	0.96	0.99	0.99	0.99
Years since immigrating	Did not immigrate	1.00 (REF)	-	-	1.00 (REF)	-	-
	≥ 10 years	0.80	0.79	0.80	0.75	0.74	0.75

	< 10 years	0.46	0.46	0.47	0.55	0.54	0.56
Education	Less than secondary	1.00 (REF)	-	-	1.00 (REF)	-	-
	Secondary school graduation	2.22	2.21	2.24	1.31	1.29	1.33
	Some post-secondary	3.13	3.10	3.15	1.62	1.60	1.64
	College or university degree	5.91	5.87	5.95	2.29	2.25	2.32
Ratio of the household low income cut-off (LICO)		1.00 (REF)	-	-	1.00 (REF)	-	-
	LICO Ratio	1.77	1.77	1.78	1.44	1.43	1.44
Alcohol	Never	1.00 (REF)	-	-	1.00 (REF)	-	-
	Less than once a month	1.54	1.53	1.55	1.07	1.06	1.08
	At least once a month	2.13	2.12	2.14	1.18	1.17	1.19
	At least once a week	2.83	2.81	2.84	1.28	1.27	1.30
	Most days a week	3.19	3.16	3.23	1.42	1.39	1.45
Smoking	Never	1.00 (REF)	-	-	1.00 (REF)	-	-
	Occasionally	0.85	0.84	0.86	1.02	1.01	1.04
	Daily	0.41	0.40	0.41	0.60	0.59	0.60
Community population size	Rural (< 1000)	1.00 (REF)	-	-	1.00 (REF)	-	-
	Urban, population < 30,000	1.49	1.48	1.50	1.45	1.43	1.46

	Urban, population 30,000 – 90,000	1.54	1.53	1.55	1.46	1.44	1.48
	Urban, population 100,000 – 499,000	1.89	1.88	1.90	1.72	1.70	1.74
	Urban, population > 500,000	1.75	1.75	1.76	1.89	1.87	1.91
Survey Year	1996-1997	1.00 (REF)	-	-	1.00 (REF)	-	-
	1998-1999	0.84	0.84	0.84	0.88	0.87	0.89
	2000-2001	1.04	1.03	1.05	0.91	0.90	0.92
	2002-2003	1.20	1.19	1.21	1.17	1.16	1.19
	2004-2005	1.30	1.29	1.30	1.53	1.51	1.56
	2006-2007	1.56	1.55	1.57	1.46	1.44	1.49
	2008-2009	1.53	1.52	1.54	1.34	1.32	1.36

*analytic sample: n=1 863 000

Table 3. Sensitivity analysis* of relationship between Sport/OPA participation and an extended list of individual and family-level factors.

		Fully Adjusted Estimate	95% Confidence Limits Lower	Upper
Individual-Level Factors (Child)				
Sex	Female	1.00 (REF)	-	-
	Male	0.82	0.81	0.83
Age	4-year-olds	1.00 (REF)	-	-
	5-year-olds	1.49	1.47	1.51
	6-year-olds	1.15	1.08	1.22
BMI-category (IOTF)				
	Normal Weight	1.00 (REF)		
	Underweight	0.77	0.76	0.78
	Overweight	0.83	0.81	0.84
	Obesity	0.73	0.72	0.74
Chronic Condition				
	No	1.00 (REF)	-	-
	Yes	1.01	1.00	1.03
Medication				
	No	1.00 (REF)	-	-
	Yes	0.80	0.78	0.81
Extra-curricular activities	About once a month or almost never	1.00 (REF)	-	-
	About once a week	1.35	1.33	1.38
	Few times a week	1.30	1.25	1.35
Duration of activity with/without a coach				
	1 – 15 minutes	1.00 (REF)	-	-
	16 – 30 minutes	3.21	3.14	3.28
	31 – 60 minutes	8.51	8.33	8.70
	> 1 hour	3.58	3.50	3.66

Sleep duration (hours per day)		1.00	1.00	1.01
Screen time (child; hours per day)	< 1 hour	1.00 (REF)	-	-
	1-2 hours	0.90	0.89	0.92
	2-3 hours	0.73	0.72	0.74
	> 3 hours	0.49	0.48	0.50
Family-Level Factors (PMK)				
Primary child care arrangement		1.00 (REF)	-	-
	Hours per week	0.99	0.99	0.99
Relationship of PMK to child	Biological mother	1.00 (REF)	-	-
	Biological father	0.81	0.79	0.83
	Others	0.33	0.30	0.35
Single parent status	Two-parent	1.00 (REF)	-	-
	One-parent (incl. Not living with a parent)	0.98	0.97	1.00
Parenting Styles		1.00 (REF)	-	-
	Positive	1.03	1.03	1.03
	Ineffective	1.00	1.00	1.01
	Consistent	1.03	1.03	1.03
	Rational	1.04	1.04	1.04
Family Functioning	Family Functioning Score	1.00 (REF)	-	-
		1.03	1.03	1.04
Maternal Depression	Depression Score	1.00 (REF)	-	-
		1.00	1.00	1.00
Social Support	Social Support Score	1.00 (REF)	-	-
		1.04	1.04	1.05
Years since immigrating	Did not immigrate	1.00 (REF)	-	-
	≥ 10 years	0.84	0.82	0.86
	< 10 years	1.12	1.09	1.15
Education	Less than secondary	1.00 (REF)	-	-
	Secondary school graduation	1.44	1.41	1.48
	Some post-secondary	1.66	1.61	1.70
	College or university degree (including trade and Other advanced degree)	2.55	2.49	2.61

Income	Ratio of the household low income cut-off	1.00 (REF)	-	-
		1.54	1.53	1.55
Alcohol	Never	1.00 (REF)	-	-
	Less than once a month	1.12	1.10	1.14
	At least once a month	1.11	1.09	1.13
	At least once a week	1.06	1.04	1.08
	Most days a week	1.48	1.42	1.54
Smoking	Never	1.00 (REF)	-	-
	Occasionally	1.27	1.24	1.30
	Daily	0.63	0.62	0.64
Safe Parks	Strongly Disagree	1.00 (REF)	-	-
	Strongly Agree	1.70	1.65	1.76
	Agree	1.50	1.46	1.55
	Disagree	1.61	1.56	1.67
Community population size	Rural (< 1000)	1.00 (REF)	-	-
	Urban, population < 30,000	1.73	1.70	1.77
	Urban, population 30,000 – 90,000	1.56	1.52	1.60
	Urban, population 100,000 – 499,000	2.30	2.25	2.35
	Urban, population > 500,000	2.14	2.10	2.18
Survey Year	2002-2003	1.00 (REF)	-	-
	2004-2005	1.37	1.35	1.39
	2006-2007	1.69	1.66	1.71
	2008-2009	1.53	1.50	1.55

*****Analytic sample: n~850 000

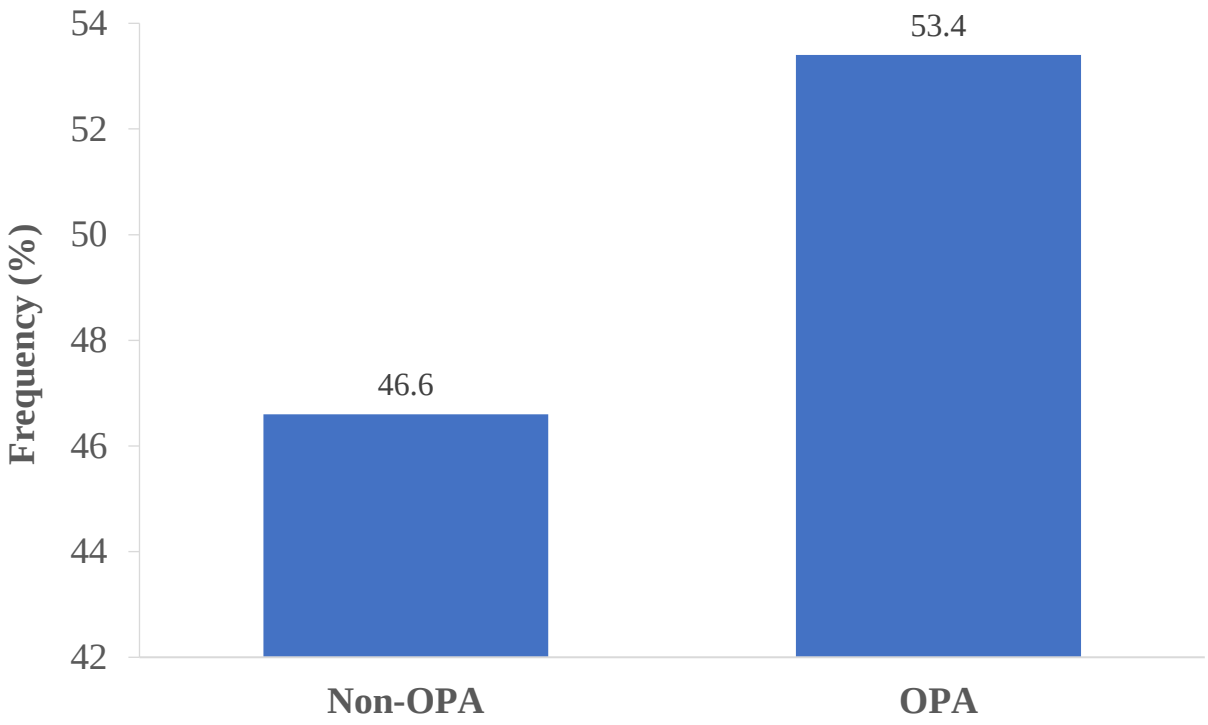

Figure 1. Prevalence of OPA vs non-OPA among 4- to 6-year-olds.

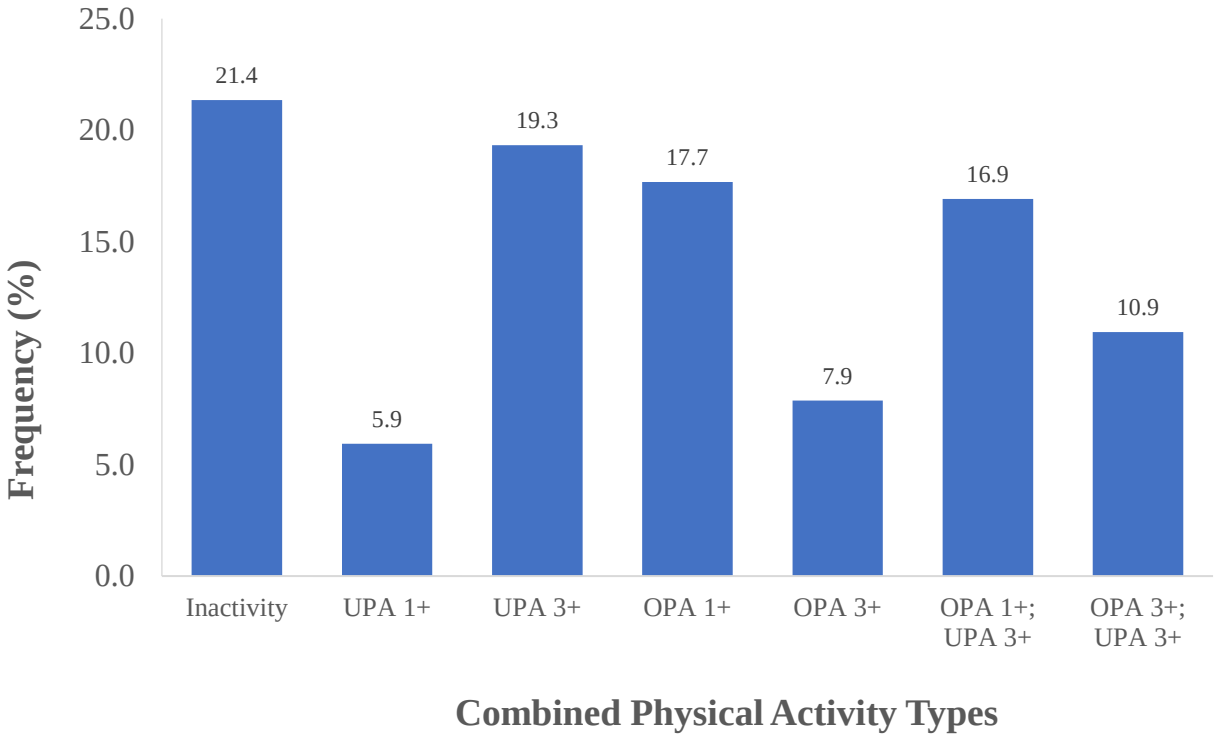

Figure 2. Prevalence of combined PA (number of times per week) among 4- to 6-year-olds.

Authors Contribution

Jessica Fraser-Thomas is the Primary Investigator, and Jennine Rawana, Rebecca Basset-Gunter, and Chris I. Ardern are Co-Investigators on the grant to support this work.

Akinkunle Oye-Ṣomẹfun performed the analysis, drafted the manuscript, and designed the figures and tables with support from CIA. JFT developed the idea, assisted with the analysis plan, and provided critical feedback on the manuscript draft.

Association between sport and non-sport physical activity participation and psychosocial health among children (ages 4 – 6 years) in Canada: Analysis of the National Longitudinal Survey of Children and Youth

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Abstract:

Background: Although the overall sport participation rate remains high among Canadian children and youth, there has been a declining trend in overall PA since 1992, which has been coupled with a rise in early sport programs for preschool-age children since 1997. The resulting shift in sport vs non-sport participation on psychosocial development, however, has not been extensively studied.

Objectives: The aim of this study is to evaluate psychosocial developmental outcomes associated with sport or organized physical activity (OPA) and unstructured physical activity (UPA), among children (ages 4 – 6 years) across Canada from 1996 to 2008.

Methods: We performed a cross-sectional analysis of 4-to-6-year-olds from the National Longitudinal Survey of Children and Youth (NLSCY) during the period of 1996 to 2008. The prevalence of psychosocial outcomes in the context of overall PA were reported. Analysis using multivariable logistic regression were then performed to determine how OPA and UPA relate to psychosocial development after adjusting for individual- and family-level characteristics. Data analysis was performed with SAS version 9.4, weighted with the master survey weights to ensure national representativeness of the data.

Results: Overall, this study found that a variety of PA types tend to shape early childhood psychosocial development. Children (ages 4 – 6 years) involved in frequent OPA (and children who are not largely inactive) could benefit from achievements in reading, writing and overall academics, as well as fewer problems regarding emotional/anxiety disorder,

hyperactivity/inattention, and poor social relationships. However, finding the right balance regarding a mix of structured and unstructured activities can be challenging for some including: males, older (maturing) preschoolers, households with one parent, as well as ineffective parenting.

Conclusion: Cross-sectional analyses suggest that parental involvement could be central to engagement in both structured and unstructured activities and for several notable indicators of childhood psychosocial development.

Introduction

Although the overall sport participation rate remains high (~75%) among children and youth (Canadian Fitness and Lifestyle Research Institute [CFLRI], 2011; CFLRI, 2014), the rate amongst 5-to 14-year-olds declined by 51% between 1992 and 2005 (Clark, 2014; Gruneau, 2010; Ifedi, 2005). At the same time, participation in early sport specialization (e.g. aspiring athlete) programs, which are tailored towards preschool-age children, grew from 9 to 12 percent, between 1997 and 2008 (Malina, 2010). This trend is disconcerting because only a few years earlier the American Academy of Pediatrics (AAP) (1992) declared that sport may not be appropriate for children under age 6. This was also echoed by Canadian institutions as early sport involvement continues to expand (CS4L, 2011). Given that over one-third of children tend to drop out of sport between childhood and adolescence, sport engagement may be contributing to negative outcomes (Findlay et al., 2009; Fraser-Thomas et al., 2008; Whitehead, 2001; Whitehead, 2007). To this point, dropouts are more common among children whose parents were high-performing athletes, and drop out has been shown to be a factor among children who engaged in sport at an early age or were the youngest in their training cohort (Fraser-Thomas et al., 2008). However, considerably less is known about the effects of sport engagement on psychosocial development (Fraser-Thomas et al., 2008; Holt & Neely, 2011; Holt et al., 2011).

Key psychosocial domains of early childhood development guided by a positive youth development (PYD) framework include cognitive, emotional, and social competence; as such, children who tend to have poor behavioural control also tend to have poor social relationships with teachers, as well as disinterest or difficulty in school achievement (Hertzman, 2004; Janus & Duku, 2005). These children also tend to have difficulties managing aggression (Lynch & Cicchetti, 1997); thus, PYD is a strength-based developmental approach – an alternative to

conventional deficit reduction – which views children as social resources (Holt & Neely, 2011). As such, PYD does not focus on shortcomings, rather, it promotes the ways sport develops life skills by validating the different strengths of individuals and facilitating a pathway to achievement (Fraser-Thomas et al., 2005; Holt & Neely, 2011). Therefore, cognitive, emotional, and social development are important psychosocial outcomes (Weiss & Wiese-Bjornstal, 2009). However, without national prevalence estimates on the developmental outcomes in relation to sport and OPA, considerable gaps in the literature precludes the ability for parents, coaches, and educators to make informed choices about early sport involvement, and potential psychosocial effects.

As a consequence, more comprehensive research on early childhood PA is needed due to the popularity of sport, and in order to explore broader socioeocological and psychosocial challenges (Pate et al., 2013; Timmons et al, 2012). To date, what is known is that sport associates positively with development among adolescents and youth (Holt & Neely, 2011; Holt et al., 2011); however, what remains to be investigated are the broad characteristics of sport engagement in relation to early childhood development, while taking into consideration the perceived social and environmental barriers to PA (White & McTeer, 2012). The main objective of this paper was to therefore examine developmental outcomes associated with sport/OPA and unorganized physical activity (UPA) among 4- to 6-year-olds in Canada, using a cross-sectional analysis of the National Longitudinal Survey of Children and Youth (NLSCY; 1996 to 2008).

Methods

Database

This study performed a cross-sectional analysis of the National Longitudinal Survey of Children and Youth (NLSCY) – a database which began in 1994 through a joint venture between Statistics Canada and Human Resources and Skills Development Canada (HRSDC), until its final year in 2008/09. NLSCY was designed to collect national and provincial prospective data regarding risk factors and/or protective factors contributing to a child's behavioral, psychological, and social development and well-being from birth to early adulthood (Statistics Canada, 2010). Self-reported data was collected from parents/guardians (person most knowledgeable [PMK]) in all provinces – except the territories, indigenous lands, or individuals who were institutionalized, from 1996 to 2008. Data included information on a child's behavioural, cognitive, emotional, and social development, as well as sociodemographic information on the PMK. Complete details are described elsewhere (Statistics Canada, 2010). Access the NLSCY database was granted after permission was obtained through the Social Sciences and Humanities Research Council of Canada (SSHRC) application process. Upon approval by the SSHRC, the NLSCY database was accessed through a Research Data Centre (RDC) at York University in Toronto.

Study Sample

An overall weighted sample of ~5 626 000 children (ages 4 – 6 years) was analyzed. The analytic sample was obtained from a pooled dataset consisting of seven consecutive cycles or about 12 years of survey data collected from 1996 to 2008 in order to ensure enough sample size for the prediction of psychosocial outcomes of interest. The earliest cycle (1994/1995) was

omitted to avoid inconsistencies in measurements of key sport/OPA types. The child was the unit of analysis, and the biological mother was the PMK who (most often) self-reported data about the child. The estimated unweighted analytic sample was ~ 37 000 children (ages 4 – 6 years). After applying the sample weights, the estimated weighted analytic sample was ~5 572 000 children including 1 800 000 to 1 860 000 children in the adjusted multivariable logistic regression models of social development; 112 000 to 138 000 children in the models of academic achievement engagement, and; a subsample of ~850,000 children in a sensitivity analysis. Lastly, a preliminary scan was performed on the unweighted data and no interactions were found; therefore, the main effects of the final weighted adjusted multivariable logic models were kept for ease of interpretation and consistency among all the psychosocial outcomes.

Measurement of Outcomes

Child Behaviours

To identify the presence of potential emotional and behavioural difficulties, parents were asked to rate a child's behavioural health (a high score indicates the presence of disruptive behaviours) using age-specific items found in the NLSCY's Child Behavior Checklist (Cronbach's alpha was used to report internal consistency): a) *Hyperactivity and inattention*: 7-8 items adapted from the Montreal Longitudinal Survey and Ontario Child Health Study (Cronbach's alpha between 0.774 – 0.817), b) *Emotional disorder and anxiety*: 7-8 items from the Ontario Child Health Study (Cronbach's alpha between 0.665 – 0.756), c) *Physical aggression and conduct disorder*: 6 items from the Montreal Longitudinal Survey and the Ontario Child Health Study (Cronbach's alpha between 0.714 – 0.782), and; d) *Indirect aggression*: 5 items adapted from Lagerspetz, Bjorngvist and Peltonen of Finland (Cronbach's alpha between 0.632 – 0.745), details described elsewhere (Statistics Canada, 2010, p.76).

Thresholds for identifying potential emotional and behavioural difficulties were determined by measuring the score at or above the 90th percentile for each behavioural scale (Cussen et al., 2011; Currie & Stabile, 2004; Hertzman, 2004; Janus & Duku, 2005).

Child Social Relationships

To identify the presence of potential relationship problems, parents were asked to rate items within the questionnaire about their children's social relationships. The relationship subscales include items that ask about how well this child was getting along, in the past six months with: them as the parent, siblings, other children, such as friends or classmates (excluding siblings), childcare provider, and teacher(s) at school. Each item had five potential responses ranging form "very well" to "not well at all". A composite "adult-child" social relationship dichotomized variable was created based on how well the child got along with the adults (e.g. parent, childcare provider, and teacher) using pooled categories to show no problems (e.g. *"very well/quite well/pretty well"*), in contrast to *frequent problems* (e.g. *"not too well/not well at all"*). A composite "peer" social relationship dichotomized variable was created based on how well the child got along with their peers (e.g. siblings, and other children) using pooled categories to show no problems (e.g. "*very well/quite well/pretty well"*), in contrast to *frequent problems* (e.g. *"not too well/not well at all"*) (Lynch & Cicchetti, 1997).

Child Academic Achievements

To identify the presence of school achievement, parents were asked to rate age-specific items within the questionnaire about their children's educational experiences based on their report cards. Questions were asked about achievement in specific subject areas such as reading, mathematics, writing, and overall school achievement. The subscales had five potential responses ranging form "very well" to "very poorly". A composite dichotomized variable was

created based on the child performing "very well" in each subject area (e.g. reading, math, writing, and overall) in contrast to the pooled "other" categories (e.g. "*well/average/poorly/very poorly"*). These categories were formatted to show the required the key outcomes while mitigating risk to respondent confidentiality vetting process, details are described elsewhere (Statistics Canada, 2010).

Measurement of Exposures

Children's sport and OPA engagement was measured through two items from the NLSCY completed by the PMK: a) *"outside of school hours, how often has your child taken part in sports with a coach or instructor [except dance, gymnastics or martial arts]?"* and b) *"outside of school hours, how often has your child taken lessons or instruction in other organized physical activities with a coach or instructor such as dance, gymnastics or martial arts?"*. Both items had five potential responses ranging form "most days" to "almost never". These questions framed the sport/OPA assessment. To observe children's UPA involvement, one item in the NLSCY was used to measure this exposure (e.g. *"outside of school hours, how often has your child taken part in unorganized sports or physical activities without a coach or instructor?"*), with responses ranging form "most days" to "almost never". A composite "any" sport/OPA dichotomized variable was created based on the sport/OPA items and using pooled categories to show regular involvement: "OPA" (e.g. about once a week/a few times a week/most days), in contrast to non-regular involvement: "non-OPA" (e.g. about once a month/almost never). To describe broader PA patterns, a composite "combined" PA variable was created to show: a) inactivity, b) once a week UPA, c) few times a week UPA, d) once a week OPA, e) few times a week OPA, f) OPA once a week with UPA a few times a week, and g) both OPA and UPA a few times a week. These categories were formatted to show the required PA patterns while mitigating

risk to respondent confidentiality vetting process, details are described elsewhere (Statistics Canada, 2010).

Covariates

In all multivariable analyses, this study controlled for children's age, sex, body mass index (BMI) – based on the cut-offs set by the International Obesity Task Force (IOTF), childcare (e.g. "*hours per week spent in primary care arrangement [to allow PMK and spouse to work or study]"*), extracurricular activities (a composite polychotomized variable taken from five responses ranging form "most days" to "almost never", and formatted to show: almost never/about once a month, about once a week, a few times a week), screen time (hours per day), and childcare (hours per week), as well as several PMK reported family level factors: biological parent status, single parent status, immigration status, education, income status (ratio of household income to the related Low-Income Cut-off [LICO] level), alcohol status, smoking status, survey collection year, family-functioning score (a high score indicates family dysfunction), and maternal depression score (a high score indicates symptoms of depression), and parenting styles: positive interaction (a high score indicates positive interactions), ineffective (a high score indicates hostile/ineffective interactions), consistent (a high score indicates consistent parenting behaviour), and rational parenting (a high score indicates punitive/aversive interactions), and community size (population), which have been described elsewhere (Statistics Canada, 2010).

Statistical Analysis

A secondary analysis of seven cycles (1996 to 2008) of the NLSCY was performed, and findings including sociodemographic characteristics were reported (using prevalence estimates,

and logistic regression) to understand the relationship between psychosocial outcomes and PA patterns, including children who engaged in OPA versus non-OPA. The purpose of this analysis was to understand how sport/OPA as well as the total PA context relates to psychosocial development among 4- to 6-year-olds.

In an initial step, psychosocial outcomes were compared across PA categories and across survey cycles (see **Appendix**): T-test and ANOVA (including post hoc tests) were performed for continuous variables, and chi-square tests were performed for categorical variables. Crude or unadjusted odds ratios and 95% confidence intervals (95% CI) were then reported for bivariate relationships to compare OPA and non-OPA for the outcomes of *hyperactivity/inattention*, *emotional/anxiety disorders*, *physical aggression/conduct disorder*, *indirect aggression*, adult-child social relationships (*frequent problems*), peer social relationships (*frequent problems*), reading, mathematics, writing, and overall academic achievement. Multivariable logistic regression, adjusting for individual and family-level characteristics was then conducted. Because the barriers to PA may differ, children with self-identified reduced or differential abilities were not included in these analyses. Data analysis was performed with SAS version 9.4, weighted with the master survey weights to ensure national representativeness of the data, and statistical significance was set at alpha = 0.05. Results were aggregated in tables to summarize the frequencies of all covariate and predictors according to PA types.

Results

Figure 1, 2, and 3 show the overall prevalence of OPA compared to non-OPA in relation to the outcomes: academic or school achievement (reading, math, overall), social relationships (*frequent problems* with adults, or peers), and behavioural health (*hyperactivity*, *emotional*/*anxiety disorder*, *physical aggression/conduct disorder*, and *indirect aggression*),

respectively. **Figure 4, 5, and 6** present PA patterns in relation to the same outcomes. The groups differed significantly (p<0.0001) for all outcomes.

Prevalence of OPA vs Non-OPA and Combined PA

Academic Achievement

Children (4- to 6-year-olds) with higher levels of achievement tended to be engaged in some type of OPA, compared to non-OPA: reading achievement (OPA [51.4%] vs non-OPA [38.5%], mathematics achievement (OPA [52.9%] vs non-OPA [41.1%], overall achievement (OPA [54.9%] vs non-OPA [39.6%]). In the context of combined/total PA patterns, in reading achievement the highest prevalence tends to be OPA (few times a week (57.1%)), and the least prevalence tends to be frequent UPA (a few times a week (37.6%)); however, in mathematics and overall achievement, weekly OPA (once a week [56.3%] and [62.0%], respectively) tended to be the most prevalent, and inactivity ([37.8%] and [36.1%], respectively) was the least prevalent.

Social Relationships

Higher proportion of children (ages 4 – 6 years) who had *frequent problems with adults* with adults tended to be involved in OPA (1.04%) *vs* non-OPA (1.03%); however, a lower proportion of 4- to 6-year-olds engaged in OPA (3.6%) vs non-OPA (4.3%) were having *frequent problems with peers*. In the context of combined/total PA patterns and *frequent problems with adults*, children involved in weekly OPA (once a week) and frequent UPA (a few times a week) (1.5%) tended to be the most prevalent group, and those involved in weekly UPA (once a week (0.6%)) were the least prevalent group. Regarding *frequent problems with peers*, the most prevalent group was UPA a few times a week (4.6%), and the least prevalent groups (3.4%) were weekly

OPA (once a week), frequent OPA (a few times a week), and frequent OPA and UPA (a few times a week).

Emotional and Behavioural Difficulties

Prevalence of emotional and behavioural difficulties were higher among 4- to 6-year-olds in non-OPA compared to the OPA group: *hyperactivity* (OPA [11.5%] vs non-OPA [16.5%]), *emotional/anxiety disorder* (OPA [13.6%] vs non-OPA [14.9%]), *conduct disorder* (OPA [12.8%] vs non-OPA [15.3%]), *indirect aggression* (OPA [12.9%] vs non-OPA [15.3%]. In the context of combined/total PA patterns and behavioural health: the prevalence of *hyperactivity* was highest among inactive children (16.8%), and lowest among children with frequent OPA and UPA (a few times a week (9.3%)); however, the prevalence of *conduct disorder* was highest among children engaged in frequent UPA (a few times a week (16.8%)), and lowest among the frequent OPA (a few times a week (11.1%)) group. Lastly, the prevalence of *emotional/anxiety* as well as *indirect aggression* were highest among weekly UPA (once a week (16.0% and 17.3%, respectively)), and the least prevalence was among children engaged in frequent OPA and UPA (a few times a week (12.3% and 11.9%, respectively)).

Psychosocial Outcomes: Sport Context

Table 1 shows the pooled sociodemographic characteristics. The variables differed significantly (p<0.0001) for all individual and family level characteristics, except for the *emotional disorder/anxiety* mean score, *poor social relationships with adults*, and ineffective parenting style. **Table 2** shows the results from the adjusted multivariable logistic regression models reporting the odds ratio estimates of the outcomes in relation to OPA engagement, and total PA patterns. In a bivariate analysis using a logistic regression, OPA in relation to each outcome was

significant (p<0.05), with the exception of social relationships with adults (*frequent problems*) (1.01, 0.99–1.02). The likelihood of disruptive behaviours was lower among *hyperactivity* (0.66, 0.66–0.66), *emotional/anxiety disorder* (0.89, 0.89–0.90), *conduct disorder* (0.81, 0.81–0.82), and *indirect aggression* (0.82, 0.81–0.82). In terms of social relationships, there was a lower likelihood of *frequent problems with peers* (0.82, 0.82–0.83). Regarding academic achievement, there was a higher likelihood of achievement in reading (1.69, 1.67–1.71), writing (1.98, 1.95–2.01), mathematics (1.61, 1.59–1.63), and overall (1.86, 1.84–1.88).

Most of the preceding effects were maintained after adjusting for all key covariates, except *hyperactivity* and *physical aggression/conduct disorder*. Regarding behavioural health, the likelihood of *emotional/anxiety disorder* was lower in relation to OPA (0.87, 0.86–0.88); however, there was a higher likelihood of *indirect aggression* associated with OPA (1.06, 1.05–1.07). Regarding social relationships, there was a higher likelihood of *frequent problems with adults* (1.20, 1.16–1.24), or *peers* (1.27, 1.25–1.29). Finally, in terms of academic achievement, there was a higher likelihood of reading (1.33, 1.29–1.37), writing (1.09, 1.04–1.13), and overall achievement (1.30, 1.26–1.34).

Psychosocial Outcomes: Combined or Total PA Context

Regarding combined/total PA patterns, the bivariate relationships were mixed except for a higher likelihood of achievement in mathematics (24-112%) as well as overall achievement (23-189%), and a lower likelihood of *hyperactivity* (2-49%). After adjusting for all key covariates, the relationships were mixed and many outcomes were significant, except: reading achievement (UPA once a week: [1.02, 0.95–1.10]), mathematics achievement (OPA a few times a week: [1.00, 0.95–1.06]), overall achievement (UPA once a week: [1.07, 0.99–1.15]; UPA a few times

a week: [1.01, 0.96–1.07]), and *frequent problems with peers* (OPA a few times a week: 0.99, 0.95–1.02).

Sensitivity Analysis

A sensitivity analysis was performed on an estimated subsample 850 000 children (ages 4 – 6 years) (cycle 5-7, or 2002/03 – 2008/09) in order to adjust for covariates and mitigate potential residual confounding effects due to unexpected proportions of children with chronic conditions and medication usage. Furthermore, the measurements of other key covariates, such as duration of PA, duration of sleep, access to safe neighbourhood parks, and social support, were only developed and added in the later cycles (e.g. cycles 5-8) or found to be inconsistent in the earlier cycles. Included in the multivariable logistic regression reporting the adjusted odds ratio estimates of behavioural health in relation to OPA, with an expanded panel of related child level characteristics (e.g. chronic conditions, medication use, duration of activity (with or without a coach), and sleep duration) and family level characteristics (e.g. social support (PMK), and neighbourhood parks). **Table 3** shows only the results of the adjusted odds ratio estimates of the behavioural health in relation to OPA.

In general, the sensitivity analysis showed that the odds of disruptive behaviours – *hyperactivity* (0.73, 0.72–0.74), *indirect aggression* (0.93, 0.92–0.95), and *physical aggression/conduct disorder* (1.17, 1.15–1.19) – except *emotional/anxiety disorder*, in relation to OPA, were significant (p<0.05). This suggests that some OPA may have protective effects regarding *hyperactivity*, *indirect aggression*, and even *emotional/anxiety disorder* – although it was clearly not significant (0.98, 0.96–1.00).

Furthermore, most of the effects from the comprehensive analysis were maintained in the sensitivity analysis, except where the effects were reversed; for example: 6-year-olds (higher odds of *hyperactivity*, and *emotional/anxiety* disorder), 5-6-year-olds (lower odds of *indirect aggression*), urban settings (higher odds of *hyperactivity*), underweight (lower odds of *hyperactivity*, and higher odds of *emotional/anxiety disorder*), parent's education (some post-secondary education [higher odds of *physical aggression/conduct disorder*]), weekly extracurricular activities (higher odds of *indirect aggression*), and extracurricular activities about a few times a week (lower odds of *indirect aggression*).

Overall, the odds of disruptive behaviours were generally higher amongst children with self-reported chronic conditions, medication use, 31-60 minutes of PA (in *indirect aggression*, [1.20, 1.17–1.24]), one hour or more of PA (in *hyperactivity*, [1.35, 1.30–1.39]), greater amounts of screen time (> 3 hours, in *hyperactivity* and *indirect aggression* [30-38%] higher), and ineffective parenting (14-28% higher). However, the odds of *emotional/anxiety disorder* or *physical aggression/conduct disorder* were typically lower among children with at least 31 minutes of PA (26-39% lower) and 16-60 minutes of PA (16-24% lower), respectively; furthermore, the odds were found to be lower with greater amounts of screen time (> 3 hours, in *emotional/anxiety disorder* and *physical aggression/conduct disorder* [22-30%] lower).

Discussion

Existing research has reported benefits to psychosocial health among children who participated in sports; for example, social competence and enhanced social skills to resolve conflicts and manage behavioural difficulties, emotional control and better social relationships

with adults and peers, social connectedness and social well-being, behavioural control, cooperation, and self-esteem, as well as reduced anxiety (Dimech A, Seiler R, 2011; Findlay & Coplan, 2008; Holt et al., 2011; Holt et al., 2017; Howie et al., 2010; Zarrett et al., 2009). This study investigated PA patterns as well as sport contexts in relation to psychosocial health among children (ages 4 – 6 years). Pooling of multiyear survey cycles was advantageous to the analysis of younger age groups which mitigates the likelihood of confounding by pre-existing conditions, and; the determination of robust national prevalence estimates.

Academic Achievement

This study found higher rates of OPA (51.4–54.9%) compared to non-OPA (38.5–41.1%). In terms of combined/total PA patterns, the most prevalent subgroup overall was OPA weekly (once a week (62.0%)), and the least prevalent group was *inactivity* (36.1%). After adjusting for covariates, a higher likelihood of achievement among children involved in OPA (9-33%) was found in most subject areas (except mathematics (28% less likely)). Although the findings for combined/total PA were mixed, it is clear that children who were engaged in frequent OPA were more likely (116-202%) to achieve in most subject areas. Aptly, children who had a combination of frequent UPA and weekly OPA were also more likely (48-217%) to achieve in most academic subjects. Surprisingly, children who were involved in a combination of frequent OPA and UPA were *less* likely (47-82%) to achieve in *all* subject areas. Achievement was also more likely among 5- to 6-year-old (2–12-folds), higher BMI (3-123%), extracurricular activities (4–26-folds), landed immigrants (> 10 years since first immigrating [11-154%]), and those who lived in urban centres (< 500,000 [42-123%]). Achievement was less likely when children were: male (8-62%), exposed to screen time (20-92%), exposed to parent's smoking habit (4-31%), and landed immigrants (< 10 years [70-81%]).

Social Relationships

With resect to social relationships, no differences in the prevalence of OPA (1.04%) compared to non-OPA (1.03%) were found amongst children with *frequent problems with adults*; however, a lower proportion of children engaged in OPA (3.6%) compared to non-OPA (4.3%) had *frequent problems with peers*. In the context of combined/total PA patterns, the most prevalent subgroup was a combination of weekly OPA (once a week) and frequent UPA (a few times a week) (1.5%), and the least prevalent group was weekly UPA (once a week (0.6%)). For the variable *frequent problems with peers*, frequent UPA (a few times a week (4.6%)) was the most prevalent classification, while weekly OPA (once a week), frequent OPA (a few times a week), and frequent OPA as well as UPA (a few times a week) were all least prevalent (3.4%). After adjusting for covariates, OPA associated with a higher likelihood of *frequent problems with adults* (1.20, 1.16–1.24]), or *peers* (1.27, 1.25–1.29]). Taken all together, children (ages 4 – 6 years) who were involved in frequent OPA or frequent UPA context were less likely (31-66%) to have problems with adults, and children in frequent UPA were less likely (23%) to have problems with peers; however, children who participated in frequent OPA and UPA were surprisingly less likely (13-22%) to have problems with either adults or peers.

Emotional and Behavioural Difficulties

There was a higher prevalence among children in non-OPA (14.9-16.5%), compared to the OPA group (11.5-13.6%). In the context of combined/total PA patterns and disruptive behaviours: the prevalence was highest for *indirect aggression* with weekly UPA (once a week (17.3%)), and the prevalence was least in *hyperactivity*, among children engaged in OPA and frequent UPA (a few times a week (9.3%)). After adjusting for covariates, the likelihood of *emotional/anxiety disorder* was lower in relation to OPA (0.87, 0.86–0.88]); however, there was

a higher likelihood of *indirect aggression* associated with OPA (1.06, 1.05–1.07). Further, most combined PA contexts tended to associate with a lower likelihood of *emotional/anxiety disorder* (6-28%), and a higher likelihood of *hyperactivity* (9-46%), *indirect aggression* (5-31%), as well as *physical aggression/conduct disorder* (21-79%).

Overall, this study found that psychosocial development among children (ages 4 – 6 years) tends to be shaped by a variety of PA types. Engagement in frequent OPA (as well as most PA types) tends to benefit a variety of childhood psychosocial outcomes including: reading, writing and overall academics, as well as emotional/anxiety disorders, hyperactivity/inattention, and social relationships. However, family structure and effective parenting are important for finding the right balance regarding a mix of structured and unstructured activities for psychosocial health. This study also found that sociodemographic characteristics including: child's sex, child's age (maturity), child's BMI (higher index), family structure (and functioning), and parenting, exerted a modest to high degree of influence on psychosocial development. As such, having a parent who has been a landed immigrant for more than 10 years or having a parent who was a recently landed immigrant (<10 years), may have had protective effects with respect to academic achievement and social relationships or most disruptive behaviours (except *indirect aggression*), in that order. Higher household income tended to have protective effects for some psychosocial development (e.g. *hyperactivity*, *conduct disorder*, social relationships with adults, reading and writing achievement), and ineffective parenting tended to not have protective effects for most psychosocial outcomes.

Surprisingly, higher BMI (including obesity) may confer protective effects for many aspects of psychosocial development (e.g. *hyperactivity*, *emotional/anxiety disorder*, *physical aggression/conduct disorder*, social relationships with adults, as well as reading and overall

academic achievements). Further, one-parent households (including children not living with a parent) tended to be positively related to reading and overall academic achievement, and inversely related to *emotional/anxiety disorder*.

Given that PA itself tends to be shaped by several intrapersonal and interpersonal determinants during childhood (Bauman et al., 2012), such as parental involvement (which is important for children to be involved in sport and PA in general), it was expected that there would be mixed findings regarding psychosocial development during the early childhood years – a period of cognitive, emotional, and social development and challenges (Timmons et al., 2012; Whitehead, 2007). However, it is clear that there is added value in frequent involvements in either OPA or UPA. Frequent UPA tends to benefit emotional health, social relationships, and academic achievement. Similarly, frequent OPA tends to benefit emotional health, social relationships with adults, reading, writing, and overall academics. Frequent OPA and UPA tend to moderate *hyperactivity*, *emotional/anxiety disorders*, and poor social relationships. Lastly, weekly OPA tends to benefit emotional health as well as reading, writing, and overall academics. Further, a sensitivity analysis showed that weekly OPA maintained similar moderating effects on *hyperactivity* as well as *indirect aggression* after adjusting for additional covariates.

Study Limitations

Limitations of this study include the cross-sectional nature of the surveys which preclude causal inference. Because study exposures and outcomes are based on self-report and interview, we cannot exclude the possibility of a healthy responder, social desirability, or recall bias. As it relates to PA, this may result in an over-estimation of the true PA participation rates in relation to health outcomes, which may bias estimates towards the null. Furthermore, the breadth and depth of movement behaviours may not have been captured in all aspects (e.g. spontaneous bouts of

play or movement – a large portion of total daily energy expenditure in children); however, reporting bias is assumed to be low in terms of OPA due to its structured nature (e.g. commitment, cost, and scheduling). Cautious interpretations are also warranted due to the database being dated (e.g. 1994/95 – 2008/09); however, the NLSCY is a unique dataset with nationally representative estimates on which to assess the key question. Future investigation using a larger sample may be warranted.

Conclusion

This study reviewed several psychosocial outcomes in relation to sport/OPA and UPA, among children in Canada. Results suggest that parental involvement is central to balancing structured and unstructured activities for the well-being of children. Children involved in sport tend to develop feelings of relatedness and a strong sense of behavioural control, which results in a high degree of academic achievement. Thus, the positive outcomes associated with sport help to facilitate transferable skills, which is encouraging to achieving overall positive youth development, lifelong PA, and social capital over a lifecourse.

Figure Legend:

Figure 1. Prevalence of a) reading, b) math, and c) overall achievement in relation to OPA vs non-OPA, among 4- to 6-year-olds.

Figure 2. Prevalence of a) frequent problems with adults, b) peers (social relationships), and c) hyperactivity in relation to OPA vs non-OPA, among 4- to 6-year-olds.

Figure 3. Prevalence of a) hyperactivity, b) emotional disorder, c) physical aggression / conduct disorder, and d) indirect aggression in relation to OPA vs non-OPA, among 4- to 6-year-olds.

Figure 4. Prevalence of a) reading, b) math, and c) overall achievement in relation to combined PA (number of times per week), among 4- to 6-year-olds.

Figure 5. Prevalence of a) frequent problems with adults, b) peers, and hyperactivity poor social relationships with peers (frequent problems) in relation to combined PA (number of times per week), among 4- to 6-year-olds.

Figure 6. Prevalence of a) hyperactivity, b) emotional disorder, c) physical aggression / conduct disorder, and d) indirect aggression in relation to combined PA (number of times per week), among 4- to 6-year-olds

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Table 1. Sociodemographic characteristics of the pooled data, weighted to be representative of the population.

Individual-Level characteristics	POOLED	P value
Age	(%)	
4-6 years old	N=5572000	<.0001
4-year-olds	45.03	
5-year-olds	45.99	
6-year-olds	8.98	
Mean (SEM)	4.64 (0.003)	<.0001
Sex		<.0001
Girls	48.77	
Boys	51.23	
Chronic Health Condition (child)	N=5561000	0.0015
Yes	19.28	
No	80.72	
Regular Prescription Use (child)	N=5571150	<.0001
Yes	8.95	
No	91.05	
BMI-category (IOTF)	N=4269300	<.0001
Normal Weight	46.29	
Underweight	16.92	
Overweight	15.51	
Obesity	21.28	
Extracurricular activities (child)	N=5563850	<.0001

Most days	0.65	
Few times a week	1.96	
At least once a week	10.05	
At least once a month	1.70	
Almost never	85.63	
***Duration of sport or PA with/without a coach**	N=2578050	<.0001
1 – 15 minutes	8.27	
16 – 30 minutes	25.54	
31 – 60 minutes	43.40	
> 1 hour	22.79	
***Duration sleep**	N=3550000	
Hours per day: Mean (SEM)	10.45 (0.01)	<.0001
Screen Time (hours per day)	N=5514650	<.0001
< 1 hour	13.95	
1-2 hours	36.59	
2-3 hours	29.82	
> 3 hours	19.64	
Family-Level characteristics		
***Safe parks**	N=3433250	<.0001
Strongly Agree	30.06	
Agree	57.26	
Disagree	10.08	
Strongly Disagree	2.60	
Childcare (hours per week)	N=2717150	

Mean (SEM)	22.055 (0.11)	<.0001
Relations of PMK to child	N=5572000	<.0001
Biological mother	89.42	
Biological father	8.97	
Other	1.61	
Single parent status	N=5572000	<.0001
Two parents	84.42	
One parent	15.30	
Not living with parent	0.28	
Years since immigrating to Canada (PMK)	N=5305750	<.0001
Did not immigrate	82.57	
≥ 10 years	11.42	
< 10 years	6.01	
Highest level of schooling (PMK)	N=5487550	<.0001
Less than secondary	10.79	
Secondary school graduation	18.15	
Some post-secondary	19.75	
College or university degree (including trade)	50.70	
Other	0.62	
Household Low-income Ratio	N=5506750	
Mean (SEM)	2.10 (0.008)	<.0001
Alcohol consumption (PMK)	N=5448350	<.0001
Never	22.02	
Less than once a month	26.52	

At least once a month	25.56	
At least once a week	23.10	
Most days	2.79	
Smoking habit (PMK)	N=5451700	<.0001
Never	74.55	
Occasionally	4.87	
Daily	20.58	
Community population size	N=5549450	<.0001
Rural (< 1000)	12.06	
Urban, population < 30,000	14.90	
Urban, population 30,000 – 90,000	9.04	
Urban, population 100,000 – 499,000	17.01	
Urban, population > 500,000	46.99	
Survey year that child was included		
Cycle (period)	N=5572000	<.0001
2 (1996-1997)	21.92	
3 (1998-1999)	14.12	
4 (2000-2001)	14.09	
5 (2002-2003)	12.63	
6 (2004-2005)	12.19	
7 (2006-2007)	12.31	
8 (2008-2009)	12.73	
Psychosocial Factors		
Behaviours		
Hyperactivity/Inattention	N=5500750	

≥ 90th percentile	13.79	<.0001
Mean (SEM / SD)	4.32 (0.016)	<.0001
Emotional Disorder/Anxiety	N=5526100	
≥ 90th percentile	14.20	<.0001
Mean (SEM / SD)	2.07 (0.01)	0.0586
Physical Aggression/Conduct Disorder	N=5521850	
≥ 90th percentile	13.97	<.0001
Mean (SEM / SD)	1.59 (0.009)	<.0001
Indirect Aggression	N=5350000	
≥ 90th percentile	14.02	<.0001
Mean (SEM)	0.61 (0.006)	<.0001
Social Relationships		
Childcare provider:	N=2563700	<.0001
Very well	87.74	
Quite well	9.28	
Pretty well	2.80	
Not too well or not well at all	0.18	
Teacher:	N=4106100	<.0001
Very well	86.82	
Quite well	9.99	
Pretty well	2.82	
Not too well or not well at all	0.37	
Parent:	N=5552550	<.0001
Very well	60.73	
Quite well	28.05	
Pretty well	10.52	
Not too well or not well at all	0.70	

Sibling:	N=4665850	<.0001
Very well	32.12	
Quite well	33.87	
Pretty well	29.65	
Not too well or not well at all	4.36	
Other children:	N=5505000	<.0001
Very well	65.55	
Quite well	25.56	
Pretty well	8.42	
Not too well or not well at all	0.47	
Adults (parent or teacher or care provider):	N=5554900	
Frequent problems	1.03	0.5074
Peers (siblings or other children):	N=5540850	
Frequent problems	3.95	<.0001
Academic Achievements		
Reading:	N=456950	<.0001
Very well	46.23	
Well	22.83	
Average	25.35	
Poorly or very poorly	5.58	
Reading:		
Very well	46.23	<.0001
Mathematics:	N=453450	<.0001
Very well	48.26	
Well	26.82	

Average	23.13	
Poorly or very poorly	1.79	
Mathematics:		
Very well	48.26	<.0001
Composition (written work):	N=387750	<.0001
Very well	33.80	
Well	28.29	
Average	32.00	
Poorly or very poorly	5.90	
Composition:		
Very well	33.80	<.0001
Overall:	N=478450	<.0001
Very well	48.73	
Well	29.52	
Average	19.01	
Poorly or very poorly	2.74	
Overall:		
Very well	48.73	<.0001
Parenting Scales		
Positive-interaction score	N=5496750	
Mean (SEM)	14.71 (0.013)	<.0001
Ineffective parenting score	N=5419100	
Mean (SEM)	8.68 (0.18)	0.1481
Consistent-parenting score	N=5365900	
Mean (SEM)	15.21 (0.017)	<.0001

Rational parenting score	N=5467100	
Mean (SEM)	6.41 (0.016)	<.0001
Family Functioning Scale		
Family Functioning score	N=5345650	
Mean (SEM)	8.02 (0.027)	<.0001
Depression (PMK)		
Depression Sc**ore**	N=5326600	
Mean (SEM)	4.14 (0.02)	<.0001
***Social Support (PMK)**		
Social Support score	N=3420000	
Mean (SEM)	19.26 (0.02)	<.0001

***Analytic sample (Cycle 5-8)**

Table 2a. Odds of Psychosocial development according to Sport/OPA and Total PA patterns

Adjusted models	READING	MATH	WRITING	OVERALL
	N=133000	N=133000	N=112500	N=138300
	Estimate (95% Confidence Limits)	Estimate (95% Confidence Limits)	Estimate (95% Confidence Limits)	Estimate (95% Confidence Limits)
Organized Physical Activity (child)				
About once a month or almost never	1.00 (REF)	1.00 (REF)	1.00 (REF)	1.00 (REF)
At least once a week	1.33 (1.29-1.37)	0.72 (0.70-0.74)	1.09 (1.04-1.13)	1.30 (1.26-1.34)
Combined Physical Activity				
About once a month, or almost never	1.00 (REF)	1.00 (REF)	1.00 (REF)	1.00 (REF)
UPA 1+	1.02 (0.95-1.10)	0.62 (0.57-0.66)	0.28 (0.25-0.31)	1.07 (0.99-1.15)
UPA 3+	1.99 (1.88-2.11)	1.12 (1.06-1.18	1.81 (1.69-1.94)	1.01 (0.96-1.07)
OPA 1+	1.55 (1.47-1.63)	0.87 (0.82-0.91)	0.92 (0.86-0.98)	1.68 (1.59-1.77)
OPA 3+	3.02 (2.86-3.20)	1.00 (0.95-1.06)	1.45 (1.34-1.56)	2.16 (2.05-2.29)
OPA 1+ and UPA 3+	3.02 (2.85-3.20)	0.65 (0.61-0.69)	3.17 (2.96-3.40)	1.48 (1.40-1.57)
OPA 3+/UPA 3+	0.82 (0.77-0.86)	0.47 (0.44-0.49)	0.53 (0.49-0.56)	0.58 (0.55-0.61)

Table 2b. Odds of Psychosocial development according to Sport/OPA and Total PA patterns

Adjusted models	ADULT-CHILD SOCIAL RELATIONSHIPS N=1863000 Estimate (95% Confidence Limits)	PEER SOCIAL RELATIONSHIPS N=1857800 Estimate (95% Confidence Limits)
Organized Physical Activity (child)		
	1.00 (REF)	1.00 (REF)
At least once a week	1.20 (1.16-1.24)	1.27 (1.25-1.29)
Combined Physical Activity		
About once a month, or almost never	1.00 (REF)	1.00 (REF)
UPA 1+	0.27 (0.24-0.30)	1.33 (1.28-1.38)
UPA 3+	0.69 (0.66-0.73)	0.77 (0.75-0.79)
OPA 1+	0.90 (0.85-0.94)	1.16 (1.13-1.19)
OPA 3+	0.34 (0.32-0.37)	0.99 (0.95-1.02)
OPA 1+ / UPA 3+	1.33 (1.27-1.39)	1.58 (1.54-1.63)
OPA 3+/UPA 3+	0.78 (0.73-0.83)	0.87 (0.84-0.90)

Table 2c. Odds of Psychosocial development according to Sport/OPA and Total PA patterns

Adjusted models	HYPERACTIVITY/ INATTENTION	EMOTIONAL/ ANXIETY DISORDER	PHYSICAL AGGRESSION/ CONDUCT DISORDER	INDIRECT AGGRESSION
	N=1852000	N=1860000	N=1855000	N=1808500
	Estimate (95% Confidence Limits)	Estimate (95% Confidence Limits)	Estimate (95% Confidence Limits)	Estimate (95% Confidence Limits)
Organized Physical Activity (child)				
	1.00 (REF)	1.00 (REF)	1.00 (REF)	1.00 (REF)
At least once a week	0.99 (0.98-1.00)	0.87 (0.86-0.88)	1.01 (1.00-1.02)	1.06 (1.05-1.07)
Combined Physical Activity				
About once a month, or almost never	1.00 (REF)	1.00 (REF)	1.00 (REF)	1.00 (REF)
UPA 1+	1.46 (1.43-1.49)	1.38 (1.35-1.41)	1.72 (1.68-1.76)	1.05 (1.02-1.07)
UPA 3+	1.12 (1.10-1.14)	0.89 (0.88-0.91)	1.57 (1.55-1.60)	1.31 (1.29-1.34)
OPA 1+	1.17 (1.15-1.19)	0.94 (0.93-0.96)	1.32 (1.30-1.35)	1.17 (1.15-1.19)
OPA 3+	1.09 (1.06-1.11)	0.72 (0.70-0.73)	1.21 (1.19-1.24)	1.26 (1.24-1.29)
OPA 1+ / UPA 3+	1.20 (1.18-1.22)	0.84 (0.83-0.85)	1.23 (1.21-1.25)	1.17 (1.16-1.19)
OPA 3+/UPA 3+	0.86 (0.85-0.88)	0.91 (0.90-0.93)	1.79 (1.76-1.82)	1.31 (1.28-1.33)

Table 3. Sensitivity for the Relationship between Psychosocial development and Sport/OPA

Adjusted models HYPERACTIVITY-INATTENTION N= 850 000	EMOTIONAL/ ANXIETY DISORDER	PHYSICAL AGGRESSION/ CONDUCT DISORDER	INDIRECT AGGRESSION
Estimate (95% Confidence Limits)	Estimate (95% Confidence Limits)	Estimate (95% Confidence Limits)	Estimate (95% Confidence Limits)
Organized Physical Activity			
At least once a week			
1.00 (REF)	1.00 (REF)	1.00 (REF)	1.00 (REF)
0.73 (0.72-0.74)	0.98 (0.96-1.00)	1.17 (1.15-1.19)	0.93 (0.92-0.95)

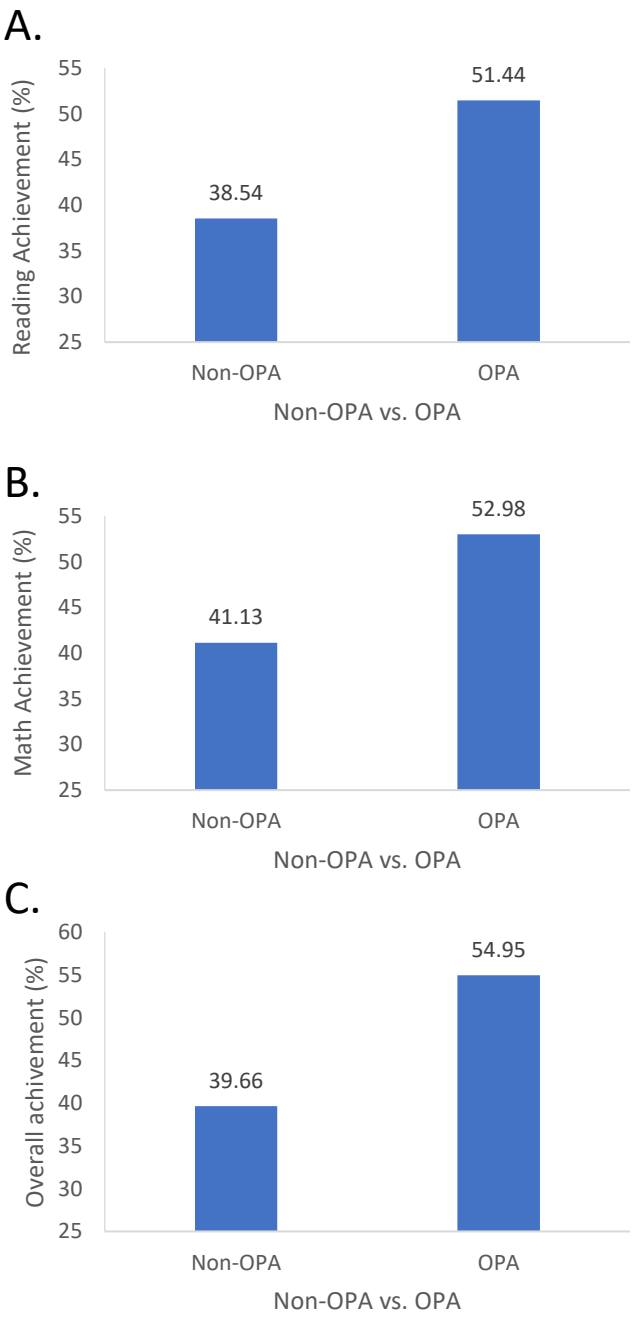


Figure 1. Prevalence of a) reading, b) math, and c) overall achievement in relation to OPA vs non-OPA, among 4- to 6-year-olds.

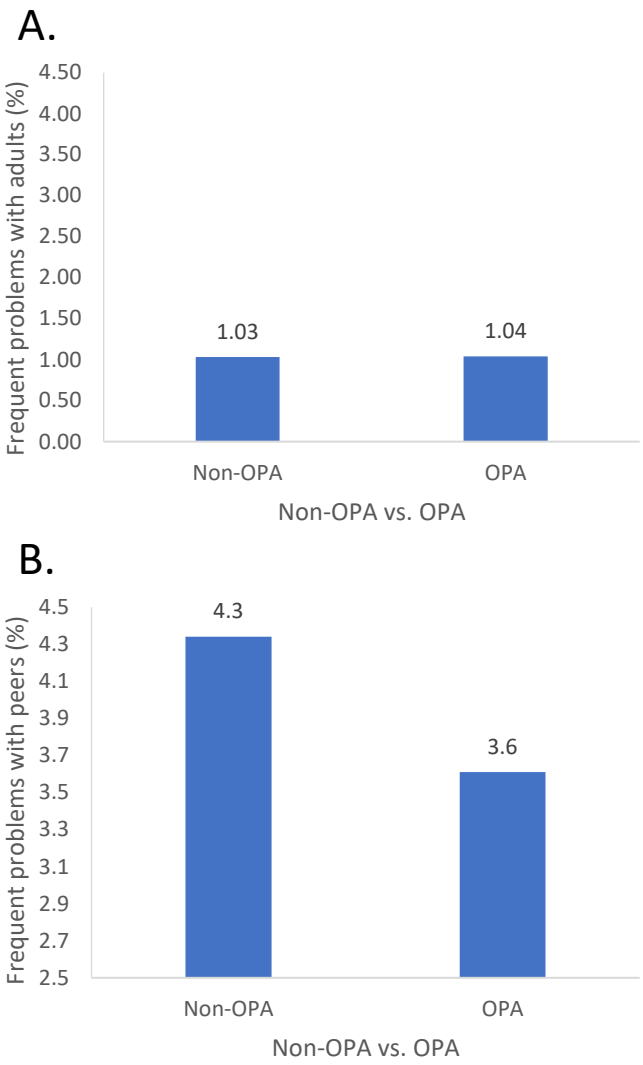
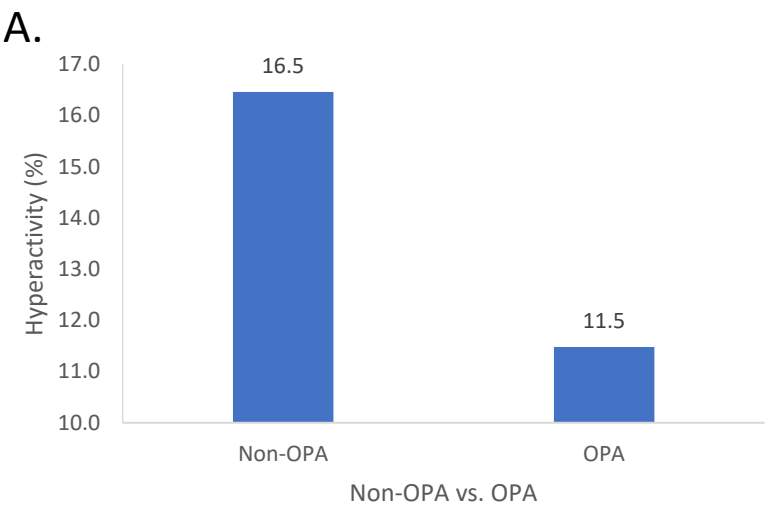
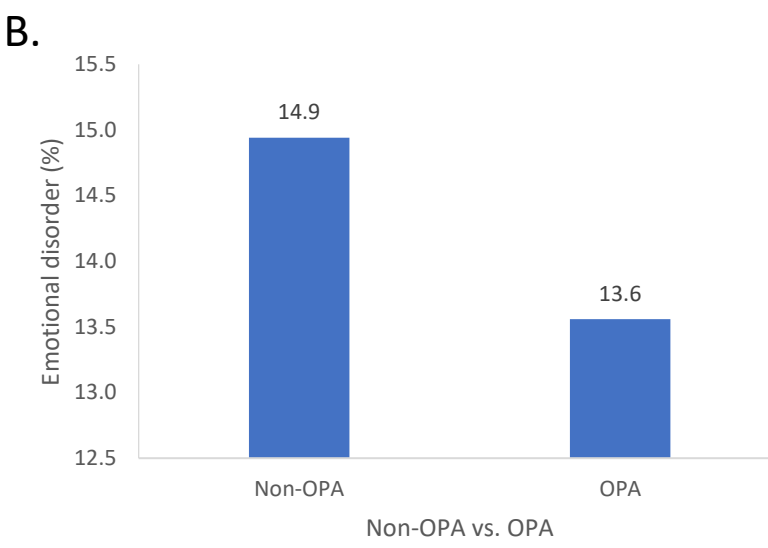
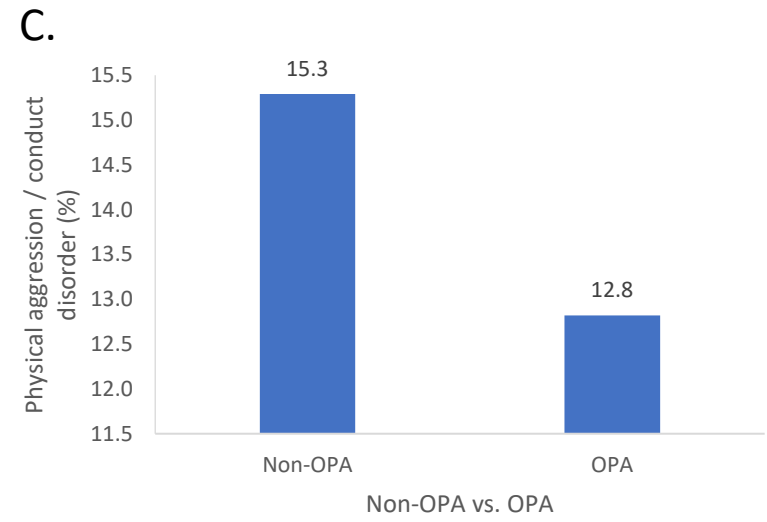


Figure 2. Prevalence of a) frequent problems with adults, and b) frequent problems with peers, in relation to OPA vs non-OPA, among 4- to 6-year-olds.







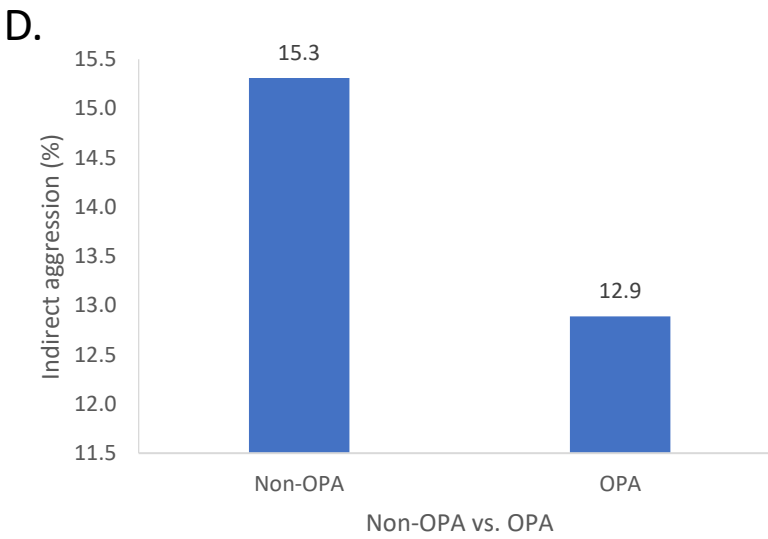


Figure 3. Prevalence of a) hyperactivity, b) emotional disorder, c) physical aggression / conduct disorder, and d) indirect aggression in relation to OPA vs non-OPA, among 4- to 6-year-olds.

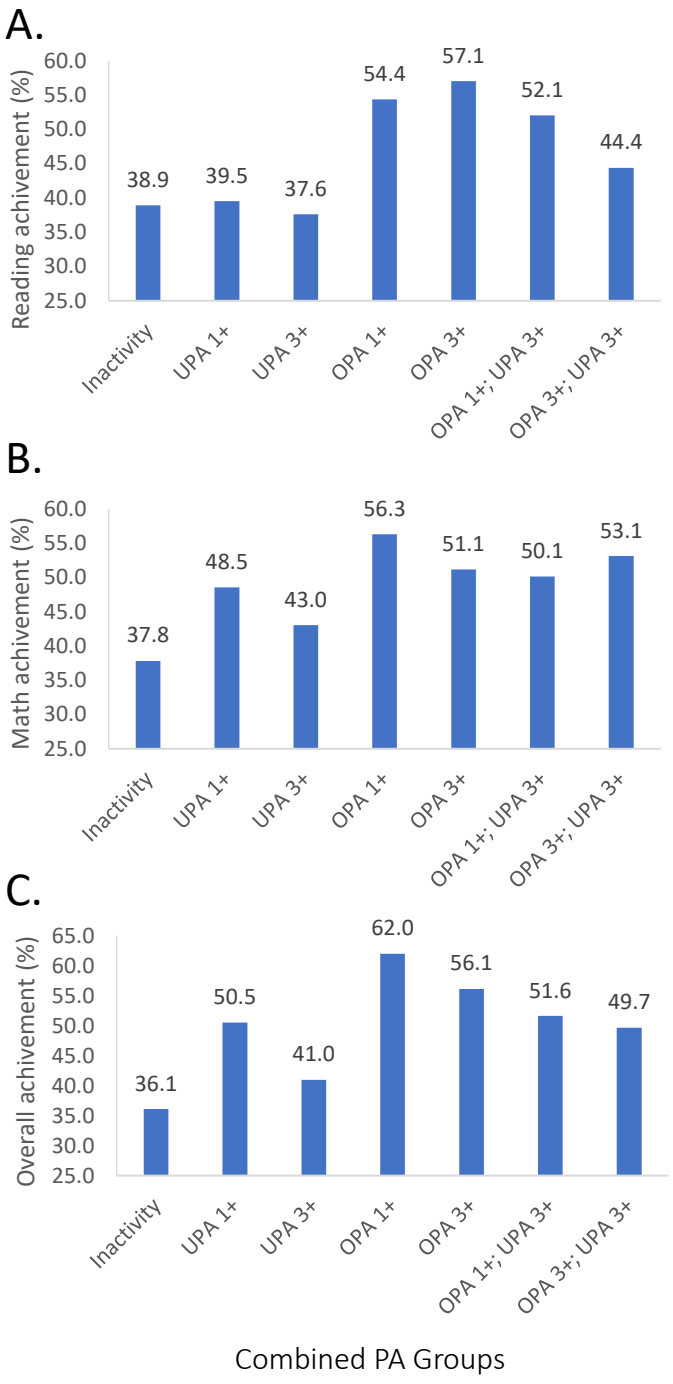


Figure 4. Prevalence of a) reading, b) math, and c) overall achievement in relation to combined PA (number of times per week), among 4- to 6-year-olds.

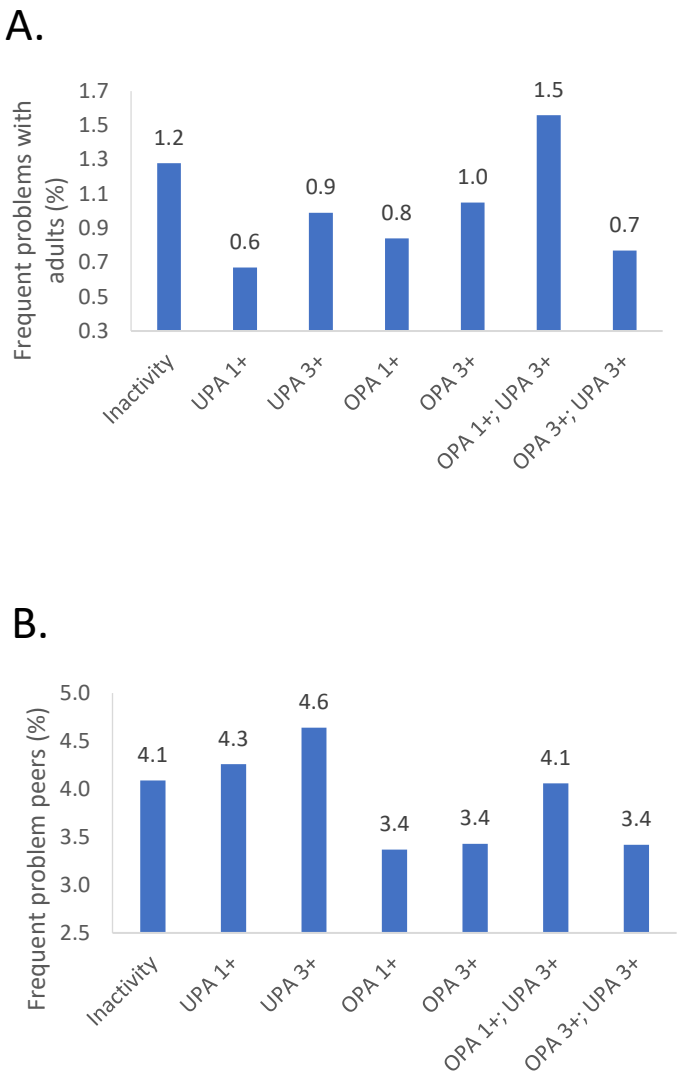


Figure 5. Prevalence of a) frequent problems with adults, b) peers, and hyperactivity poor social relationships with peers (frequent problems) in relation to combined PA (number of times per week), among 4- to 6-year-olds.

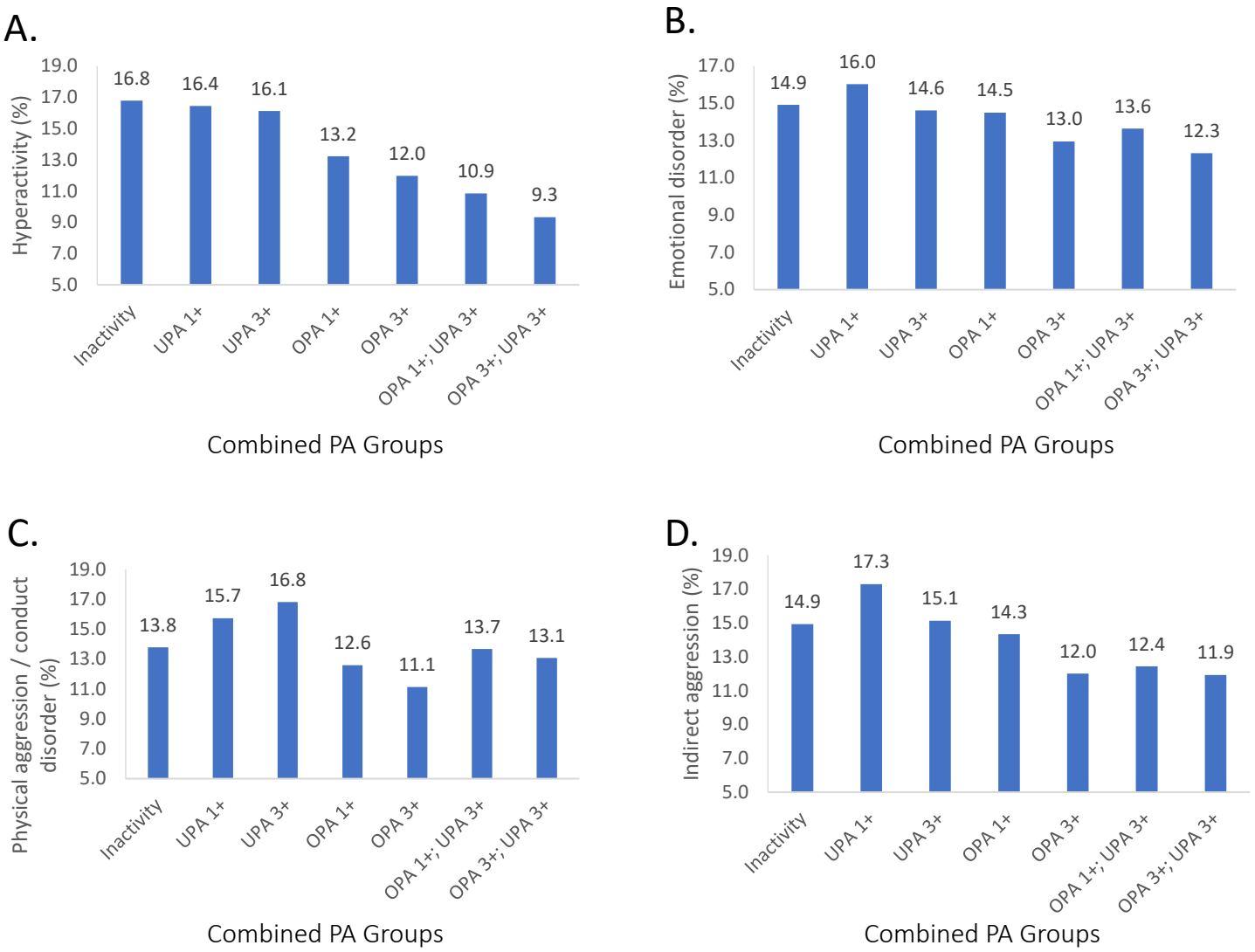


Figure 6. Prevalence of a) hyperactivity, b) emotional disorder, c) physical aggression / conduct disorder, and d) indirect aggression in relation to combined PA (number of times per week), among 4- to 6-year-olds.

Extended Discussion

Summary of Main Findings

Work from this thesis represents a first exploration of patterns of sport and organized physical activity participation in Canada. The first objective was to estimate the prevalence of OPA nation-wide and over time, and to understand the sociodemographic characteristics of children (ages 4 – 6 years) involved in OPA. The second objective was to explore the relationship between OPA participation and psychosocial development among 4- to 6-year-olds. The resulting two studies were informed by developmental and socioecological frameworks, and serve as a basis of future longitudinal research in contemporary cohorts. Following is a summary of the main findings and implications from the two studies.

Manuscript 1: Patterns and predictors of sport and organized physical activity among 4- to 6-year-olds in Canada.

This study investigated the cross-sectional prevalence and predictors of sport in a nationally representative sample of 4- to 6-year-olds collected between 1994 and 2008. Overall, almost half of 4- to 6-year-olds reported engaging in at least "some" form of OPA. Among the many individual (modifiable) factors that were related to OPA participation, frequent extracurricular activities were among the most important. In fully adjusted models, frequent extracurricular activities were associated with a 149% higher odds of OPA, whereas screen time was associated with an approximately 16-46% *lower* odds of OPA. At the family level, parental alcohol use, along with "any" or "frequent" smoking was negatively associated with OPA. As expected, OPA participation increased with age, and was also more common amongst higher

income households; however, the likelihood of OPA was lower among males, boys and girls with higher BMIs, and longer screen time and childcare hours. Indeed, future longitudinal studies investigating the socioecological factors associated with early childhood sport involvement and how these factors change over time is particularly warranted.

Manuscript 2: Association between sport and non-sport physical activity participation and psychosocial health among 4- to 6-year-olds in Canada.

In this study, the associations between OPA and non-OPA involvement in relation to psychosocial development among children (ages 4 – 6 years) was explored. At the bivariate level, frequent extracurricular activities were associated with better academic achievement, fewer emotional/anxiety disorders and indirect aggression, and a lower likelihood of social relationship problems, conduct disorder, and hyperactivity. After adjusting for other factors, these effects were maintained in achievement, peer relationships, emotional/anxiety disorder, and indirect aggression, but the effects were reversed in social relationship with adults (i.e. higher likelihood of *frequent problems*). Although this is currently the only nationally representative data on which to address this question, due to a low sample size in the achievement models, these results must be interpreted with caution and replicated in other cohorts and jurisdictions. Nonetheless, the results of this study show that OPA as well as UPA offer benefits in relation to childhood cognitive, social, and emotional development. Most interesting was the finding that children who engaged in OPA had a higher likelihood of reading, writing, and overall achievement (except mathematics); however, there was also a higher likelihood of poor social relationships with adults. Paradoxically, there was also a higher likelihood of *indirect aggression*, but a lower likelihood of *emotional/anxiety disorder*.

Implications for PA participation / Psychosocial Health of Populations

Up until now, most studies examining sport participation and psychosocial health have only been able to study older school-aged children. Given the considerable attention that the PA-sport paradox has garnered amongst researchers and sport policy-makers alike, results from this study provide new insight into the pedagogical domains of health promotion and public health concerned about the overall declining patterns of PA, as well as the management of childhood developmental outcomes. The findings of this study could be used to augment existing recommendations to parents, educators, and coaches regarding the health and psychosocial impact of early sport and OPA participation.

With regard to the sociodemographic trends in sport/OPA participation among 4- to 6-year-olds across Canada, this study will also help to inform future work by providing data on participation rates over time, as well as allowing for a direct comparison between OPA and UPA (as well as physical inactivity) and how each type of activity relates to short-term (intermediate) developmental outcomes. In so doing, this study could contribute a foundation for future sport/OPA research, interventions, and best practices for promoting early childhood development.

With regard to the developmental outcomes associated with PA patterns (e.g. sport/OPA and UPA) among children, this work could also help to inform future longitudinal studies to address health concerns about early specialization (at the high end), and inactivity (at the low end), through the lens of developmental frameworks such as PYD, in order to ascertain the appropriate engagement of activities for young children. Lastly, because positive psychosocial

health is advantageous for developing prosocial interests and positive self-worth, the findings of this study could be relevant to researchers crafting developmental guidelines on the effects of OPA on children – including those receiving clinical interventions for behavioural health disorders – as well as more generally for the *24-Hour Movement Guidelines for the Early Years*.

Limitations

As with any secondary analysis of data, a number of broader limitations of the thesis work must be considered. First, because of the need to balance the validity of questionnaire items with responder burden, as well as the accuracy, reliability, and quality of data on the type of activity and psychosocial data available (e.g. questionnaires, interviews, parental self-reports). Changes to questions and/or constructs across cycles, including changes to correct errors, tends to impact the sample sizes, as well as the content and coverage age of the target population. Qualitatively; for example, contemporary trends in popular media have shown that swimming was among the most popular structured activities among children in Canada (Alini, 2018); however, swimming was not captured by the NLSCY self-reports until Cycle 4 (2000-2001), and only among youths and young adults (Statistics Canada, 2003). Overall, subjective assessments in general are validated for PA assessments with respect to population surveys(Ellery et al., 2014) (De Vries et al., 2009; Dollman et al., 2009; Ellery et al., 2014; Fillipas, Cicuttini, Holland, & Cherry, 2010; Lauderdale, 2008; Loprinzi & Cardinal, 2011; Sternfeld & Goldman-Rosas, 2012); however, little is known about the various types of OPA (e.g. swimming, etc.), and represents an area in need of further research. Nonetheless, the NLSCY was the only nationally representative Canadian database with the appropriate age groups on which the objectives could be studied. Moreover, a considerable number of studies on older children have been published using the

NLSCY data (Alamian & Paradis, 2012; Findlay et al., 2009; Findlay et al., 2010; Tu, Mâsse, Lear, Gotay, & Richardson, 2016; White & McTeer, 2012). The exclusion of significant segments of the Canadian population and non-responding households may not be random (and may unduly influence the development of these multivariable analyses. Finally, the possibility of sampling and non-sampling errors was inherent due to the survey design; however, these tend to be mitigated by its large sample, interviewer training, experience, and data collection and processing.

Future Analysis

Given the complete lack of large-scale population studies on which to address the role of OPA participation among young children, future longitudinal analysis of the long-term effects of exposures in a subset of preschoolers as they reach adolescence should be helpful in addressing some limitations by bolstering the representativeness of the data – taking into account missing data, variation in the timing of follow-ups, and longitudinal sample weights (funnel – assigned to respondents at every cycle, and non-funnel – assigned to respondents at only the most recent cycle), in order to understand how these translate into longitudinal changes in exposures and outcomes.

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Appendix A

NLSCY Survey Methodology – Sample

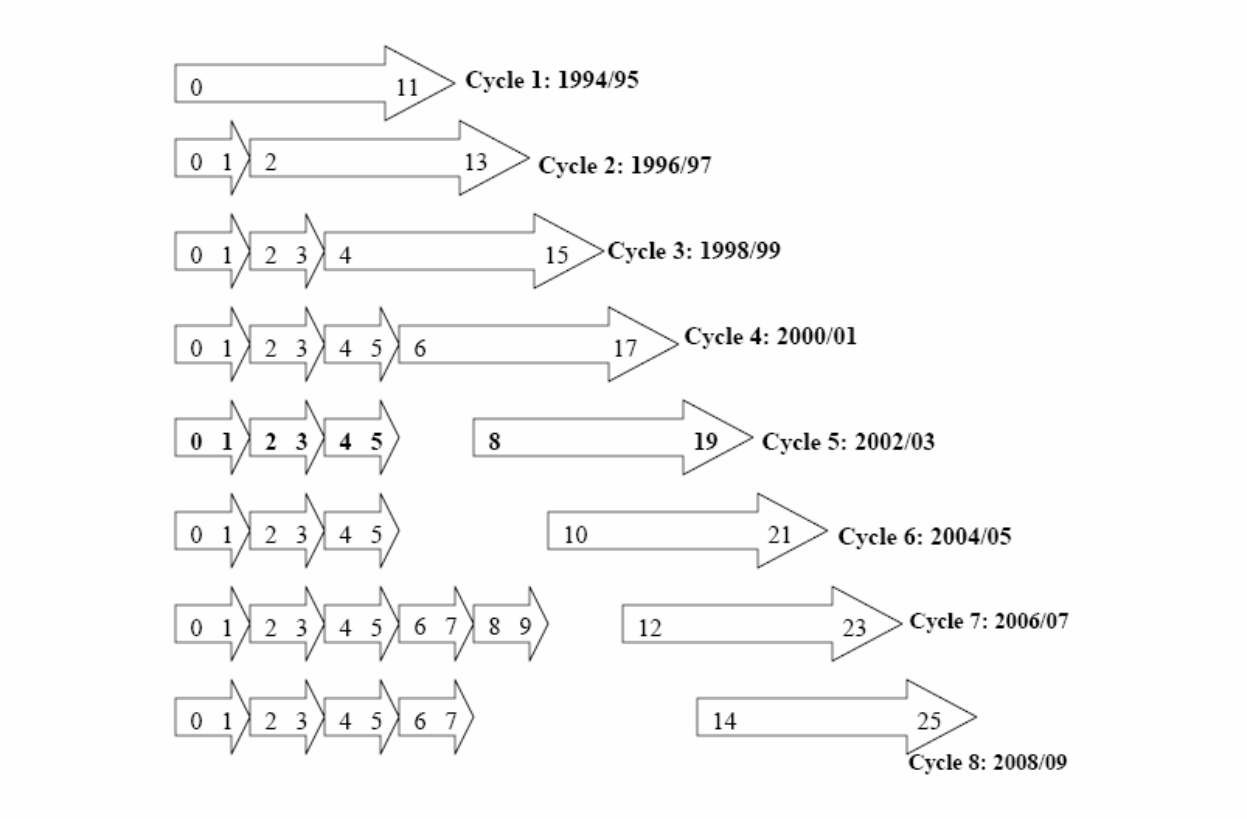
The NLSCY is a probabilistic survey developed to produce reliable estimates for a reference sample of children and youth. It was created by a joint effort between Human Resources and Social Development Canada and Statistics Canada from 1994 until 2009. The main objective of the NLSCY was to track the development and well-being of Canada's children from infancy to adulthood. Beginning in the winter of 1994, the NLSCY tracked a representative sample of Canadian children, at two-year intervals, and adding a new sample at each cycle to monitor early childhood development. Most of the data collected represents economic, environmental, and social topics, in order to assist researchers to determine how these relationships influence child and youth development. Household interviews are conducted with parents on behalf of their children.

The survey was designed to collect national and provincial prospective data regarding risk factors and/or protective factors contributing to a child's behavioral, psychological, and social development and well-being of children. Survey components include: a household component on basic demographic information for all household members; an adult component about the person most knowledgeable (PMK) and their spouse; a child component on each selected child. Parent-reported scales collected measurements about important patterns such as behaviours and social development. Seven cycles of data were available at the time of this study: Cycle 2 (1996-1997), Cycle 3 (1998-1999), Cycle 4 (2000-2001), Cycle 5 (2002-2003), Cycle 6 (2004-2005), Cycle 7 (2006-2007), and Cycle 8 (2008-2009). The large sample was made possible by the addition of new cohorts of children over the years (Statistics Canada, 2010). Key age groupings were created to lend reliable national estimates; thus, analysis can be performed

every two years according to specific age cohorts. The child is the unit of analysis, and the number of children was limited to two per household from Cycle 2 to reduce the household response burden. Pooling across cycles produced a responding sample of children 4 to 6 years of age, who were residing in any province during the collection periods. Children who were selected in an earlier cycle were not followed in subsequent cycles to adhere to a cross-sectional design. This ensured that the final sample size (approximately 37,000) composed of the original, and early childhood cohorts, could provide sufficient power for the main objectives.

Each child – the unit of analysis – in the sample represents several units in the population due to the unequal number of children from the smaller provinces. The effective age is as of December 31st; for example, 0-year-olds were born in 2008 and 1-year-olds were born in 2007. By survey design, the NLSCY allows both cross-sectional and longitudinal analysis. The longitudinal analysis can be performed on the original cohort which remained unchanged, while a cross-sectional analysis can be performed at various times. Three sets of weights are available at each cycle, two longitudinal: funnel (responded to every cycle) as well as non-funnel (responded to most recent cycle), and one cross-sectional. Survey weights are determined after the child's design weight is adjusted for survey non-response and post-stratification to ensure that the final survey weights represent the known counts of children by age, sex and province. Thus, the data can be meaningfully described and interpreted. The figure below shows the NLSCY sample collection years with the larger arrows indicating the original cohort, and the smaller arrows indicating the ECD cohorts.

Figure: Original cohort versus ECD cohorts showing the age of children – in arrows – at each cycle. Source: Statistics Canada, National Longitudinal Survey of Children and Youth.



NLSCY Surveyed Children Protocol

Original cohort

The composition of the original cohort at Cycle 1 – for context – up to 4 (see Figure) is described below. For this study, the original cohort was not followed beyond Cycle 4. By survey design, children who were considered cross-sectionally out-of-scope were excluded at each cycle, and the original cohort was typically a maximum of two children per household. The sample of respondent children (age 0 to 11) had a child-level response rate of 86% – at Cycle 1. Using two-year age groupings: 0 to 1, 2 to 3, 4 to 5, 6 to 7, 8 to 9 and 10 to 11, households were sampled from the labour force survey (LFS) prior to 1994, the 1994 redesigned LFS, and the

National Population Health Survey (NPHS). At Cycle 2, the NPHS sample were not followed due to budgeting and household response burden; as such, the maximum number of children selected per household was reduced from four to two, and a child-level response rate of 91%, as well as a collective longitudinal response rate of 79% for original cohort. At Cycle 3, some children were dropped from the sample due to being cross-sectionally out-of-scope at the end of Cycle 2; thus, the child-level response rate was 89%, and 76% for the original longitudinal cohort. At Cycle 4, households with two or more consecutive cycles of non-response were excluded from collection, as well as households with one cycle of non-response followed by the status "Temporarily moved"), and some children were excluded from Cycle 4 due to being cross-sectionally out-of-scope or non-response; thus, the child-level response rate was 84%, while the cumulative longitudinal response rate for the original cohort was 67%. After pooling the relevant cycles, the original cohort sample – children in Cycle 2 to 4 – was *approximately* (emphasis due to strict RDC confidentiality vetting process) 19,300 responding children.

Early childhood development cohorts

The ECD cohort were sampled in Cycles 5, 6, 7 and 8. The first ECD cohort of 0-1-year-olds was selected at Cycle 2, which limited households surveyed to a maximum of one child per household, except for twins; however, at Cycle 5, only one child per household was surveyed without exception. Mostly respondents from the previous cycle were surveyed at subsequent cycles; however, a modification rule modified at Cycle 7 allowed non-respondents to be surveyed if there were not 2 or more consecutive cycles of nonresponse. By Cycle 8, all non-respondents from previous cycles were surveyed, regardless of nonresponse. Thus, the relevant ECD cohorts at Cycle 5 to 8 were *approximately* (emphasis due to strict RDC confidentiality vetting process) 17,700 responding children, and the response rates were on average about 78%.

Appendix B

Table Suppl 1. Variable labels and names - National Longitudinal Survey of Children and Youth.

VARIABLE LABELS	VARIABLE NAMES
DEMOGRAPHIC – CHILD	
Age	HMMCQ01
Gender	HMMCQ02
HEALTH – CHILD	
What is child's height in metres and centimetres? (without shoes)	HHLCQ03B
What is child's weight in kilograms and grams?	HHLCQ04A
Is he/she usually able to walk without difficulty and without mechanical support such as braces, a cane or crutches?	HHLCQ20
Is he able to walk at all?	HHLCQ21
Presence of chronic condition	HHLCbD45
Use of prescription medication on a regular basis	HHLCD51
ACTIVITIES – CHILD	
In the past 12 months, outside of school hours, how often has this child:...taken part in sports with a coach or instructor (except dance, gymnastics or martial arts)?	HACCe3A
In the past 12 months, outside of school hours, how often has this child:...taken lessons or instruction in other organized physical activities with a coach or instructor such as dance, gymnastics or martial arts?	HACCb3AA
In the past 12 months, outside of school hours, how often has this child:...taken part in unorganized sports or physical activities without a coach or instructor?	HACCQ3B

Thinking of the sport or physical activity that he does the most often, how long does this child usually spend being active in one session? This may be an activity with or without a coach or instructor.	HACCe3B1
In the past 12 months, outside of school hours, how often has this child:...taken lessons or instruction in music, art or other non-sport activities?	HACCQ3C
On average, how much time per day does he watch T.V., videos or DVDs or play video games?	HACCgQ4B
How many hours a day does this child sleep on average?	HSLCdQ7

ACADEMIC ACHIEVEMENT - CHILD

Based on your knowledge of his school work, including his report cards, how is this child doing in the following areas at school this year: ...Reading?	HEDCQ14A
Based on your knowledge of his school work, including his report cards, how is this child doing in the following areas at school this year: …Mathematics?	HEDCQ14B
Based on your knowledge of his school work, including his report cards, how is this child doing in the following areas at school this year: …...Written work such as composition?	HEDCQ14C
Based on your knowledge of his school work, including his report cards, how is this child doing in the following areas at school this year: …overall?	HEDCg14D

SOCIAL RELATIONSHIPS - CHILD

During the past 6 months, how well has this child gotten along with other kids, such as friends or classmates (excluding brothers or sisters)?	HRLCgQ06
During the past 6 months, how well has he gotten along with his parent(s)?	HRLCgQ08
During the past 6 months, how well has this child gotten along with his brother(s)/sister(s)?	HRLCgQ09
Since starting school in the fall, how well has he gotten along with his teacher(s) at school?	HRLCgQ07
During the past 6 months, how well has this child gotten along with his main caregiver?	HCRCQ03

EARLY CHILDHOOD DEVELOPMENT - CHILD

Hyperactivity - Inattention score	HBECdS06
Emotional disorder-anxiety score	HBECdS08
Conduct disorder - Physical aggression score	HBECdS09
Indirect aggression score	HBECS10

CHILDCARE ARRANGEMENTS - CHILD

Number of hours per week spent in primary care arrangement (to allow PMK and spouse to work or study)	HCRCgD02

DEMOGRAPHIC - PMK

Age	HMMPQ01
Gender	HMMPQ02

SOCIO-DEMOGRAPHIC - PMK

Number of years since first immigrating to Canada - Grouped	HSDPD02B
Child lives with:	HDMCD04
Relationship of the PMK to the child	HDMCD06

EDUCATION - PMK

Highest level of schooling obtained	HEDPgD02

HOUSEHOLD INFORMATION

Ratio of the household low income cut-off	HINHgD4A
Size of area of residence in which the child lives	HGEHgD04
There are safe parks, playgrounds and play spaces in this neighbourhood	HSFHhQ5C

HEALTH - PMK

At the present time do you smoke cigarettes daily, occasionally or not at all?	HHLPQ02
During the past 12 months, how often did you drink beer, wine, liquor or any other alcoholic beverage?	HHLPcQ05
Depression Scale	HDPPS01
Family Functioning - Scale	HFNHhS01
Social Support - Scores	HSPHhS01

PARENTING - SCALES

Positive interaction score	HPRCS03
Ineffective parenting style score	HPRCgS04
Consistent parenting style score	HPRCgS05
Rational parenting style score	HPRCS06

Appendix C

Weighted Appendix. Sociodemographic characteristics of children (ages 4 – 6 years) by data collection year.

	POOLED	CYCLE 2	CYCLE 3	CYCLE 4	CYCLE 5	CYCLE 6	CYCLE 7	CYCLE 8
Individual-Level characteristics	N=5626350							
Age								
4-6 years old	N=5626350	21.78	14.29	14.22	12.62	12.22	12.23	12.65
4-year-olds	45.12	32.81	49.17	47.23	49.14	49.36	48.29	48.17
5-year-olds	45.90	33.37	48.81	49.04	50.86	50.64	48.88	48.26
6-year-olds	8.98	33.81	2.02	3.73	0	0	2.82	3.56
Mean (SEM)[a]	4.64 (0.003)	5.02 (0.01)	4.53 (0.01)	4.57 (0.01)	4.51 (0.01)	4.51 (0.01)	4.55 (0.01)	4.55 (0.01)
Sex	N=5626350							
Girls	48.71	48.88	48.24	48.87	48.9	48.61	48.72	48.69
Boys	51.29	51.12	51.76	51.13	51.1	51.39	51.28	51.31
Sex-specific ages	N=2740800							
Girls		21.85	14.15	14.26	12.67	12.2	12.23	12.64

4-year-olds	45.20	32.82	49.58	47.12	49.17	49.4	48.47	48.31
5-year-olds	45.91	33.46	48.77	48.87	50.83	50.6	49.07	48.41
6-year-olds	8.89	33.72	1.65	4.01	0	0	2.46	3.28
Mean (SEM)[b]	4.64 (0.005)	5.01 (0.02)	4.52 (0.008)	4.57 (0.01)	4.51 (0.01)	4.51 (0.01)	4.54 (0.01)	4.55 (0.01)
Boys	N=2885500	21.71	14.42	14.17	12.58	12.25	12.23	12.65
4-year-olds	45.04	32.81	48.78	47.33	49.12	49.33	48.13	48.04
5-year-olds	45.89	33.29	48.84	49.2	50.88	50.67	48.71	48.13
6-year-olds	9.07	33.9	2.37	3.47	0	0	3.17	3.84
Mean (SEM)[c]	4.64 (0.005)	5.01 (0.02)	4.54 (0.01)	4.56 (0.01)	4.51 (0.01)	4.51 (0.01)	4.55 (0.01)	4.56 (0.01)
Chronic Health Condition (child)	N=5564000	21.95	14.15	13.94	12.65	12.22	12.34	12.75
Yes	19.29	19.99	18.17	19.94	19.76	18.99	19.08	18.61
No	80.71	80.01	81.83	80.06	80.24	81.01	80.92	81.39
Regular Prescription Use (child)	N=5574350	21.91	14.11	14.1	12.62	12.2	12.32	12.73
Yes	8.94	7.84	8.97	9.3	9.51	10.6	8.81	8.38

No	91.06	92.16	91.03	90.7	90.49	89.4	91.19	91.62
BMI-category (IOTF)	N=4270350	24.34	15.13	14.34	12.67	11.22	11.13	11.17
Normal Weight	46.28	47.26	44.54	42.39	48.22	44.19	45.79	51.94
Underweight	16.92	16.62	15.69	20.11	16.07	16.7	17.35	15.88
Overweight	15.51	15.11	16.91	15.62	15.29	16.73	15.72	13.19
Obesity	21.28	21.01	22.86	21.88	20.42	22.38	21.14	18.99
Extra-curricular activities (child)	N=5564000	21.95	14.14	14.1	12.59	12.16	12.31	12.74
Most days	0.65	0.84	0.69	0.51	0.46	0.7	0.4	0.82
Few times a week	1.96	2.26	1.35	1.61	1.86	2.14	2.22	2.22
At least once a week	10.05	8.74	8.67	9.54	10.58	11.35	12.04	10.71
At least once a month	1.70	1.66	1.09	1.25	1.75	2.09	2.05	2.21
Almost never	85.63	86.5	88.2	87.09	85.35	83.72	83.29	84.05

Physical Activity types	N=5568000	21.94	14.13	14.09	12.63	12.18	12.3	12.72
Inactivity	21.35	24.09	26.61	25.17	19.06	20.76	14.36	16.17
UPA 1+	5.93	5.71	6.25	6.37	6.85	6.93	4.79	4.73
UPA 3+	19.32	20.36	21.66	17.63	19.73	16.1	19.98	18.84
OPA 1+	17.68	15.89	16.32	19.34	19.22	20.29	17.07	16.97
OPA 3+	7.87	7.28	6.2	7.54	8.21	8.05	8.76	9.73
OPA 1+ and UPA 3+	16.91	15.83	14.83	14.57	17.1	16.66	21.05	19.73
OPA 3+/UPA 3+	10.94	10.84	8.14	9.37	9.82	11.21	14	13.85
Sport/PA duration per session: (starting from cycle 5)	N=2578050	n/a	n/a	n/a	26.95	26.14	23.18	23.73
1 – 15 minutes	8.27	n/a	n/a	n/a	10.28	12.8	4.9	4.27
16 – 30 minutes	25.54	n/a	n/a	n/a	24.75	26.03	25.93	25.51
31 – 60 minutes	43.40	n/a	n/a	n/a	42.16	41.56	44.67	45.6
> 1 hour	22.80	n/a	n/a	n/a	22.81	19.61	24.5	24.62
Sleep duration (starting from	N=3551200	n/a	n/a	22.04	19.81	19.11	19.18	19.86

cycle 4								
Mean (SEM)[d]	10.45 (0.01)	n/a	n/a	10.34 (0.01)	10.44 (0.01)	10.45 (0.02)	10.47 (0.02)	10.53 (0.02)
Screen Time (hours per day): **T.V. or Videos**	N=5516150	21.6	13.96	14.23	12.69	12.29	12.41	12.83
< 1 hour	13.95	3.76	4.38	4.74	11.01	10.6	35.49	36.98
1-2 hours	36.6	39.57	31.76	31.61	38.04	36.21	38.96	39.03
2-3 hours	29.82	35.92	34.1	34.57	31.51	32.59	16.84	17.82
> 3 hours	19.64	20.74	29.76	29.07	19.44	20.6	8.7	6.17
Family-Level characteristics								
Safe parks, playgrounds, (starting cycle 5)	N=3455350	N/A	N/A	22.45	19.73	19.35	19.18	19.29
Strongly Agree	30.00	N/A	N/A	25.3	29.65	29.06	32.09	34.71
Agree	57.30	N/A	N/A	60.82	56.34	57.37	56.82	54.59
Disagree	10.10	N/A	N/A	11.21	11.21	10.63	8.98	8.25

Strongly Disagree	2.60	N/A	N/A	2.67	2.8	2.95	2.1	2.45
Child care (hours per week)	N=2717800	19.51	13.20	15.08	13.97	11.47	13.37	13.39
Mean (SEM)[f]	22.05 (0.10)	20.5 (0.37)	22.31 (0.22)	22.32 (0.25)	22.44 (0.23)	22.25 (0.33)	22.44 (0.29)	22.77 (0.29)
Relations of PMK to child	N=5626350	21.78	14.29	14.22	12.62	12.22	12.23	12.65
Biological mother	89.39	89.65	92.1	91.28	91.04	83.49	87.5	89.62
Biological father	8.99	7.98	6.62	7.66	7.97	14.76	11.09	8.28
Other	1.62	2.36	1.28	1.06	0.98	1.75	1.41	2.1
Number of parents living with child (single parent status)	N=5626350	21.78	14.29	14.22	12.62	12.22	12.23	12.65
Two parents	84.25	82.87	83.34	83.42	84.51	86.14	86.08	84.72
One parent	15.47	16.88	16.55	16.17	15.37	13.55	13.62	14.74
Not living with parent	0.29	0.25	0.11	0.41	0.12	0.31	0.3	0.54

Years since immigrating to Canada (PMK)	N=5348650	22.6	13.61	14.58	12.82	12.06	12.17	12.16
Did not immigrate	82.51	82.75	86.67	84.76	82.18	79.56	79.06	81.44
≥ 10 years	11.48	10.91	8.49	10.59	12.42	14.12	13.32	11.5
< 10 years	6.01	6.34	4.85	4.65	5.4	6.32	7.62	7.06
Highest level of schooling (PMK)	N=5537500	22.1	14.31	14.11	12.64	12.38	12.42	12.05
Less than secondary	10.84	11.17	12.04	11.59	12.21	11.58	7.95	8.67
Secondary school graduation	18.17	18.52	16.54	17.27	23.56	22.21	14.59	14.42
Some post-secondary	19.79	28.25	26.82	23	14.54	12.17	12.24	13.24
College or university degree (including trade)	50.59	42.06	44.6	48.14	49.04	53.25	63.11	62.21
Other	0.62	0	0	0	0.65	0.78	2.1	1.45
Household Low-	N=5560200	21.46	14.05	14.18	12.77	12.37	12.38	12.80

income Ratio								
Mean (SEM)[g]	2.09 (0.01)	1.83 (0.021)	1.96 (0.015)	2.19 (0.02)	2.20 (0.02)	2.10 (0.02)	2.24 (0.02)	2.31 (0.03)
Alcohol consumption (PMK)	N=5488700	22.09	14.23	14.22	12.62	12.32	12.11	12.41
Never	22.06	21.02	23.02	19.38	22.12	22.6	23.78	23.64
Less than once a month	26.53	27.71	27.83	29.32	27.99	24.42	23.19	23.62
At least once a month	25.57	26.96	26.28	24.59	24.25	26	25.64	24.25
At least once a week	23.06	22.13	20.44	23.71	23.07	23.37	24.16	25.57
Most days	2.78	2.18	2.44	3	2.57	3.62	3.23	2.91
Smoking habit (PMK)	N=5492400	22.09	14.23	14.23	12.62	12.31	12.12	12.41
Never	74.51	68.45	71.45	73.13	76.96	77.47	78.59	80.98
Occasionally	4.86	4.08	4.79	5.63	5.27	5.3	4.7	4.77
Daily	20.63	27.47	23.77	21.25	17.77	17.23	16.71	14.25
Community	N=5603250	21.58	14.23	14.27	12.67	12.27	12.28	12.7

population size								
Rural (< 1000)	12.06	12.99	12.55	11.43	10.57	10.39	12.38	13.39
Urban, population < 30,000	14.90	14.99	13.18	12.05	23.7	23.25	9.04	8.7
Urban, population 30,000 – 90,000	9.05	9.22	8.98	7.83	9.77	8.56	8.78	10.22
Urban, population 100,000 – 499,000	16.97	17.77	18.07	19.69	13.58	12.42	17.69	18.4
Urban, population > 500,000	47.02	45.02	47.22	49	42.39	45.38	52.11	49.29
Psychosocial Factors								
Behaviours								
Hyperactivity/Inattention	N=5501950	22	14.05	14.14	12.66	12.21	12.28	12.66
≥ 90th percentile	13.79	17.76	19.02	10.13	11.29	11.38	10.63	13.04

Mean (SEM)[h]	4.32 (0.015)	4.78 (0.053)	4.71 (0.035)	3.86 (0.036)	4.07 (0.033)	4.09 (0.046)	4.13 (0.045)	4.23 (0.044)
Emotional Disorder/Anxiety	N=5526950	22	14.08	14.09	12.63	12.20	12.30	12.70
≥ 90th percentile	14.20	15.18	14.85	12.02	13.6	14.52	13.66	14.98
Mean (SEM)[i]	2.06 (0.01)	2.17 (0.035)	1.98 (0.022)	1.92 (0.024)	2.10 (0.024)	2.03 (0.03)	2.034 (0.03)	2.13 (0.03)
Physical Aggression/Conduct Disorder	N=5522650	21.97	14.09	14.09	12.66	12.22	12.29	12.69
≥ 90th percentile	13.97	15.13	12.89	12.19	15.26	15.18	12.91	13.68
Mean (SEM)[j]	1.59 (0.009)	1.53 (0.03)	1.57 (0.02)	1.47 (0.02)	1.71 (0.02)	1.67 (0.03)	1.61 (0.03)	1.60 (0.03)
Indirect Aggression	N=5350850	21.76	13.85	14.14	12.76	12.35	12.35	12.79
≥ 90th percentile	14.02	16.78	15.31	13.53	14.5	12.8	12.65	10.46
Mean (SEM)[k]	0.61 (0.006)	0.81 (0.02)	0.62 (0.013)	0.56 (0.014)	0.58 (0.013)	0.55 (0.02)	0.55 (0.02)	0.44 (0.015)
Child's Social Relationships								

Care provider:	N=2564300							
Very well	87.74							
Quite well	9.28							
Pretty well	2.8							
Not too well or not well at all	0.18							
Teacher:	N=4106600	24.64	12.66	13.86	11.98	12.17	11.92	12.76
Very well	86.82	85.77	85.44	87.77	87.57	87.67	86.17	88.27
Quite well	9.99	11.22	10.57	9.14	9.29	9.54	10.13	8.9
Pretty well	2.82	2.63	3.47	2.74	2.61	2.62	3.38	2.49
Not too well or not well at all	0.37	0.38	0.52	0.35	0.53	0.17	0.32	0.34
Parent:	N=5553850	21.96	14.15	14.05	12.66	12.21	12.27	12.69
Very well	60.73	58.01	60.21	64.84	58.88	60.84	62.45	61.55
Quite well	28.05	30.28	29.22	24.71	28.48	27.65	27.2	27.33
Pretty well	10.52	11.06	9.76	9.7	11.93	11.06	9.93	9.99
Not too well or not well at all	0.70	0.65	0.81	0.75	0.71	0.45	0.43	1.13

Sibling:	N=4667000	21.63	13.91	13.99	12.8	12.2	12.4	13.08
Very well	32.12	29.9	32.67	33.39	29.38	33.49	32.94	34.48
Quite well	33.87	34.22	35.66	33.53	35.01	33.42	33.13	31.77
Pretty well	29.65	31.8	28.33	28.91	30.47	28.92	29.18	28.61
Not too well or not well at all	4.36	4.08	3.34	4.17	5.15	4.17	4.75	5.15
Other children:	N=5506300	21.91	14	14.13	12.66	12.23	12.33	12.73
Very well	65.55	60.66	63.21	68.55	67.05	67.08	67.7	68.19
Quite well	25.56	28.22	27.68	23.42	25.16	25.31	23.88	23.25
Pretty well	8.42	10.63	8.66	7.64	7.49	7.34	7.67	7.86
Not too well or not well at all	0.47	0.48	0.44	0.38	0.3	0.26	0.75	0.7
Academic Achievements								
Reading:	N=456950							
Very well	46.23							

Well	22.83							
Average	25.35							
Poorly or very poorly	5.58							
Mathematics:	N=453500							
Very well	48.26							
Well	26.82							
Average	23.13							
Poorly or very poorly	1.79							
Composition (written work):	N= 387800							
Very well	33.8							
Well	28.29							
Average	32							
Poorly or very poorly	5.9							
Overall:	N=478500							

Very well	48.73							
Well	29.52							
Average	19.01							
Poorly or very poorly	2.74							
Parenting								
Positive-interaction score	N=5497600	21.97	14.16	14.11	12.66	12.20	12.26	12.63
Mean (SEM)[l]	14.71 (0.013)	14.23 (0.04)	14.39 (0.03)	14.45 (0.03)	15.02 (0.03)	15.10 (0.04)	15.06 (0.04)	15.15 (0.03)
Ineffective parenting score	N=5419800	22.24	14.21	14.15	12.76	12.24	12.10	12.31
Mean (SEM)[m]	8.68 (0.02)	9.04 (0.06)	8.80 (0.04)	8.60 (0.04)	8.45 (0.04)	8.54 (0.05)	8.40 (0.05)	8.67 (0.05)
Consistent-parenting score	N=5366650	22.44	14.35	14.15	12.66	12.16	11.99	12.25
Mean (SEM)[n]	15.21 (0.02)	14.80 (0.05)	14.84 (0.04)	15.22 (0.04)	15.31 (0.04)	15.40 (0.05)	15.62 (0.05)	15.67 (0.04)
Rational	N=5467800	22.04	14.14	14.10	12.68	12.22	12.22	12.61

parenting score								
Mean (SEM)[o]	6.41 (0.02)	8.81 (0.03)	8.63 (0.02)	8.47 (0.02)	4.24 (0.02)	4.32 (0.03)	3.93 (0.03)	4.02 (0.03)
Family Functioning score	N=5386350	22.15	14.20	14.23	12.58	12.35	12.18	12.30
Mean (SEM)[p]	8.03 (0.03)	8.08 (0.07)	8.04 (0.06)	8.44 (0.06)	7.97 (0.06)	7.98 (0.08)	7.83 (0.08)	7.69 (0.08)
Maternal Depression Score	N=5364700	22.38	14.32	14.09	12.46	12.20	12.13	12.42
Mean (SEM)[q]	4.15 (0.03)	4.50 (0.08)	4.40 (0.05)	4.06 (0.06)	4.03 (0.06)	4.04 (0.08)	3.80 (0.08)	3.94 (0.07)
Social Support Score	N=3442000	n/a	n/a	22.43	19.78	19.30	19.19	19.31
Mean (SEM)[r]	19.25 (0.023)	n/a	n/a	18.68 (0.04)	19.31 (0.04)	19.35 (0.06)	19.28 (0.06)	19.75 (0.06)

Areas shaded due to low sample and disclosure risk.

a - *P<0.05 for all cycles except 4-7, 4-8, 8-7, 8-3, 7-3, 7-5, 3-5, 3-6, 5-6.
b - *P<0.05 for all cycles except 4-8, 4-7, 4-3, 8-7, 8-3, 8-5, 8-6, 7-3, 7-5, 7-6, 3-5, 3-6, 5-6.
c - *P<0.05 for all cycles except 4-8, 4-7, 4-3, 8-4, 8-7, 8-3, 8-5, 8-6, 7-3, 7-5, 7-6, 3-5, 3-6, 5-6.
d - *P<0.05 for all cycles except 8-7, 7-6, 7-5, 6-5.
e - *P<0.05 for all cycles except 7-8, 3-4, 6-5.
f - *P<0.05 for all cycles except 8-7, 8-5, 8-4, 8-3, 8-6, 7-5, 7-4, 7-3, 7-6, 5-4, 5-3, 5-6, 4-3, 4-6, 3-6, 3-2.
G - *P<0.05 for all cycles except 8-7, 7-5, 7-4, 5-4, 5-6, 4-6.

H - *P<0.05 for all cycles except 2-3, 8-7, 8-6, 8-5, 7-6, 7-5, 6-5.
I - *P<0.05 for all cycles except 2-8, 2-5, 8-5, 8-6, 8-7, 5-6, 5-7, 7-6, 6-3, 6-4, 7-3, 7-4, 3-4.
J - *P<0.05 for all cycles except 5-6, 5-7, 5-8, 6-7, 6-8, 6-3, 7-8, 7-3, 7-2, 8-3, 8-2, 3-2, 3-4, 2-4.
K - *P<0.05 for all cycles except 3-5, 3-4, 3-7, 3-6, 5-4, 5-7, 5-6, 4-7, 4-6, 7-6.
L - *P<0.05 for all cycles except 8-6, 8-7, 8-5, 6-7, 6-5, 7-5, 4-3.
M - *P<0.05 for all cycles except 3-4, 3-8, 8-4, 8-6, 4-6, 4-5, 4-7, 6-5, 6-7, 5-7.
N - *P<0.05 for all cycles except 8-7, 6-5, 6-4 ,4-5, 3-2.
O - *P<0.05 for all cycles except 6-5, 7-8.
P - *P<0.05 for all cycles except 2-3, 2-5, 2-7, 2-6, 3-5, 3-7, 3-6, 5-7, 5-6, 5-8, 7-6, 7-8, 8-6.
Q - *P<0.05 for all cycles except 2-3, 4-5, 4-6, 4-7, 4-8, 6-5, 6-8, 6-7, 5-8, 5-7, 8-7.
R - *P<0.05 for all cycles except 6-5, 6-7, 5-7.