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Exploring the Influence of Childcare Type on Physical Activity and Sedentary Time of a Nationally Representative Sample of Canadian Preschoolers

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Abstract

A large number of Canadian children are enrolled in childcare, and they spend substantial time there. Capturing a national picture of the relationship between childcare type and physical activity (PA; i.e., light, moderate-to-vigorous, and total) and sedentary time (ST) in young children is needed. Using a nationally representative sample of preschoolers (aged 3-5 years), this cross-sectional study used cycles 3 and 4 of the Canadian Health Measures Survey. Childcare type (e.g., centre-, home-based childcare, home with parent, kindergarten) was reported by parents. Preschoolers wore an accelerometer for 5 consecutive days. Device and population-specific cut-points were applied to delineate PA intensities and ST. Means and descriptive statistics were calculated to analyze the weighted data. No significant differences in PA or ST were found across the 4 childcare environments. Future research is necessary to clarify the influence of childcare type on PA and ST.

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Table of Contents

List of Tables

List of Appendices

Chapter I: Introduction

Physical Activity and Health Benefits

Physical activity is an important lifestyle behaviour for supporting the health of children (Strong et al., 2005). Defined as "any bodily movement that burns calories, whether it's for work or play, daily chores or the daily commute" (Caspersen, Powell, & Christenson, 1985, p. 126), the benefits of physical activity are numerous. The many health benefits of physical activity exist for all ages, including young children. In preschoolers, adequate levels of physical activity can contribute to better cardiometabolic health indicators (Timmons et al., 2012), fitness (Carson et al., 2017), bone and skeletal health (Carson et al., 2017), motor skill development (Timmons et al., 2012; Carson et al., 2017), self-confidence (Canadian Society for Exercise Physiology [CSEP], 2011), psychosocial health (Timmons et al., 2012), improved learning and attention span (CSEP, 2011), as well as, better measures of adiposity (Timmons et al., 2012). In particular, moderate-to-vigorous (MVPA) and total physical activity (TPA) are favourably associated with multiple health indicators such as adiposity and cognitive development among preschool children (Carson et al., 2017). Ensuring Canadian children engage in adequate levels of physical activity and minimize sedentary pursuits may help foster healthy habits from a young age, as research suggests that activity behaviours in the early years may track across the lifespan (Campbell et al., 2008).

Sedentary Time and Health Consequences

Sedentary time (ST) is defined as "any waking activity characterized by an energy expenditure of ≤ 1.5 metabolic equivalents (METs), while in a sitting, reclining, or lying

posture" (Tremblay et al., 2017; p. 9). For young children, this may include sitting or reclining in a stroller or car seat, watching television or playing with non-active electronic devices such as computers and smartphones (CSEP, 2011). Similar to a lack of physical activity, a high level of sedentary time is associated with higher skinfold measurements (Proctor et al., 2003) and body mass index (BMI; Jago, Baranowski, Baranowski, Thompson, & Greaves, 2005) during childhood. While some sedentary pursuits offer developmental benefits for young children, screen time in particular is associated with numerous negative consequences. Increased exposure to screens has been linked to negative psychosocial and cognitive developmental health outcomes in preschoolers (LeBlanc et al., 2012). Other health consequences include increased adiposity (LeBlanc et al., 2012), feelings of boredom or sadness (Shea et al., 1994) and issues with sleep (Thompson & Christakis, 2005). However, it should be noted that there may be cognitive benefits of interactive non-screen based sedentary behaviours such as reading and storytelling (Poitras et al., 2017).

In addition, sedentary time in the form of TV viewing has been shown to negatively impact the sleep quality of preschoolers (Brockmann, Diaz, Damiani, Villarroel, Nunez, & Bruni, 2016). Healthy sleep patterns in preschoolers are important in the prevention of obesity (Bathory & Tomopolous, 2017) and support better school performance (Bathory et al., 2017). Sleep duration was found to be inversely associated with girls' sedentary time and boys' screen time (Downing, Hinkely, Salmon, Hnatiuk, & Hesketh, 2017). Like physical activity, sedentary time has been shown to track from childhood to adulthood (Biddle, Pearson, Ross, & Braithwaite, 2010), making early habit

formation an important consideration. The health consequences of high levels of sedentary time, in addition to those related to low levels of physical activity, are of great concern. As such, addressing these behaviours early on has been recognized as an appropriate health promotion approach (Reilly, 2010).

Physical Activity and Sedentary Time Recommendations for Canadian Preschoolers

Physical activity levels among young children have received increased attention in the last decade. The Canadian Physical Activity Guidelines are split into multiple categories based on age. Relevant to this study is the Early Years (aged 0-4) and Children (aged 5-11) cohorts. In 2012, CSEP developed the first Canadian Physical Activity Guidelines for the Early Years (aged 0-4), stating that preschoolers (aged 3-4) should obtain at least 180 minutes of physical activity at any intensity (light, moderate or vigorous) throughout the day (CSEP, 2012). This minimum requirement of 180 minutes of daily physical activity has been accepted in a variety of other countries including the United Kingdom (Government Digital Service, 2011) and Australia (Australian Government Department of Health, 2017). CSEP suggests that physical activity for preschoolers can be classified as any activity that gets young children moving, such as climbing stairs, playing outside, and dancing (CSEP, 2012). The Canadian Sedentary Behaviour Guidelines for the Early Years (0-4 years) were released at the same time and suggested that preschoolers should engage in less than 1 hour of sedentary screen time per day (CSEP, 2012). In late 2017, the physical activity and sedentary behaviour guidelines were replaced by the Canadian 24-Hour Movement Guidelines for the Early Years (0-4 years; CSEP, 2017). The 24-Hour Movement Guidelines still advise that

preschoolers (3-4 years) obtain 180 minutes of physical activity per day, but a new requirement is that at least 60 minutes of this activity should be of higher intensity, specifically energetic play (CSEP, 2017). Active play, both structured and unstructured as well as aerobic activities and dance all have favourable associations with health indicators in preschoolers 3-4 years old (Carson et al., 2017). The recommendation regarding sedentary time remains the same for preschoolers aged 3-4 years but also suggests sedentary and screen time should be replaced with outdoor time to provide greater health benefits (CSEP, 2017). The 24-Hour Movement Guidelines also incorporate sleep and suggest preschoolers (3-4 years) get 10 to 13 hours of quality sleep daily (CSEP, 2017). CSEP recommended that by age 5, children should participate in 60 minutes of energetic play per day, at a moderate-to-vigorous intensity and obtain less than 2 hours of screen time daily (CSEP, 2012). Examples of MVPA at this age include hopping, jumping, skipping, and bike riding (CSEP, 2012). As described in the Canadian 24-Hour Movement Guidelines for Children and Youth (5-17 years), in addition to MVPA and screen time recommendations, 5-year old children should also participate in several hours of light physical activity (LPA) daily and sleep, uninterrupted, for 9-11 hours per night (CSEP, 2016).

Physical Activity Levels of Canadian Preschoolers

According to data from the Canadian Health Measures Survey (CHMS), measured via accelerometry, in 2012-2013, 84% of 3-and 4- year olds met the 180 minutes of physical activity required per day (Garriguet, Carson, Colley, Janssen, Timmons, & Tremblay, 2016). At age 5, when intensity of physical activity was considered, only 14%

of children from this same CHMS cycle met the CSEP guideline of 60 minutes of MVPA daily (Garriguet et al., 2016). A likely consideration for the high percentage of young children (3-4 years) meeting the CSEP physical activity guideline is that in this age group, the *intensity* of physical activity was not considered, as movement at all intensities is important, which makes the physical activity guidelines more obtainable for this rapidly developing population (Garriguet et al., 2016). When rates of meeting Canadian recommendations are considered in light of the new 24-Hour Movement Guidelines, Chaput and colleagues (2017) reported that only 12.7% of Canadian preschoolers (aged 3-4) met all three of the movement requirements (physical activity, screen time, and sleep) and 3.3% of these children met none of the guidelines (Chaput et al., 2017). When examined individually, 83.9% of Canadian preschoolers met the recommendation for sleep duration and 61.8% met the recommendation for physical activity, and therefore, screen viewing behaviours in line with Canadian recommendations appears to be a challenge for this population (Chaput et al., 2017).

Additional research exploring physical activity levels among preschoolers suggest significant variability across studies. For example, Obeid and colleagues reported that in their 2011 study (n = 30) that preschooler participants obtained an average of 220 minutes of TPA per day (at any intensity) and accumulated at least 60 minutes of daily MVPA (Obeid, Nguyen, Gabel, & Timmons, 2011). Of note, the majority of participants' time (144.3 min/day) was spent in LPA and the least was vigorous physical activity (VPA; 30.2 min/day; Obeid et al., 2011). In contrast, Tucker's systematic review (2008), which was conducted prior to the internationally accepted standard for 180 minutes of

physical activity per day, found only 54% of study participants (*n* = 10,316), aged 2-6 years, obtained 60 minutes of MVPA each day. While discrepancies have been observed in physical activity levels within the preschool population, this is likely a consequence of the differing techniques adopted when measuring physical activity participation (e.g., Actical, Actigraph, etc.; Vanderloo, Di Cristofaro, Proudfoot, Tucker, & Timmons, 2015), variability in observation period for measuring these behaviours (e.g., during childcare hours, 24 hours of monitoring, etc.) and different sampling designs. Despite the noted variation, physical activity levels during childhood and adolescence can be a predictor of physical activity during adulthood (Telama et al., 2005) and these levels have been shown to decrease with age (Tammelin, Laitinen, & Nayha, 2004; Ellis et al., 2017), there is great importance in developing healthy physical activity habits in childhood.

Sedentary Time Among Canadian Preschoolers

The preschool cohort has been noted to be highly sedentary throughout the day (Colley et al., 2013). In fact, Colley et al. found that preschoolers spend 50% of their day, nearly 6 hours, in sedentary pursuits (Colley et al., 2013). The most recent CHMS results assist in understanding where Canadian preschoolers stand regarding sedentary behaviour. Large amounts of screen time remain a concern for 3-and 4-year olds; in this age group, only 18% met the CSEP screen time guideline of no more than 1 hour per day in 2016 (Garriguet et al., 2016) and only 24.4% as reported in the context of the new 24-Hour Movement Guidelines (Chaput et al., 2017). As Colley et al. stated in 2013, few Canadian children met both the now outdated physical activity and sedentary behaviour guidelines; only 15% of 3–4 year olds and 5% of 5 year olds (Colley et al., 2013). As

stated above, more recently, only 12.7% of Canadian 3-4 year olds met the new physical activity and sedentary behaviour guidelines (Chaput et al., 2017). Similar findings exist internationally; an Australian study found preschoolers to be sedentary 301.1 min/day (approximately 41.8% of waking hours; Downing et al., 2017) while a review (Hnatiuk, Salmon, Hinkley, Okely, & Trost, 2014) using primarily American, Scottish and Australian studies found preschoolers to be sedentary up to 95% of the time or 2.9-12.4 hours per day via accelerometry measurement. Observational studies from the same review found more consistent results; preschoolers were sedentary 55-85% of the time or 7.2-11.5 hours per day (Hnatiuk et al., 2014). National surveillance data support sufficiently active young children but very few meet both the physical activity and sedentary behaviour requirement (Colley, 2013). Variability exists in both the physical activity levels and sedentary time of children enrolled in the various childcare settings.

Childcare Enrollment in Canada

As the number of Canadian families with two working parents (i.e., dual-earners) increases, the prevalence of childcare enrollment also rises (Uppal, 2015). This is largely due to an increase in women entering the workforce, a result of a change in cultural attitudes, improved educational opportunities for females, and generally improved labour market conditions (Uppal, 2015). In 1976, only 36% of couple families with at least one child under 16 years were dual-earner families; in 2014, this number increased to 69% (Uppal, 2015). The increase in dual-earner families, and consequently in childcare enrollment, has resulted in approximately 80% of Canadian preschoolers attending these facilities (Cleveland, Forer, Hyatt, Japel, & Krashinsky, 2008). Childcare

refers to mainly centre-based and home-based facilities that offer (varying sized) group-based care outside of the home. According to the Ontario Ministry of Education, a licensed childcare centre (i.e. centre-based childcare), is for infants, toddlers, preschool and school-age children (Ministry of Education, 2016). It includes nursey schools, full-day and extended hours care, and before-and-after school programs (Ministry of Education, 2016). Licensed home child care (i.e. home-based childcare), also cares for infants, toddlers and preschool-age children but is not licensed by the Ministry of Education and is instead, contracted by home child care agencies (Ministry of Education, 2016). In 2014, the percentage of parents with children aged 4 and under, using childcare (centre-based, home-based or private) on a full-time basis (at least 30 hours per week) was 70% (Sinha, 2014). These numbers indicate that young Canadian children are spending many hours in these venues. In fact, young children are reported to spend 48.4% of their time in childcare setting (Ellis et al., 2017). As such, the childcare environment is an optimal setting to support the physical activity and sedentary behaviour patterns of young Canadian children.

Physical Activity in the Childcare Environment

Levels of physical activity vary across different childcare environments. Vanderloo and colleagues conducted a study to measure objectively the physical activity levels of preschoolers in centre-based childcare, and found that preschoolers engaged in 1.54 min/hr of MVPA and 17.42 min/hr of TPA per day (Vanderloo et al., 2014). Similarly, Kuzik et al. (2015), measured the physical activity levels of children aged 1.5-5 years and found them to spend only 7.0% of their time, or 4.2 min/hr, engaged in MVPA

(Kuzik, Clark, Ogden, Harber, & Carson, 2015). Moreover, when compared to home-based childcare and full-day kindergarten, children enrolled in centre-based childcare have been found to be significantly less active, and also, more sedentary than preschoolers in other early year's settings (Tucker, Vanderloo, Burke, Irwin, & Johnson, 2015; Vanderloo et al., 2014). For example, preschoolers enrolled in family childcare were found to participate in only 1.76 min/hr of MVPA (Temple, Naylor, Rhodes, & Higgins, 2009). In addition, Vanderloo et al. found preschoolers in centre-based childcare to obtain only 1.58 min/hr of MVPA and 1.74 min/hr in home-based daycare, while those in school obtained 3.33 min/hr (Vanderloo, Tucker, Johnson, Burke & Irwin, 2015). However, activity levels in home-based childcare appear to be particularly variable; Vanderloo, Martyniuk, and Tucker (2015) found MVPA levels to range from 1.8 to 9.7 min/hr in the preschooler cohort.

Similar low levels of physical activity among preschoolers in childcare have been noted internationally. In Reilly's 2010 systematic review, the 6 studies (from the United States, Belgium, and Scotland) which used Actigraph accelerometers to measure physical activity in childcare found activity rates during childcare hours to be very low with varying rates of MVPA from 1.5 min/hr to 7 min/hr (Reilly, 2010). Even when the accelerometry data was extrapolated to the entire day, none of the participants met the 60 minutes of MVPA recommendation across all of the studies (Reilly, 2010). In the United States, Pate et al. estimated that of the 30 hours per week many children spend in preschool, 25 hours are spent sedentary, while less than 1 hour per week spent engaged in MVPA (Pate, McIver, Dowda, Brown, & Addy, 2008). Brown et al. (2009), also

in the United States, found low levels of MVPA in centre-based childcare programs, even when children were playing outdoors (Brown, Pfeiffer, McIver, Dowda, Addy, & Pate, 2009), where children have been noted to engage in more physical activity (Vanderloo, Tucker, Johnson, & Holmes, 2013). Similarly to Canadian findings, researchers in the United Kingdom reported preschoolers aged 3-4 years old engaged in an average of 8.44 min/hr of TPA (Hesketh, Griffin, & van Sluijs, 2015). Furthermore, these preschoolers spent more time in LPA and MVPA when in childcare compared to at home with their parents (Hesketh et al., 2015). A possible explanation for these findings is that childcare may provide more active opportunities than home and that parents may perceive their children to be receiving adequate levels of activity while in childcare (Hesketh et al., 2015).

Finn, Johannsen, and Specker (2002), and Pate and colleagues (2004) noted that the physical activity levels of preschoolers were strongly influenced by the specific preschool attended. In fact, Pate et al. (2004) suggested that close to 50% of the variation in preschoolers' physical activity could be accounted for by the individual childcare facility, more so than demographic variables. Factors contributing to decreased physical activity among preschoolers in childcare include a lack of appropriate indoor (Cardon, Van Cauwenberghe, Labarque, Haerens, & De Bourdeaudhui, 2008) and/or outdoor (van Zandvoort, Tucker, Irwin, & Burke, 2010) space and physical activity specific resources (van Zandvoort et al., 2010). Daily time spent outdoors has been highly correlated with physical activity among preschoolers. Vanderloo and colleagues reported that preschoolers were 5 times more active

outdoors than indoors during childcare hours (Vanderloo et al., 2013). In a systematic review by Gray et al. (2015), outdoor time, in children 3-12 years, was found to be positively related to physical activity and negatively related to sedentary behaviour. Studies included in Gray and colleagues review examining habitual behaviours showed that when comparing children who spent more time outdoors to those with less outdoor affordances, those engaged in more outdoor time had higher levels of physical activity and lower amounts of ST (Gray et al., 2015). Furthermore, studies included in Gray's review examining acute behaviours found that when children were outside they were more physically active and less sedentary than when children were inside (Gray et al., 2015). In addition, based on direct observation, Finnish and Dutch 3-year olds were found to spend 79% of their time indoors, but only 53% of their time outdoors participating in sedentary activities (Soini et al., 2016).

Differences in time spent outdoors may be responsible for the variation in physical activity and sedentary time noted in childcare environments (Tucker et al., 2015; Vanderloo et al., 2010). This is an important consideration as the outdoor playtime requirements in childcare vary substantially across Canada (Vanderloo & Tucker, 2018). Since 2012, 62% of Canadian provinces and territories have updated their childcare regulations in relation to activity to include daily activity guidelines specifying duration and in some cases, intensity and outdoor time (Vanderloo & Tucker, 2018). All provinces and territories now provide general recommendations to encourage gross motor movement (Vanderloo et al., 2018). However, there are no requirements on intensity or duration of activity (Vanderloo et al., 2018). While all provinces and

territories require daily outdoor play, only Northwest Territories, Nunavat and Nova Scotia require *daily* physical activity and only New Brunswick mentions screen time in their regulations (Vanderloo et al., 2018). Consideration of outdoor affordances in childcare is important, as, according to Larouche et al., an increase in outdoor time for older children (age 7-14 years) is associated with an increased likelihood of meeting Canadian physical activity guidelines (Larouche, Garriguet, Gunnell, Goldfield, & Tremblay, 2016).

Sedentary Time in the Childcare Environment

Preschoolers in centre-based childcare have been reported to accumulate more sedentary time than preschoolers in other childcare settings (Tucker et al., 2015). Tucker et al. (2015) objectively measured sedentary time in 28 early learning environments (centre-based and home-based childcare and full-day kindergarten) in London, Ontario. They found preschoolers in centre-based childcare to obtain 41.62 min/hr of sedentary time while preschoolers in home-based childcare to obtain 40.72 min/hr and in kindergarten to obtain 39.68 min/hr (Tucker et al., 2015). According to Temple et al. (2009), children in home-based childcare accumulated 39.49 min/hr of sedentary time . Vanderloo et al. (2014) reported that children in centre-based childcare accumulated 40.64 min/hr or 5.08 hours per day of sedentary time. In comparison, a different article reported preschoolers to spend up to 12 hours per day sedentary (Hnatiuk et al., 2014). A recent Australian study (2017), reported preschool children obtained 12.55 min/hr of sedentary time (Downing et al., 2017). On the contrary, a Norwegian study found preschoolers aged 3 to 5 years to only obtain 2.86 min/hr of sedentary time (Aadland &

Johannessen, 2015). It should be noted that Aadland and Johannessen's study was comprised of three preschools only (*n* = 91), all from the county of Sogn og Fjordane, Norway.

In a systematic review (*n* = 31 studies) comparing sedentary time in preschoolers, participants were found to be sedentary 34-94% of the time (Hnatiuk et al., 2014). The authors suggest variability in study results could be attributed to differing accelerometer cut-points. Regardless, these numbers suggest preschoolers, from a variety of countries, are obtaining high levels of sedentary time. The high levels of sedentary time in childcare may be related to two factors: availability of, and accessibility to, active opportunities and screen time. Using data from London, Ontario, childcare facilities (centre- and home-based) have been identified to have differing regulations, staff ratios, outdoor affordances, in addition to varied environments (e.g., outdoor play space), and fixed and portable play equipment (Vanderloo et al., 2014). This, along with differing physical activity policies and training, may contribute to the varying levels of physical activity and sedentary behaviours seen in Canadian children (Vanderloo, Tucker, Ismail, & van Zandvroort, 2012). Greater amounts of sedentary time in centre-based childcare could be related to staff behaviour, particularly increased regulation and safety concerns, and therefore, reduced outdoor play time (Tucker et al., 2015). In addition, childcare centres may lack appropriate outdoor space and play equipment needed to foster adequate physical activity (Tucker et al., 2015).

Since screen time is one of the most common forms of sedentary behaviour in preschoolers (De Decker et al., 2013), it is important to examine its pervasiveness in

childcare. Although limited research has been conducted to date, Vanderloo's (2014) systematic review found children in centre-based childcare to obtain 0.1-1.3 hrs/day of screen time while children attending home-based childcare obtained 1.8-2.4 hrs/day of screen time. The high levels of screen time were prevalent across all childcare types examined in the review (Vanderloo, 2014).

Knowledge Gap

To date, current research exploring the relationship between physical activity and sedentary time among preschoolers in various childcare environments has only been conducted on a small scale. Generally speaking, preschoolers enrolled in childcare experience low levels of physical activity (Cardon & De Bourdeaudhuij, 2008; Reilly, 2010; Tucker, 2008; Vanderloo et al., 2014) and high amounts of sedentary time (Reilly, 2010; Tucker et al., 2015). While these data offer a good foundation, the data are not drawn from a representative sample and are not generalizable across Canada due to factors such as the variability in childcare regulations (Vanderloo et al., 2012) and the varying weather conditions experienced (Tucker & Gilliland, 2007) across the nation. Given the large number of Canadian children enrolled in various types of childcare, coupled with the substantial number of hours they spend in this setting, 6 or more hours per day (Uppal, 2015), capturing a national picture of the relationship between childcare type and physical activity and sedentary behaviours in young children is needed. While previous research has been conducted examining the activity behaviours of young children using CHMS data (Chaput et al., 2017; Colley et al., 2013; Garriguet et al., 2016), to date, no consideration has been given to the impact of childcare type.

Purpose of Study

The purpose of this study was to explore the influence of childcare type on physical activity levels and sedentary time among a nationally representative sample of preschoolers (age 3-5 years). Based on previous research (Tucker et al., 2015; Vanderloo et al., 2015), it was hypothesized that preschoolers from centre-based childcare would engage in less physical activity and more sedentary time than young children enrolled in other childcare arrangements.

Chapter II: Methods

Cross-sectional in design, this study used CHMS data to explore the relationship between childcare type with physical activity levels and sedentary time among preschoolers in Canada. For the purpose of this study, both cycles 3 and 4 of the CHMS were used. Previous cycles (i.e., cycle 1 and 2) were not included, as childcare enrollment was not captured within the survey. A brief description of the CHMS protocol and data are provided below; however, for more information on the methodology behind the CHMS, please consult the CHMS user guide for cycles 3 and 4 (Statistics Canada, 2014).

Procedure

CHMS was designed to capture a nationally representative sample of the population aged 3 to 79 years and was developed in 2007 to collect key information relevant to the health of Canadians (Statistics Canada, 2014). According to Statistics Canada, 96% of Canadians are represented in CHMS (Statistics Canada, 2014). The goal of the survey is to produce national baseline data on health markers of Canadians such as obesity, hypertension, and cardiovascular disease (Statistics Canada, 2014). Health Canada's Research Ethics Board approved all CHMS procedures and tools prior to the survey being conducted (Day, Langlois, Tremblay, & Knoppers, 2007). For young children, such as the 3- to-5 year old preschoolers used in the current study, parents were required to provide written consent and written assent was obtained from the child when possible (Statistics Canada, 2011). Participants were not obligated to

participate in the survey and were able to stop and discontinue at any time (Statistics Canada, 2011).

There were three components to the CHMS protocol; participants were involved in an interview in their own home, asked to visit a mobile examination centre (MEC) to have physical measurements taken, and lastly, participants were required to wear an accelerometer. In the first stage, participants completed an in-person interview with a CHMS interviewer to obtain socio-demographic, health, and lifestyle data. For preschool-age children, 3-to-5 year olds, a parent-administered questionnaire was completed to gather information about their child's physical activity, time spent outdoors, sedentary activities, hobbies and sleep. Secondly, the participant visited a mobile examination centre (MEC) for direct physical measures, to determine blood pressure, height, weight and physical fitness (Statistics Canada, 2014). To test for chronic and infectious disease, samples of blood, urine, saliva and hair were also taken from survey participants, both children and adults (Statistics Canada, 2014). Following the MEC visit, ambulatory participants were asked to wear an Actical accelerometer during waking hours for 7 consecutive days (Statistics Canada, 2014).

CHMS Tools (Relevant to the Current Study)

During the in-person interview, via parent report, researchers collected information on the participant's age, sex, childcare type, parental education and household income. Parents were asked 'During the past month did ^NAME…?' before 6 response options were given. Response options for the question about childcare type include 6 types of childcare arrangements: (1) daycare centre, (2) home-based daycare,

(3) nursery school or preschool, (4) school (including kindergarten), (5) stay at home with parent, guardian or caregiver, (6) receive any other type of childcare (e.g., day camp; Statistics Canada, 2014). Parents were asked to select all of the childcare venues that their child(ren) attended in the last month (multiple response options).

During the visit to the MEC, height and weight were objectively measured. A fixed stadiometer with vertical backboard and a moveable headboard was used for height and a Mettler Toldeo digital scale following Canadian Physical Activity, Fitness, and Lifestyle Approach (CPAFLA) protocol was used for weight (Statistics Canada, 2011). BMI was calculated using percentiles in line with the World Health Organization's BMI-for-age Growth References (Statistics Canada, 2015). Two variables were used for BMI since 3-and 4-year olds and 5-year olds are in different BMI categories (HWMDWHOK & HWMDWHOP, respectively). A description of the two BMI categories can be found in Appendix A.

Actical accelerometers (Phillips – Respironics, Oregon, USA; dimensions: 2.8 x 2.7 x 1.0 centimetres, weight: 17 grams) were programmed to start collecting data at midnight after the participant left the MEC. Participants wore the Actical monitor on their right hip on an elasticized belt during their waking hours for 7 consecutive days. The accelerometer, validated to measure physical activity and sedentary time in preschool-age children (Pfeiffer, McIver, Dowda, Almeida, & Pate, 2006), is used to assess and record time-stamped acceleration in all directions, providing an index of movement intensity, duration, and frequency. A 15-s epoch length was used and a count value per 15s (cp15s) was calculated using the digitized values collected by the

Actical. Although participants wore the Actical for 7 days, the Actical only has memory capacity for approximately 5.5 days when 15s epoch lengths are used (Chaput et al., 2017); therefore, data for days 6 and 7 were not available.

Using a prepaid envelope, monitors were returned to Statistics Canada to download the data collected. For the preschool age group, a valid day was defined as 5 or more hours of monitor wear time and participants were required to have at least 3 valid days to be included. Average number of valid days among participants was 4.72 days. Non-wear time consisted of 60 minutes of consecutive zero counts, with allowance for 1 or 2 minutes of counts between 0 and 100. It should be noted that most participants well exceeded the 5-hour minimum wear time requirement and collected approximately 12 hours of accelerometry data since accelerometers were worn during all waking hours. After invalid days were removed from the dataset, daily time spent at various activity intensities (i.e., LPA, MVPA, TPA, ST) were determined for valid days based on laboratory-derived cut-points corresponding to each intensity level (Adolph, Puyau, Vohra, Nicklas, Zakeri, & Butte, 2012; Wong, Colley, Connor Gorber, & Tremblay, 2011). Adolph et al.'s (2012) preschooler specific physical activity cut-point for MVPA (288 cp15s) was used, while Wong et al.'s cut point to differentiate sedentary behaviour from LPA (25 cp15s) and to measure TPA was applied (Wong et al., 2011).

Participants

The general inclusion criteria for each cycle of CHMS are, a participant must: (a) be between 3 to 79 years of age; (b) live in a private household at the time of the survey and reside in one of the 10 provinces; (c) not be a person living in the three territories;

persons living on reserves and other Aboriginal settlements in the provinces; full-time members of the Canadian Armed Forces; the institutionalized population and residents of certain remote regions (altogether these exclusions represent approximately 4% of the target population; Statistics Canada, 2014). The CHMS aims to produce reliable national level estimates for each of the age (e.g., 3-5 year olds, 6-11 year olds, etc.) and gender (male and female) groups and sample-specific and bootstrap weights are applied during analysis to achieve this. For this study, participants were included in the analysis if they met the following three criteria: (a) were between the ages of 3 and 5 years; (b) had 3 or more valid days of physical activity data; and, (c) enrolled in one type of childcare arrangement exclusively (i.e., daycare, nursery school or preschool; home-based daycare; school – including kindergarten; stay at home with parent or caregiver). Participants were excluded from the sample if they were enrolled in multiple childcare types and if they were >6 years old.

Data Processing

Participants' data (e.g., age, sex, parental education, BMI, physical activity, etc.) were pulled from three CHMS files: household (HHD), clinic (CLC) and activity monitoring (AM_SUB) for cycles 3 and 4 independently. Then, participants were matched by clinic ID to merge the data from the three data sources for each of cycle 3 and 4 uniquely. Then participants in cycle 3 and 4 were merged into one dataset.

Parents were offered six options (select all that apply) when asked about their child's childcare type, but after collapsing categories, four childcare options were included in the analysis (see appendix A, question TSO_Q01). Due to their similarities in

daily structure, programming and class size, childcare arrangements, 1 (daycare centre), and 3 (nursery school or preschool), were combined to create, (i) daycare centre, nursery school or preschool. Childcare arrangement, 6 (receive any other type of childcare), was removed due to its small sample size (*n* =9). The four childcare groups are: (i) daycare centre, nursery school or preschool; (ii) home-based daycare; (iii) school (including kindergarten); or (iv) stay at home with parent, guardian or caregiver. Participants enrolled in more than one type of childcare were excluded from the analysis to allow for better comparability between groups. These childcare groups were created by generating a new variable and assigning a new number (1,2,3, or 4) to participants enrolled exclusively in one type of childcare or two in the case of daycare and nursery school or preschool. Due to differences in percentiles used for BMI (for ages 3, 4 and 5) in the WHO BMI-for-age Growth References chart, BMI is separated into two categories: 3 and 4-year olds and 5-year olds.

CHMS created variables for average daily rates for LPA (AMMDLA), MVPA (AMMDMVA), ST (AMMDXSA), were used. A new variable was created for average daily TPA by combining scores for LPA and MVPA for days 1-5 and dividing by the number of valid days. Many studies exploring physical activity in childcare frequently report hourly rates of activity. To improve comparability with previous studies and to remove a potential bias resulting from differing hours of wear time, hourly rates of activity were also explored. To do this, new variables for hourly rates of LPA, MVPA, TPA & ST were generated for all participants. Hourly rates of activity for LPA, MVPA, TPA & ST were calculated by multiplying the denominator in average daily rates of activity by 60 and

then multiplying the entire average daily rate of each activity by 60 to create a rate in min/hr. Hourly rates of activity were calculated for each of the intensities (LPA, MVPA, TPA, ST).

Data Analysis

All statistical analyses were performed in SAS version 9.4 and were based on weighted data for the combined CHMS cycle 3 and 4 accelerometry data, as per Statistics Canada requirements. Sampling weights were taken from a separate CHMS file and added to the combined cycle 3 and 4 dataset of participants meeting age and wear time criteria. Sampling weights allowed the data to be representative of the Canadian population rather than the sample by showing how many persons in a population each participant represents. Since activity monitoring data were used in this study, an activity specific weighting file, WGT_AM, was used. Other weighted files are available from CHMS for other purposes other than activity monitoring data. These weights (WGT_AM) were standardized to preserve the sample size for analysis. To calculate sampling variance, a result of studying a sample of the population rather than a census, bootstrap techniques were also incorporated. Each set of bootstrap weights (500 for CHMS) represented a random subsample of the original sample. The activity monitor weights (WGT_AM) and bootstrap files were provided with the CHMS data.

To explore participant demographics, means were calculated (via the PROC DESCRIPT function) to generate descriptive statistics. To compare activity levels by childcare type, population means and sample totals were calculated (via the PROC SURVEY MEANS function) to examine average daily *and* hourly rates of activity (LPA,

MVPA, TPA, ST) by childcare type for the entire sample, and again by sex. Alpha was set at 0.05 to produce 95% confidence intervals.

Chapter III: Results

A total of 650 participants (50.8% male) from cycles 3 and 4 had sufficient activity monitoring data to be included in the analysis. There was an equal distribution of 3-year olds (*n* = 225), 4-year olds (*n* = 206) and 5-year olds (*n* = 219; Table 1), with the majority of preschoolers classified as healthy weight. See Table 1 for a complete list of participant demographics.

Daily rates of MVPA and TPA ranged from 65.99 – 74.62 min/day and 274.20 – 281.66 min/day, respectively, while sedentary time ranged from 443.13 – 460.57 min/day (Table 2). No significant differences were observed for the full sample, or in boys or girls separately in *daily* rates of each activity level (LPA, MVPA, TPA, ST) across the four childcare settings. *Hourly* rates of MVPA and TPA ranged from 5.48 – 6.18 min/hr and 22.69 – 23.21 min/hr, respectively, while ST ranged from 36.80 – 37.31 min/hr (Table 3). Again, no significant differences were observed for mean *hourly* rates of the various activity intensities across the four childcare venues.

Despite a lack of significant differences observed for *daily* rates of activity, compared with other childcare arrangements, for both sexes and for boys only, MVPA and TPA was highest in the school setting. Specifically, participants enrolled in this venue obtained 74.62 min/day of MVPA and 281.66 min/day of TPA; with boys obtaining 80.93 min/day of MVPA and 298.07 min/day of TPA. In contrast, girls enrolled in home-based childcare were found to obtain the most MVPA (73.21 min/day), while girls who stayed at home with a parent or guardian exhibited the most TPA (286.01 min/day). ST was noted to also be the highest for preschoolers enrolled in the school

system, when explored for the entire sample (460.57 min/day), as well as when examined among boys (457.39 min/day) and girls (463.67 min/day) independently.

When exploring *hourly* rates of activity, more variable findings were observed. For the total sample, and for girls, the highest MVPA was reported in home-based childcare (6.18 min/hr and 6.17 min/hr, respectively) while boys displayed the highest MVPA if they stayed at home with a parent, guardian or other caregiver (6.39 min/hr). For TPA, those who stayed home with a parent, guardian or other caregiver obtained the most for the entire sample (23.21 min/hr), while boys enrolled in school (23.69 min/day) and girls in home-based childcare (23.53 min/hr) obtained the most TPA. Childcare venues with the most ST was varied as well. For both sexes and for boys only, ST was highest in centre-based childcare (daycare, preschool or nursery school; 37.31 min/hr entire sample and 37.22 min/hr for boys only) but for girls only, ST was highest at school (38.05 min/hr).

Table 1

Selected Characteristics of Preschooler Participants and For Boys and Girls Separately.

Characteristics	Full sample (*n*=650)		Boys (*n*=330)		Girls (*n*=319)	
	n	**%**	***n***	**%**	***n***	**%**
Age (years)						
3	225	34.6	114	34.6	110	34.6
4	206	31.7	102	30.8	104	32.6
5	219	33.8	114	34.6	105	32.9
Household income						
$0 -$39,999	157	24.2	102	31.0	55	17.1
$40,000 -$79,000	192	29.5	86	26.1	106	33.1
$80,000 or higher	301	46.3	142	42.9	159	49.8
Highest household education						
Secondary school or less	102	16.2	50	15.9	51	16.4
Post-secondary completed	527	83.9	266	84.1	262	83.6
Body weight status†						
Age 3&4:						
Healthy weight	399	92.5	…	…	…	…
Overweight/obesity	32	7.5	…	…	…	…
Age 5:						
Healthy weight	161	74.2	…	…	…	…
Overweight/obesity	56	25.8	…	…	…	…
Childcare type attended						
Centre-based	179	27.5	82	24.9	97	30.2
Home-based	62	9.5	37	11.1	25	7.9
At home with parent/guardian	209	32.1	112	34.0	96	30.1
School	200	30.9	99	30.0	101	31.8

Note: Some values shown in the table may not add up to 100% due to weighting and some individuals chose not to answer certain questions; centre-based childcare = daycare, nursey school or preschool; stayed at home = stayed at home with parent, guardian or other caregiver; † = defined according to the World Health Organization criteria

Table 2

Average Daily Physical Activity, by Childcare Type, Among Canadian Preschoolers and for Boys and Girls Separately.

		LPA				MVPA				TPA				ST			
	n	min/d	S.E.	95% CI		min/d	S.E.	95% CI		min/d	S.E.	95% CI		min/d	S.E.	95% CI	
Total																	
Centre-based	223	208.21	4.80	198.78	217.64	65.99	2.33	61.40	70.57	274.20	6.20	262.02	286.39	450.63	6.99	436.89	464.37
Home-based	66	203.02	4.83	193.54	212.51	74.26	4.99	64.46	84.05	277.28	9.01	259.58	294.98	444.81	13.08	419.12	470.50
Stayed home	165	206.85	7.89	191.36	222.35	73.46	3.82	65.95	80.96	280.31	10.77	259.14	301.47	443.13	8.46	426.51	459.74
School	196	207.04	4.89	197.44	216.65	74.62	2.25	70.19	79.05	281.66	6.26	269.37	293.95	460.57	9.78	441.35	479.78
Boys																	
Centre-based	106	206.72	8.86	189.30	224.13	67.13	3.61	60.04	74.22	273.84	11.79	250.69	297.00	456.36	9.67	437.36	475.36
Home-based	30	200.94	7.39	186.42	215.46	74.98	7.64	59.98	89.98	275.92	13.71	248.98	302.85	451.41	19.67	412.77	490.05
Stayed home	92	199.77	8.76	182.56	216.98	75.66	4.89	66.05	85.27	275.43	12.66	250.56	300.31	436.44	13.33	410.24	462.63
School	92	217.14	11.39	194.76	239.51	80.93	4.20	72.68	89.19	298.07	14.73	269.13	327.01	457.39	17.80	422.42	492.36
Girls																	
Centre-based	117	209.49	4.73	200.21	218.78	65.02	2.52	60.06	69.97	274.51	5.39	263.92	285.10	445.74	11.58	422.99	468.50
Home-based	36	206.04	5.17	195.89	216.20	73.21	6.88	59.69	86.73	279.25	11.13	257.39	301.12	435.24	16.17	403.48	467.01
Stayed home	73	215.13	9.10	197.26	233.00	70.88	4.69	61.67	80.09	286.01	12.22	262.00	310.01	450.95	10.37	430.57	471.32
School	104	197.19	6.05	185.29	209.08	68.45	4.03	60.54	76.37	265.64	9.79	246.40	284.87	463.67	9.17	445.66	481.68

Note: variations in sample size due to weighting & missing data; LPA = light physical activity; MVPA = moderate-to-vigorous physical activity; TPA = total physical activity; ST = sedentary time; centre-based childcare = daycare, nursey school or preschool; stayed home = stayed at home with parent, guardian or other caregiver; S.E. = standard error; CI = confidence interval

Table 3

Average Hourly Physical Activity, by Childcare Type, Among Canadian Preschoolers and for Boys and Girls Separately.

		LPA				MVPA				TPA				ST			
	N	min/hr	S.E.	95% CI		min/hr	S.E.	95% CI		min/hr	S.E.	95% CI		min/hr	S.E.	95% CI	
Total																	
Centre-based	223	17.22	0.31	16.61	17.82	5.48	0.19	5.10	5.85	22.69	0.41	21.89	23.50	37.31	0.41	36.50	38.12
Home-based	66	16.90	0.44	16.04	17.77	6.18	0.42	5.36	7.00	23.08	0.79	21.52	24.64	36.92	0.79	35.36	38.48
Stayed home	165	17.11	0.43	16.27	17.95	6.10	0.30	5.52	6.68	23.21	0.65	21.94	24.48	36.80	0.65	35.53	38.08
School	196	16.73	0.31	16.11	17.34	6.08	0.22	5.65	6.52	22.81	0.41	22.00	23.61	37.19	0.41	36.39	38.00
Boys																	
Centre-based	106	16.87	0.36	16.17	17.57	5.51	0.21	5.10	5.93	22.38	0.47	21.46	23.31	37.62	0.47	36.69	38.55
Home-based	30	16.59	0.63	15.36	17.82	6.18	0.65	4.90	7.47	22.78	1.20	20.43	25.12	37.22	1.20	34.87	39.57
Stayed home	92	16.83	0.50	15.84	17.83	6.39	0.40	5.60	7.18	23.23	0.83	21.59	24.86	36.78	0.83	35.15	38.42
School	92	17.18	0.70	15.81	18.55	6.51	0.32	5.89	7.13	23.69	0.85	22.02	25.37	36.31	0.85	34.64	37.98
Girls																	
Centre-based	117	17.51	0.52	16.50	18.53	5.44	0.24	4.98	5.91	22.96	0.64	21.71	24.21	37.05	0.64	35.80	38.30
Home-based	36	17.36	0.50	16.38	18.34	6.17	0.55	5.09	7.24	23.53	0.96	21.64	25.41	36.48	0.96	34.59	38.37
Stayed home	73	17.43	0.55	16.36	18.50	5.75	0.35	5.07	6.43	23.18	0.76	21.69	24.67	36.83	0.76	35.34	38.32
School	104	16.28	0.42	15.46	17.10	5.66	0.31	5.06	6.27	21.94	0.69	20.59	23.30	38.05	0.69	36.69	39.41

Note: variations in sample size due to weighting & missing data, LPA = light physical activity; MVPA = moderate-to-vigorous physical activity; TPA = total physical activity; ST = sedentary time; centre-based childcare = daycare, nursey school or preschool; stayed home = stayed at home with parent, guardian or other caregiver; S.E. = standard error; CI = confidence interval.

Chapter IV: Discussion

The purpose of this study was to explore the influence of childcare type on the physical activity levels and sedentary time of Canadian preschoolers. Although no significant differences were found in the four childcare types (daycare, preschool or nursery school; home-based childcare, stayed at home with parent, guardian or other caregiver; school), this study is the first of its kind to explore childcare status among a representative sample of the Canadian population. Specifically, when measured in min/day, preschoolers enrolled in school obtained the most MVPA and TPA but, also the most ST. They did not obtain the most LPA. However, when activity was measured in min/hr, preschoolers obtained the most MVPA in home-based childcare and TPA when participants stayed at home with a parent. The most ST was obtained in centre-based childcare. The inconsistency in settings with the most activity reported, by daily and hourly rates, is a consequence of varied wear time, and therefore, hourly rates may provide a more accurate picture.

The higher rates of activity noted in the current study align with the work of Vanderloo et al. who found that preschoolers in school (3.33 min/hr) obtained significantly more MVPA than those in centre- (1.58 min/hr) or home-based daycare (1.74 min/hr; Vanderloo et al., 2015). While the current study did not find a significant difference in rates of MVPA across childcare venues, centre-based childcare (5.48 min/hr) also had the lowest MVPA in comparison to the other arrangements (8.63 min/day and 0.30 min/hr). In general, the current study had much higher rates of MVPA (5.48 min/hr to 6.18 min/hr) than participants from the various childcare settings in

Vanderloo and colleagues' study (1.58 min/hr to 3.33 min/hr). While both studies employed Actical accelerometers to measure activity levels, this variation could be a consequence of the cut-points applied by each of the studies; Vanderloo et al. used higher cut-points validated by Pfeiffer and colleagues (2006; LPA – 50 cp15s, MVPA – 715 cp15s), whereas the current study used lower cut-points (consistent with other CHMS studies), provided by Adoph et al. (2012; MVPA – 288 cp15s) and Wong et al. (2011; LPA – 25 cp15s).

In 2014, Pate et al. found children in private Montessori school to have higher rates of physical activity than those in public preschools (LPA, MVPA, TPA; Pate et al., 2014). The rates of LPA and MVPA in private (7.7 min/hr; 7.7 min/hr) and public (6.5 min/hr; 6.5 min/hr) preschools are similar to our hourly rates of LPA and MVPA (Pate et al., 2014). Although different methodology than our study because of the use of subjective measures of activity (SOPLAY), Jones et al. reported that children in childcare services with large enrollment (>50 children), as defined by the researchers, were more active than those in childcare services with small enrollment (Jones et al., 2017). Jones et al. studied 18 childcare services (of varying size) and measured activity by scanning the environment to see how many children were 'sedentary', 'walking' or 'very active' at any point in time (Jones et al., 2017). On average children were sedentary 48.6% of the time but were very active 19% of the time during outdoor free play and 34.2% were very active (observed doing activities such as running, jumping, basketball, etc.) during structured play (Jones et al., 2017). Since schools typically have larger child enrollment, in comparison to the other "childcare arrangements" explored in the current study,

Jones et al. had results similar to Vanderloo et al. and the current study (for daily rates of activity) where children in school experienced more MVPA than the other childcare arrangements. The difference in results between the current study and Jones et al. could be a consequence of subjective versus objective measures of activity.

Vanderloo et al., also reported significantly more TPA (20.31 min/hr) in school than in centre-based childcare (18.36 min/hr; Vanderloo et al., 2015). This is not surprising given they observed the same trend with MVPA. However, unlike Vanderloo and colleagues, the CHMS data support more TPA among preschoolers enrolled in centre-based childcare, when measured using hourly rates of activity. However, no significant difference was found in rates of TPA in our study. The difference in results between the two studies could be attributed to one being a local (London, Ontario) study and the other reporting on national data. TPA could be higher than the national average in London, Ontario.

With respect to sedentary time, the results of the current study are similar to those of Tucker and colleagues who found preschoolers enrolled centre-based daycare to have the highest rate of ST (41.62 min/hr) compared to young children who attend other childcare arrangements, specifically home-based childcare and full-day kindergarten (Tucker et al., 2015). It should be noted that Tucker and colleagues (2015) did not explore rates of sedentary time among preschoolers at home with a parent or guardian. Sedentary time across all childcare venues was not significantly different in either study but generally higher rates of ST were found in Tucker et al.'s study in comparison to the current study (39.68 min/hr to 41.62 min/hr vs. 36.80 min/hr to

37.31 min/hr respectively). Like Vanderloo et al.'s 2015 study, which reported on physical activity levels in these settings, the differences observed could be a consequence of the participant collection (local vs. national) or accelerometry cut points, adopted protocols and/or length of data collection (all factors recognized to influence activity intensity rates; Vanderloo et al., 2016). In the studies by Vanderloo et al., and Tucker et al., participants wore accelerometers during childcare hours only, whereas CHMS participants wore accelerometers during all waking hours. This resulted in more wear time (approximately 12 hours) in current study participants versus others (Tucker et al., 2015; Vanderloo & Tucker, 2015) who wore the device during childcare hours only (and therefore have lower average wear time, approximately 7 hours). Having children wear the device during childcare hours only is more indicative of true differences in activity levels between childcare arrangements because activity that occurs before and after childcare hours in not reported on. However, due to the wide range of data collected via CHMS on topics not limited to physical activity and sedentary time during childcare, children cannot wear the accelerometer only during childcare hours in CHMS data collection.

In 2017, Carson and Kuzik reported that toddlers (12-35 months) in centre-based childcare, home-based childcare and 'other' types of childcare obtained significantly less minutes per day of screen time in the form of video and computer games than those in parental care (Carson & Kuzik, 2017). Screen time is a frequent form of sedentary time because most screen time is obtained while seated (De Decker et al., 2013). As for general screen time, toddlers in centre-based childcare obtained 52.5 min/day less than

those in parental care (Carson & Kuzik, 2017). In addition, the study found sex to be the only demographic variable significantly associated with activity (LPA, MVPA, TPA) or sedentary time. Although study participants were younger (average age = 19 months), than the participants in the current study, the study design of Carson and Kuzik's is the very similar to the current study. Carson et al. had four childcare arrangements: stayed at home with parent (*n* = 48), centre-based childcare (*n* = 26), home-based childcare (*n*=24) and other (*n*=51; Carson & Kuzik, 2017). In this study participants qualified for one of the first 3 types of childcare if they used any other childcare arrangement less than 4 hours per week. This allowed for some flexibility in childcare arrangement whereas the current study required participants to use one type of childcare exclusively. Smaller sample sizes in Carson and Kuzik's study could explain the difference in results. Like Tucker et al.'s study, Carson and colleagues study reported on local data only (Edmonton, Alberta). Differences in results could also be attributed to the use of different accelerometers; Carson used ActiGraphs to objectively measure activity (Carson & Kuzik, 2017), whereas the current study used the Actical. According to Vanderloo et al., accelerometer choice results in differences in activity rates (Vanderloo et al., 2016). Specifically, Actigraph accelerometers were found to report higher rates of MVPA (9.2 min/hr vs 2.6 min/hr at 15-s epoch lengths) and TPA (31.7 min/hr vs 22.3 min/hr at 15-s epoch lengths), while Actical accelerometers reported higher rates of sedentary time (42.7 min/hr vs 33.5 min/hr at 15-s epoch lengths; Vanderloo et al., 2016).

Anderson and colleagues objectively measured activity (via Actigraph) in Norwegian 3- and 4-year olds attending public preschools in Sandefjord municipality (Anderson et al., 2017). Study participants obtained between 162 min/day and 390 min/day of ST (Anderson et al., 2017). CHMS data cannot report minimum and maximum values but results in the current study found ST ranged from an average of 443.13 min/day for participants who stayed at home with a parent or guardian and 450.63 min/day for participants who attended centre-based childcare. The highest rate of sedentary time found in Anderson et al.'s study (390 min/day) is not as high as the current study's lowest average rate of ST (443.13 min/day). The higher levels of ST in the current study compared to Anderson et al.'s could be attributed to a potentially generally healthier lifestyle in Norway than in Canada. In particular, participants that stayed at home with a parent or guardian may be experiencing additional influential factors (such as lifestyle) from their caregivers. An example of this is the positive or negative impact of an adult role model on a preschooler's activity levels. Furthermore, Anderson et al. tracked preschool rates of physical activity for one week whereas our study tracked for 5 days. Since all participants in Anderson et al.'s study began data collection on the same day, inconsistency caused day of data collection does not exist. Participants in the current study did not necessarily begin data collection on the same day. In 2015, Vanderloo and Tucker showed that day of the week does influence activity levels and most preschoolers in childcare accumulate more activity (LPA, MVPA and TPA) midweek, from Tuesday through Thursday (Vanderloo & Tucker, 2015). Activity gradually increases beginning on Monday, peaking midweek and decreases again at the

end of the week (Vanderloo & Tucker, 2015). It is not known what day accelerometer data collection began for participants in the current study and this research from Vanderloo and Tucker (2015) indicates that day of the week does influence activity rates. Berglind and Tynelius added to this concept finding that 4-year olds during preschool time obtained 24.8 min/day of MVPA during weekday preschool hours and 26.6 min/day of MVPA on weekdays outside of preschool time (e.g., in the evening; Berglind & Tynelius, 2018). Interestingly, participants obtained less MVPA on weekends during preschool hours (e.g., 9am – 5pm) and on weekends outside of preschool time. They obtained 22.4 min/day and 25.3 min/day of MVPA respectively (Berglind et al., 2018). This indicates that preschoolers are more active during childcare hours. Therefore, having different start dates of accelerometer data collection could be a factor in the consistency of activity levels across childcare centres found in the current study if differences in activity rates are a consequence of childcare type.

The childcare environment itself can largely influence the activity levels among preschoolers (Pate et al., 2004). CHMS does not currently ask characteristic questions about the childcare venue attended. Sex, history of pre-term birth and father's BMI are characteristics that have been found to influence the activity levels of young children (Finn et al., 2002). However, childcare centre attended has been recognized as a having a strong influence (Finn et al., 2002). Byun et al. found children enrolled in Montessori school to obtain less sedentary time than those in traditional preschool while they were both in and out of preschool (Byun, Blair, & Pate, 2013). Both Pate et al. and Byun et

al.'s results indicate it may be beneficial to include another childcare centre option for Montessori school and a question in CHMS about whether childcare is public or private.

Peden et al. used Environment and Policy Assessment and Observation (EPAO) scoring to differentiate 11 childcare services (high, medium, low; Peden, Jones, Costa, Ellis, & Okely, 2017). The EPAO is a comprehensive measure of nutrition, physical activity, and sedentary practices, policies, and environments in early care and education (ECE) settings and ratings were created by assessing each childcare service's practices and policies on sedentary time and physical activity (Peden et al., 2017). Peden et al. found no statistical difference in time spent sitting, standing or stepping across their high, medium and low scoring EPAO childcare settings. Results of the current study also found no statistically significant difference in activity levels across childcare venues, although it is not known how CHMS childcare types would score using the EPAO method since policies and practices across the country may differ in each type of childcare.

While not currently feasible, LPA, MVPA, TPA and ST can be explored by childcare type and by age to further understand the role age plays in the childcare environment. This will not be possible until another cycle of CHMS is released and a larger sample size is available. In 2017, Ellis et al. found toddlers (<3 years) spent significantly more time in activity (intensity not specified) than preschoolers (> 3years; Ellis, Cliff, Janssen, Jones, Reilly, & Okely, 2017). On the contrary, as previously discussed, Vanderloo et al. (2015) saw increased rates of MVPA in school, a common childcare venue for older preschoolers. This could be caused by increasing motor skills and potentially more accessibility to play equipment and exposure to organized

activities. In support of this argument, Grontved et al. found 3- to 4-year old children to spend less time in MVPA and have decreased TPA than those 4-5-years old and those 5-6-years old (Grontved, Pedersen, Andersen, Kristensen, Moller, & Froberg, 2009). These inconsistent results speak to the need for further exploration of activity levels by age in various childcare settings.

Limitations

This study helps to understand the rates of physical activity and sedentary time among preschoolers in childcare environments across the country. However, limitations of this study should be noted. First, a number of participants (*n* = 172) were enrolled in multiple childcare arrangements (e.g., daycare centre and stayed at home with a parent) which "convolutes" the interaction, and therefore, were not included in our analyses. This limitation means that those children enrolled in more than one childcare arrangement, or those enrolled only part-time, were excluded from the analysis. However, this decision allowed for better comparability between groups in attempt to limit confounding influences. Overall, this led to a smaller sample size (*n* = 650) in comparison to other articles using similar CHMS data. In addition, because children were not selected to participate in the study based on which childcare setting they attended (as that was not the primary purpose of CHMS data collection), the four childcare groups were unbalanced.

In addition, while CHMS aims to be nationally representative, the participants in this study live in households with higher education and income levels than the national average (Table 1). In 2016 Statistics Canada stated that 54% of Canadians had a college

or university education and 10.8% had obtained an apprenticeship or trades certification or diploma (Statistics Canada, 2017). These numbers differ from the current study in which 83.9% of participants had at least one parent who had completed post-secondary education (Table 1). Although not as drastic, a similar finding was found for household income; the current study shows 46.3% of participants having a household income of over $80,000 (Table 1), whereas results from the 2016 Census show 35.6% of Canadians earning the same household income (Statistics Canada, 2018). Implications of having a wealthier, more educated sample than the national average could influence the childcare enrollment, childcare centre attended and activity levels among this age group. However, the implementation of sample and bootstrap weights assisted to reduce this potential bias.

Moreover, the sample distribution across different areas of the country is unknown. Each province has differing policies regarding physical activity and outdoor time in childcare (Vanderloo & Tucker, 2018); which has been strongly correlated with increased physical activity among this population (Tucker et al., 2013). Therefore, childcare venues included in the same category (e.g., daycare) may be quite different. Moreover, no information is available to indicate the characteristics (e.g., quality of childcare setting or hours of operation) of the childcare venues attended by study participants. Geographical differences may influence the set-up and daily structure of childcare settings across the country. This is important to recognize given recent evidence suggests that the individual childcare venue can account for up to 50% of the variability in preschoolers' activity levels (Finn et al., 2002; Pate et al., 2004).

Additionally, CHMS does not control for the time of year in which data are collected; therefore, weather may have influenced the amount of outdoor time study participants obtained during the time of data collection. This could subsequently influence physical activity level; given preschoolers in childcare are 10 times more active outdoors than indoors (Vanderloo et al., 2013). Poor weather is a barrier to physical activity in various populations (Carson, Spence, Cutumisu, Boule, & Edwards, 2010; Tucker & Gilliand, 2007) and preschoolers are more active outdoors than indoors (Vanderloo et al., 2013).

Although accelerometers are an effective, objective measure of physical activity and sedentary time (Pfeiffer et al., 2006), they are associated with some limitations. Activities such as cycling may not be properly measured by an accelerometer (Garriguet et al., 2014), creating the possibility that physical activity was underestimated in some study participants. As well, time spent at the various intensities (LPA, MVPA, TPA, ST) is dependent on a chosen threshold. Changing the threshold could result in vastly different results (Hnatiuk et al., 2014). Lastly, participants began using the accelerometer the day after their visit to the MEC. Since participants did not visit the MEC on the same day, it is not possible to compare activity levels on particular days of data collection since some weekdays may be more active than others and children are often not enrolled in childcare on the weekend. Since only 5 days of data were collected per child (due to accelerometer memory capacity), some participants may have had weekend days included while others did not, which further confounds the results.

Conclusion

No significant differences were observed in preschooler sedentary time and physical activity levels across childcare arrangements in Canada. While this study provides a comprehensive look at childcare status as an influential construct for preschoolers' physical activity, there are a variety of limitations that warrant additional research in this area. Specifically, an exploration of how childcare arrangements vary across the country (e.g., programming, policies, environments), and the subsequent impact on activity levels is needed. More information about this topic will guide decision makers when creating policies surrounding physical activity and sedentary time in Canadian preschoolers attending childcare. Moreover, exploring preschoolers who stay at home with a parent or guardian and the impact of having more than one childcare status is necessary given the strong influence that both parents and childcare providers have been noted to have on young children's activity affordances. With a larger sample size and exploring activity levels by age, future iterations of CHMS may address childcare type and activity monitoring to improve our ability to explore this relationship. Nevertheless, this study provides a national depiction of the physical activity and sedentary time among preschooler's enrolled in common childcare venues.

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Appendix A – CHMS Interview and Accelerometry Variables

CHMS variables:

Demographic variables:

- **DHH_AGE**
- **DHH_SEX**
- **EDUDHO4** (highest level of education – household)
    - Secondary school or less (1,2)
    - Some post-secondary (3) *no participants in this category*
    - Post-secondary graduate (4)
- **THID14** (total household income)
    - $0 - $39,999 (1-6)
    - $40,000 - $79,999 (7-10)
    - $80,000 or more (11-14)
- **HWMDWHOK** (BMI class – 5- to 18- years old)
    - Healthy weight (1,2)
    - Overweight/obesity (3,4)
- **HWMDWHOP** (BMI class – 3- to 4-years old)
    - Healthy weight (1,2,3)
    - Overweight/obesity (4,5)

Childcare variables:

- **TSO_Q01** During the past month did ^FNAME…?

    1 Attend a daycare centre
    2 Attend a home-based daycare
    3 Attend nursery school or preschool
    4 Attend school (including kindergarten)
    5 Stay at home with a parent, guardian or caregiver
    6 Receive any other type of childcare (eg. attend day camp) – Specify

Accelerometry variables:

- **AMMDHR** (Avg. Wear Time), **AMDHR1-7** (Wear Time - Day X)
- **AMMDLA** (Avg. Daily Light Physical Activity), **AMMDLA1-7** (Total Light Physical Activity - Day X)
- **AMMDMVA** (Avg. Daily Mod-to-Vig Physical Activity), **AMMDMVA1-7** (Total Mod-to-Vig Physical Activity - Day X)
- **AMMDXSA** (Avg. Daily Sedentary Time), **AMMDXSA1-7** (Total Sedentary Time - Day X)

Created variables:

Demographic variables:

- **DHH_AGE** (age)
  - 3
  - 4
  - 5
- **DHH_SEX** (sex)
  - Male (1)
  - Female (2)
- **Childcare_type**
  - Attended daycare, nursery school or preschool (1)
  - Attended home-based daycare (2)
  - Stayed at home with parent, guardian or other caregiver (3)
  - Attended school (4)
- **INCOME**
  - $0 - $39,999 (1)
  - $40,000 - $79,999 (2)
  - $80,000 or more (3)
- **EDUCATION**
  - Secondary school or less (1)
  - Some post-secondary (2)
  - Post-secondary graduate (3)
- **BMI_5**
  - Healthy weight (1)
  - Overweight/obesity (2)
- **BMI_3_4**
  - Healthy weight (1)
  - Overweight/obesity (2)

Appendix B - Curriculum Vitae

Julie Statler

Education

2016 – Present	Master's of Science in Health Promotion Western University, London, ON Supervisor: Dr. Trish Tucker Area of Research: Physical activity & sedentary time in preschoolers
2011-2015	Honours Bachelor of Science in Foods & Nutrition Western University (Brescia University College), London, ON

Scholarships and Academic Honours

2016-2017	Dean's Honours List – Western University
2011	The Western Scholarship of Distinction

Research Experience

Volunteer Research Assistant
October 2016 – December 2016
Western University, London, ON
Transcribed patient interviews to assist with research on hospital stays and patient learning

Independent Study Research Student
September 2015 – December 2015
Western University, London, ON
Conducted background research and designed methodology to study child play on playgrounds and cognitive development.

Volunteer Research Assistant
May 2014 – May 2015
Brescia University College, London, ON
Input quantitative and qualitative data for the project, *Nutrition Ignition!*
Scribed for focus groups with elementary school children

Teaching Experience

Teaching Assistant
September 2017 – December 2017
Indigenous Services, Western University, London, ON

Teaching Assistant
January 2016 – April 2016
Health Issues in Aging, HS2711B, Western University, London, ON

Training and Certifications

2018	CPR- C with AED
2017	Introduction to Motivational Interviewing Workshop
2015	Emergency First Aid & CPR-C with AED

Conference Presentations

Statler, J., Wilk, P., Timmons, B. W., Colley, R., & Tucker, P. Exploring the influence of childcare enrollment on physical activity and sedentary time of a nationally representative sample of Canadian Preschoolers. Health and Rehabilitation Sciences Graduate Research Conference. February 2018. **Abstract & Oral Presentation.**