

Electronic Thesis and Dissertation Repository

---

11-16-2016 12:00 AM

## Assessing Physical Activity and Sedentary Time in the Early Years

Leigh M. Vanderloo  
*The University of Western Ontario*

Supervisor  
Dr. Trish Tucker  
*The University of Western Ontario*

Graduate Program in Health and Rehabilitation Sciences  
A thesis submitted in partial fulfillment of the requirements for the degree in Doctor of  
Philosophy  
© Leigh M. Vanderloo 2016

Follow this and additional works at: <https://ir.lib.uwo.ca/etd>



Part of the [Maternal and Child Health Commons](#), and the [Public Health Education and Promotion Commons](#)

---

### Recommended Citation

Vanderloo, Leigh M., "Assessing Physical Activity and Sedentary Time in the Early Years" (2016).  
*Electronic Thesis and Dissertation Repository*. 4239.  
<https://ir.lib.uwo.ca/etd/4239>

This Dissertation/Thesis is brought to you for free and open access by Scholarship@Western. It has been accepted for inclusion in Electronic Thesis and Dissertation Repository by an authorized administrator of Scholarship@Western. For more information, please contact [wlsadmin@uwo.ca](mailto:wlsadmin@uwo.ca).

## Abstract

The overall purpose of this dissertation was to explore young children's (18 months to 5 years) physical activity and sedentary time. Study 1 assessed the physical activity and sedentary time among a sample of toddlers from London, Canada using two data processing approaches. Study 2 explored the impact of three different early learning environments, and their respective characteristics (e.g., staff behaviours, equipment, sedentary opportunities, etc.), on preschoolers' activity levels. Study 3 examined differences in two popular accelerometers used to measure young children's physical activity and sedentary time to better understand measurement discrepancies.

Study 1 revealed that toddlers engaged in 37.27 ( $SD = 3.79$ ) to 49.40 mins/hr of sedentary time, 9.79 to 18.78 mins/hr of light physical activity (LPA), 0.82 to 3.95 mins/hr of moderate-to-vigorous physical activity (MVPA), and 10.60 to 22.73 mins/hr of total physical activity (TPA), based on the Trost et al. and the Canadian Health Measures Survey cut-points respectively; these rates were significantly different.

The results of Study 2 identified that preschoolers in Full-Day Kindergarten (FDK) accumulated significantly more MVPA (3.33 mins/hr) than those in centre- (1.58 mins/hr) and home-based (1.75 mins/hr) childcare, and significantly more TPA (20.31 mins/hr) than those in centre-based childcare (18.36 mins/hr). For FDK, the Active Opportunities, Sedentary Opportunities, Sedentary Environment, and Fixed Play Environment subscales of the Environment Policy Assessment and Observation (EPAO) tool significantly impacted both MVPA and TPA. For centre-based childcare, only Sedentary Environment was found to impact MVPA and TPA. No subscales were influential of children's MVPA or TPA in home-based childcare.

The results of Study 3 suggest that, regardless of epoch length, Actical accelerometers, compared with ActiGraph accelerometers, reported significantly higher rates of sedentary time (15s: 42.7 mins/hr vs. 33.5 mins/hr; 60s: 39.4 mins/hr vs. 27.1 mins/hr). ActiGraph accelerometers captured significantly higher rates of MVPA (15s: 9.2 mins/hr vs. 2.6 mins/hr; 60s: 8.0 mins/hr vs. 1.27 mins/hr) and TPA (15s: 31.7 mins/hr vs. 22.3 mins/hr; 60s: 39.4 mins/hr vs. 25.2 mins/hr) in comparison to Actical accelerometers.

In sum, these articles serve as foundational studies for future work in paediatric exercise science and health promotion as well as in the betterment of young Canadians' health.

*Keywords:* physical activity, sedentary time, preschoolers, toddlers, accelerometer, childcare environment, health promotion

Co-Authorship

While the contents of this dissertation are my original work, I would like to acknowledge the contributions and collaborations of seven co-authors. Firstly, thank you to Dr. Trish Tucker who played an integral role in the conceptualization, design, and implementation of all three studies. Next, I would like to thank Drs. Jennifer Irwin, Andrew Johnson, and Shauna Burke for their guidance as well as their analytical and editorial expertise for Study 2. Lastly, I would like to extend my sincere thanks to the researchers at McMaster University (notably, Dr. Brian Timmons, Natascja Di Cristofaro, and Nicole Proudfoot) for their assistance in collecting the data for Study 3, in addition to their editorial assistance in revising the corresponding manuscript.



## Acknowledgments

The completion of my Doctoral degree (which includes this thesis) would not have been possible without a number of key individuals. I would like to sincerely thank the following people for their ongoing support, encouragement, and assistance over the past four years:

**Dr. Trish Tucker** for her continuous guidance and encouragement. Thank you for supporting my academic goals and for challenging me to better myself in many ways. Over the past few years I have learned many things working and studying under your supervision – all of which will serve me immensely in my future work. I am proud of what I have learned and accomplished and feel extremely fortunate to have had you as my supervisor. I could not have asked for a better mentor (and friend!) to guide me through my doctoral work.

**Drs. Jennifer Irwin, Shauna Burke, and Angie Mandich** for serving as members of my advisory committee. Your expertise, feedback, and mentorship greatly contributed to the successful completion of my PhD and I am immensely thankful.

My examiners (**Drs. Angie Mandich, Anita Cramp, Jason Gilliland, and Kristi Adamo**) for taking the time to review my dissertation and for providing me with valuable feedback throughout my defence.

The **study participants and their families** for making my studies possible.

The **Canadian Institutes of Health Research (CIHR)**, the **Ontario Graduate Scholarship (OGS)**, and the **North American Society of Pediatric Exercise Medicine (NASPEM)** for funding my Doctoral work.

**My friends:** Thank you for keeping me smiling and for helping make this journey an enjoyable one.

**My family:** Thank you for all that you have done for me. Your support and encouragement over the years has been very much appreciated. I dedicate my dissertation to you.

## Table of Contents

Abstract .....	i
Co-Authorship.....	iii
Acknowledgements.....	iv
List of Tables.....	viii
List of Figures.....	x
List of Appendices .....	xi
List of Abbreviations.....	xii
<b>Chapter 1: Introduction, Rationale, and Purpose Statement .....</b>	<b>1</b>
Guidelines for Young Children (0-4 years) .....	3
Prevalence of Physical Activity and Sedentary Behaviours - What Do We Know?.....	4
The Early Learning Environment .....	5
Assessing Young Children's Physical Activity Levels via Accelerometry.....	9
Health Promotion Program Planning: The PRECEDE-PROCEED Model.....	10
Research Rationale.....	12
Purpose Statement.....	13
References.....	15
<b>Chapter 2: An Objective Assessment of Toddlers' Physical Activity and Sedentary</b>	
<b>Levels: A Cross-Sectional Study .....</b>	<b>26</b>
Methods.....	28
Study sample and recruitment.....	28
Study protocol.....	29
Measurement.....	30
Toddlers' physical activity and sedentary time.. ..	30

Toddlers' screen-viewing behaviours.....	30
Participant characteristics.....	31
Statistical analyses.....	31
Results.....	34
Sample description.....	34
Toddlers' levels of sedentary time and physical activity.....	34
Screen-viewing among toddlers.....	41
Discussion.....	43
Conclusion.....	49
References.....	50
<b>Chapter 3: Environmental Influences on Preschoolers' Physical Activity Levels in Various Early Learning Environments.....</b>	<b>58</b>
Study Purpose.....	61
Methods.....	62
Research design.....	62
Participants.....	62
Procedures and tools of measurement.....	63
Statistical analysis.....	64
Results.....	69
Preschoolers' physical activity levels across different early learning environments..	67
EPAO physical activity subscales and MVPA.....	67
EPAO physical activity subscales and TPA.....	74
Total physical activity environment EPAO score and MVPA and TPA.....	77
Discussion.....	85
References.....	92

<b>Chapter 4: Comparing the Actical and ActiGraph Approach to Measuring Young Children’s Physical Activity Levels and Sedentary Time</b> .....	91
Methods.....	96
Study design and recruitment.....	96
Tools.....	97
Data collection.....	98
Data analysis.....	98
Results.....	106
Participant demographics.....	106
Rates of physical activity and sedentary time using 15s epochs.....	106
Rates of physical activity and sedentary time using 60s epochs.....	106
Comparing rates of physical activity and sedentary time - limits of agreement analysis.....	106
Discussion.....	109
Limitations.....	113
Conclusion.....	114
References.....	115
<b>Chapter 5: Summary, Discussion of Implications, and Future Directions</b> .....	122
Summary.....	122
Discussion of Implications.....	124
Embedding these Findings within a Health Promotion Model.....	126
Future Directions and Next Steps.....	128
References.....	132
Appendices.....	135
Curriculum Vitae .....	215

List of Tables

**Study 1**

Table 1. Toddler and Family Demographic Information.....35

Table 2. Toddlers’ Means (Standard Deviations) Physical Activity and Sedentary Time  
(Mins/Hr and Percentage of Monitoring Time) Based on Two Different Cut-  
Points.....36

Table 3. Summary of Coefficients, *t*-Values, *p*-Values, and Partial Correlations for  
Toddlers’ Sedentary Time and Physical Activity Using Trost et al. Cut-  
Points.....37

Table 4. Summary of Coefficients, *t*-Values, *p*-Values, and Partial Correlations for  
Toddlers’ Sedentary Time and Physical Activity Using CHMS Cut-Points  
.....40

**Study 2**

Table 1. Preschooler and Family Demographic Information.....68

Table 2. Mean (Standard Deviation) of Preschoolers’ Physical Activity Levels in Mins/Hr  
by Early Learning Environment Type .....69

Table 3. Mean (Standard Deviation) Physical Activity Subscale Scores and Total Physical  
Activity EPAO Score for Participating Early Learning Environments.....70

Table 4. Summary of Coefficients, Confidence Intervals, *t*-Values, *p*-Values, and  
Correlations for the EPAO Physical Activity Subscales and Daily MVPA.....72

Table 5. Summary of Coefficients, Confidence Intervals, *t*-Values, *p*-Values, and  
Correlations for the EPAO Physical Activity Subscales and Daily TPA.....75

Table 6. Summary of Coefficients, Confidence Intervals, *t*-Values, *p*-Values, and Correlations for the Total Physical Activity EPAO Score and MVPA and TPA.....78

**Study 3**

Table 1. Applied Preschool-Specific Cut-Points for Actical and ActiGraph Accelerometers at 15s and 60s Epochs.....101

Table 2. Mean (Standard Deviation) Physical Activity and Sedentary Time (Mins/Hr and Percentage of Wear Time) and Ranges of Physical Activity and Sedentary Time for Actical and ActiGraph Methodological Approaches at 15s and 60s Epochs.....107

Table 3. Mean Differences and Limits of Agreement of Physical Activity and Sedentary Time in Mins/Hr as Measured by Actical and ActiGraph Methodological Approaches at 15s and 60s Epochs (Bias  $\pm$  2 *SD*).....107

List of Figures

**Study 1**

Figure 1. Number of Days Physical Activity Guidelines Were Met.....38

Figure 2. Minutes of Television Viewing among Toddlers.....42

Figure 3. Minutes of Computer Use Among Toddlers.....42

**Study 3**

Figure 1. Bland-Altman Plots Showing Differences in Activity (Mins/Hr) Between  
Accelerometer Protocols (Actical Minus ActiGraph) Plotted Against Mean  
Activity Rates for Various Epoch Lengths.....102

## List of Appendices

Appendix A: Ethics Approval Notice for Study 1 .....	135
Appendix B: Participant Recruitment Poster for Study 1 .....	137
Appendix C: Parent/Guardian Consent Form and Letter of Information for Study 1.....	139
Appendix D: Wear-Time Log for Study 1 .....	144
Appendix E: Toddler Screen-Viewing Questionnaire for Study 1....	146
Appendix F: Participant Demographic Questionnaire for Study 1.....	149
Appendix G: Ethics Approval Notice for Study 2 .....	153
Appendix H: Parent/Guardian Consent Form and Letter of Information for Study 2 ....	155
Appendix I: Environment and Policy Assessment and Observation (EPAO) Instrument for Study 2.....	160
Appendix J: Participant Demographic Questionnaire for Study 2.....	182
Appendix K: Wear-Time Log for Study 2.....	187
Appendix L: Description of Each Environmental Subscale from the EPAO Instrument for Study 2.....	189
Appendix M: EPAO Scoring Tool for Study 2.....	191
Appendix N: Ethics Approval Notice for Study 3.....	204
Appendix O: Parent/Guardian Consent Form and Letter of Information for Study 3.....	206
Appendix P: Wear-Time Log for Study 3.....	211
Appendix Q: Height and Weight Data Recording Sheet for Study 3.....	213



List of Abbreviations

CHMS: Canadian Health Measures Survey

CI: confidence interval

CSEP: Canadian Society of Exercise Physiology

ECE: early childhood educator

EPAO: Environment and Policy Assessment and Observation

FDK: full-day kindergarten

HOPP: Health Outcomes and Physical Activity in Preschoolers

LEAPP: Learning Environment Activity Potential for Preschoolers

LPA: light physical activity

MVPA: moderate-to-vigorous physical activity

PA: physical activity

PRECEDE-PROCEED: Predisposing, Reinforcing and Enabling Constructs in  
Educational Diagnosis and Evaluation – Policy, Regulatory, and  
Organizational Constructs in Educational and Environmental  
Development

SD: standard deviation

SPACE: Supporting Physical Activity in the Childcare Environment

TPA: total physical activity

## CHAPTER 1

### **Introduction, Rationale, and Purpose Statement**

Defined as “any planned combination of political, regulatory, and organizational supports for actions and conditions of living conducive to the health of individuals, groups, and communities” (p. G-4; Green & Kreuter, 2005), health promotion aims to help individuals or populations to improve their health. Likewise, the World Health Organization (1998) describes health promotion as “the process of enabling people to increase control over, and to improve, their health. It moves beyond a focus on individual behaviour towards a wide range of social and environmental interventions”. In light of the growing obesity crisis and high levels of sedentary behaviours among young children globally, health promoters have been tasked with creating novel approaches to improve the activity behaviours of this population, which includes the recognition and creation of supportive environments. The present dissertation represents a collection of studies which aimed to examine how active young children are, and how their physical activity levels can be improved (by means of identifying supportive environments and appropriate means of assessment), all in an effort to promote healthy growth and development among young Canadians.

Physical activity is integral to the overall health, growth, and development of all individuals, including those under the age of 5 years. Defined as any bodily movement that results in energy expenditures above resting levels (Caspersen, Powell, & Christenson, 1985), physical activity is related to a multitude of health benefits for young children. From a physiological standpoint, physical activity within this population has been linked to healthy bodyweight, decreased triglyceride levels, decreased risk of

diabetes and insulin resistance, and improved musculoskeletal health (Daniels, 2006; Timmons et al., 2012). Psycho-social benefits include, improved externalizing behaviour, social participation, and social competence (Timmons et al., 2012). Physical activity has also been shown to positively impact the cognitive abilities of children, including higher academic scores and improved executive function (Carson et al., 2016; Timmons et al., 2012). In addition to offering immediate health benefits (Timmons et al., 2012), activity behaviours have been shown to track from childhood to adolescence (Malina, 2001), which suggests that establishing healthful behaviours early in life is important. Often displayed in the form of active play, toddlers' (18 months to 2.5 years) and preschoolers' (2.5 to 5 years) physical activity behaviours tend to be sporadic in nature, with frequent influxes in activity intensity and rest (Bailey et al., 1995; Cardon, Van Cauwenberghe, & De Bourdeaudhuij, 2011; Eastman, 1997; Oliver, Schofield, & Kolt, 2007; Preboth, 2002). This type of activity is also typified by unstructured and free (child-directed) play (Burdette, Whitaker, & Daniels, 2004).

A separate and distinct construct from physical activity, sedentary behaviour refers to any waking activity in a sitting or reclined position that expends less than 1.5 METS (Sedentary Behaviour Research Network, 2012). Prolonged engagement in sedentary activities among young children has been linked to increased adiposity and poorer outcomes relating to cognitive development and psychosocial health (Leblanc et al., 2012). Screen-viewing is likely the most common sedentary activity in which young children engage (De Decker et al., 2013), and it is often used as a proxy measure for sedentary time among this cohort (Leblanc et al., 2012). Screen-viewing includes all exposure to television, DVDs/VHS, smartphones, tablets, computers, smart boards, and

video games. In addition to screen-viewing, other sedentary behaviours may include excessive sitting (to complete desk work, crafts, colouring, puzzles, etc.) or being restrained in a high chair or stroller.

In order to provide young children with a strong foundation for healthy active habits throughout the lifespan, it is important that both physical activity and sedentary behaviours be examined. In other words, attention is required to ensure that active behaviours are being encouraged and sedentary ones limited among this population.

### **Guidelines for Young Children (0-4 Years)**

In 2012, the Canadian Society of Exercise Physiology (CSEP) developed specific physical activity guidelines for children in the early years (i.e., under the age of 5 years). These guidelines state that children under the age of 2 years should be physically active multiple times per day (i.e., interactive floor play; CSEP, 2012a). For children 2-4 years of age, 180 minutes of daily physical activity at *any* intensity is recommended (CSEP, 2012a). While these guidelines concentrate on *all* physical activity, greater attention is paid to higher intensity activities as children age. For example, by the age of 5, children are expected to engage in 60 minutes of moderate-to-vigorous physical activity per day (MVPA; CSEP, 2012b).

With regard to sedentary behaviours, the CSEP guidelines (the first of their kind in the world) postulate that children under the age of 2 years should avoid all forms of screen viewing (CSEP, 2012c). For children 2-4 years, screen-viewing should be limited to less than 60 minutes per day and prolonged periods of sitting should be minimized as well (CSEP, 2012c).

**Prevalence of Physical Activity and Sedentary Behaviours – What Do We Know?**

The development of physical activity habits in early childhood is crucial. Not only does it increase the likelihood that children will carry these active behaviours forward (Malina, 2001), but will also help protect against many adverse health risks (Daniels, 2006; Moore et al., 2003; Trost, Sirard, Dowda, Pfeiffer, & Pate, 2003). This is particularly important given the noted decline in physical activity participation between the ages of 3 and 5 years (Taylor et al., 2009). It is also important to note that, in Canada, there is considerable variability in the estimates of young children's levels of physical activity and sedentary behaviours (Colley et al., 2013; Obeid, Nguyen, Gabel, & Timmons, 2011; Tucker, 2008; Vanderloo et al., 2014). Both nationally and internationally, studies by Colley et al. (2013) and Gunter, Rice, Ward, and Trost (2012) report young children being sufficiently active, whereas other researchers (Tucker, 2008; Hinkley, Salmon, Okely, Crawford, & Hesketh, 2012; Hnatiuk, Salmon, Hinkley, Okely, & Trost, 2014; Vale et al., 2010; Temple, Naylor, Rhodes, & Wharf Higgins, 2009) suggest this population is insufficiently active to meet national guidelines of 180 minutes per day in Canada (CSEP, 2012), Australia (Australian Government. Department of Health and Ageing., 2010), and the United Kingdom (Department of Health: Physical Activity and Health Alliance, 2011).

Although still a relatively young body of literature, a plethora of studies examining physical activity in the early years have emerged over the last five years. To date, the majority of early years research that has been conducted to date has focused on preschoolers' (i.e., 2.5 to 5 years) levels of physical activity levels and sedentary time (Cliff, Okely, Smith, & McKeen, 2009; Tucker, 2008; Vanderloo et al., 2014).

Consequently, the data available on toddlers' (i.e., 18 to 29 months) activity behaviours are limited; only nine studies to date have been conducted (Carson, Clark, Ogden, Harber, & Kuzik, 2015; Gubbels et al., 2011; Fees, Fisher, Haar, & Crowe, 2015; Hnatiuk et al., 2012; Johansson et al., 2015; Manios, 2006; Van Cauwenberghe, Gubbels, De Bourdeaudhuij, & Cardon, 2011; Vanderloo & Tucker, 2015; Witjzes et al., 2013), two of which were Canadian (Carson et al., 2015; Vanderloo & Tucker, 2015).

### **The Early Learning Environment**

Due to the changing demographics and an increase of women in the workforce (Bushnik, 2006), an escalation in children being cared for outside of the home prior to starting in the school system has been noted. Approximately 54% of Canadian children are enrolled in some form of non-parental care (Bushnik, 2006). Given the large proportion of time young children spend within this setting (i.e., upwards of 29 hours per week; Cleveland, Forer, Hyatt, Japel, & Krashinsky, 2008; Canadian Fitness and Lifestyle Research Institute, 2008), coupled with the many behaviours they learn while in care (i.e., those related to physical activity and screen viewing); the early learning environment represents an ideal venue on which to focus research efforts. Moreover, given that the children in these facilities are at an impressionable age and largely under the influence of early childhood educators (ECEs) decision-making for the majority of their day (Goldfield, Harvey, Grattan, & Adamo, 2012), research supports targeting this group in intervention programs in order to help facilitate the adoption of active behaviours by young children. Such recognitions are important since parents rely on ECEs to ensure their children are engaging in sufficient levels of physical activity during care/school hours (Eastman, 1997). Unfortunately, despite ECEs acknowledging their

important role in promoting physical activity and minimizing sedentary opportunities, many studies conclude that preschoolers are inactive the majority of their time in care (Dowda et al., 2009; Temple et al., 2009; Vanderloo et al., 2014; Tucker et al., 2015).

Specific to Ontario, there are three primary forms of early learning environments. The first, and most commonly studied, is centre-based childcare. This licensed setting tends to be institution-like and heavily regulated, with children often separated into classrooms based on age group (i.e., infant, toddler, preschool). Typically there are two to three ECEs caring for the children in each class (depending on the age), and children are offered two 1-hour outdoor play period for every six hours in care (weather permitting; Ontario Ministry of Child and Youth Services, 1990). In contrast, in home- and/or family-based childcare, up to five children (of varying ages, and excluding the caregivers own children) may be cared for in the caregivers private home. This setting tends to be less regulated, does not need to be licensed, and the frequency/duration of outdoor play periods is left to the discretion of the caregiver. The last, and most understudied to date, is Full-Day Kindergarten (FDK). Introduced in the province in 2010, the implementation of the FDK program for 3.5-5 year old children (i.e., the older preschooler groups) was thought to improve social, physical, academic, and emotional development among this population (Ontario Ministry of Education, 2010). As opposed to attending school for full days on alternating days or half-days every day, children in the FDK program are now required to attend school for full days every day. Children in this setting receive instruction from both a teacher and an ECE, and daily periods of outdoor play follow the elementary school's schedule (balanced day schedule: 55 minutes of outdoor play; traditional schedule: 70 minutes of outdoor play).

Early learning environments have been noted in the literature as having a strong influence on young children's physical activity levels (Cosco, Moore, & Islam, 2010; Pate, Pfeiffer, Trost, Ziegler, & Dowda, 2004), accounting for 43 to 50% of the variation in this particular behaviour (Pate et al., 2004). In fact, researchers purport that in comparison to demographic factors, like sex, ethnicity, and age; the early learning environment is a stronger predictor of physical activity (Pate, McIver, Dowda, Brown, & Addy, 2008a). Despite these findings, the 2010 Active Healthy Kids Canada report card highlighted the lack of attention the early learning environment has received in the literature with regard to physical activity and sedentary behaviours among young children (Active Healthy Kids Canada, 2010). Since this time, the field of paediatric exercise science has witnessed an immense growth in the number of related publications and projects (e.g., Hesketh & van Sluijs, 2016; Jones-Taylor, 2015; Jones, Okely, Hinkley, Batterham, & Burke, 2015; Kuzik, Clark, Ogden, Harber, & Carson, 2015; Tandon, Saelens, Zhou, Kerr, & Christakis, 2013; Tandon, Zhou, & Christakis, 2012; Tonge, Jones, & Okely, 2016; Vanderloo, Tucker, Johnson, & Holmes, 2013; Vanderloo et al., 2014; Vanderloo, 2014; Vanderloo, Tucker, Johnson, Burke, & Irwin, 2015). In addition, new research is emerging which is looking at the impact of *various* early learning environments on young children's activity behaviours (e.g., Tandon et al., 2012; Temple et al., 2009; Vanderloo et al., 2015).

Canadian data evaluating the relationship between young children's early learning environments (and their characteristics therein) are minimal. Although popular belief suggests that young children are naturally quite active (Pate et al., 2008), activity levels within early learning environments are low (e.g., Brown et al., 2009; Pate et al., 2004;



2008; Temple et al., 2009; Vanderloo et al., 2014). Specifically, work by Vanderloo et al. (2014) and Temple et al., (2009) found that preschoolers engaged in a mere 1.54 and 1.76 minutes per hour in centre- and home-based childcare respectively, with another study reporting that 89% of preschoolers' days are spent in inactivity during care hours (Brown et al., 2009). Tucker et al. (2015) also found that preschoolers spent 42.6 minutes per hour in sedentary time during centre-based childcare hours. Together, these findings suggest that physical activity levels are low and sedentary time high among young children enrolled in early learning environments. Increased attention is needed to address the low levels of physical activity and high levels of sedentary time accumulated by this population during care hours.

Specific characteristics of early learning environments have been identified as facilitators and/or barriers to supporting physical activity and sedentary behaviours. Specific to physical activity, attributes such as sufficient indoor and outdoor place space, gross motor equipment (e.g., balls, hula hoops, tricycles, etc.), and ECEs' level of training and engagement, have been found to support this behaviour (Cardon, Van Cauwenberghe, Labarque, Haerens, & De Bourdeaudhuij, 2008; Dowda, Pate, Trost, Almeida, & Sirard, 2004; Gordon, Tucker, Burke, & Carron, 2013; Gubbels, Van Kann, & Jansen, 2012; Gunter et al., 2012; Tonge et al., 2016; Hannon & Brown, 2008; Pate et al., 2008a; Vanderloo et al., 2014). Qualitative studies undertaken with early years staff have also underscored the important role that ECEs play in fostering active behaviours among young children during care hours (van Zandvoort, Tucker, Irwin, & Burke, 2010; Tucker, Van Zandvoort, Burke, & Irwin, 2011). Interestingly, early work by Vanderloo et al. (2014) found that fixed play equipment (i.e., climbers and jungle gyms) as well as

negative prompts provided by early years staff serve a deterrent to physical activity participation. Decreased opportunities for outdoor play were also linked to increased levels of sedentary time (Pate et al., 2004; Vanderloo et al., 2013).

### **Assessing Young Children's Activity Levels via Accelerometry**

Accelerometers have been recognized as the gold standard for measuring young children's activity levels (Cliff, Reilly, & Okely, 2009; Pfeiffer, McIver, Dowda, Almeida, & Pate, 2006). Actical™ (Bend, OR) and ActiGraph™ (Fort Walton Beach, FL) accelerometers are the two most popular devices on the market, having both demonstrated acceptable validity and reliability in objectively measuring this population's activity levels (Cliff et al., 2009; Pfeiffer et al., 2006; Pate, Almeida, McIver, Pfeiffer, & Dowda, 2006). Both the Actical and ActiGraph devices have reported a correlation between  $VO_2$  and accelerometer counts of  $r = 0.89$  and  $r = 0.82$ , respectively. Interestingly, despite the appropriateness of these devices to assess young children's activity behaviours, vast differences in data output for both physical activity and sedentary time further complicates this task. In fact, it is thought that such discrepancies and variances in reported activity levels across studies (Colley et al., 2013; Hinkley et al., 2012; Obeid et al., 2011; Pate, McIver, Dowda, Brown, & Addy, 2008b; Pate et al., 2004; Rice & Trost, 2013; Temple et al., 2009; Vanderloo et al., 2014) could be attributed to the use of different accelerometers. Adding an additional layer of complexity to this issue is the fact that applying different cut-points to data collected by the *same* device can produce different outputs of physical activity and sedentary time as well. For instance, cut-points for MVPA varied from  $>278.5$  to  $>715$  counts (Adolph et al., 2012; Pfeiffer et al., 2006) for Actical accelerometers and from  $>420$  to  $>891$  counts

(Pate et al., 2006; Sirard, Trost, Pfeiffer, Dowda, & Pate, 2005) for ActiGraph accelerometers per 15s epoch lengths, respectively. Furthermore, the choice of epoch length (or time sampling interval) poses an additional challenge to ascertain a clear picture of young children's physical activity levels (Obeid et al., 2011). Specifically, a recent study by Obeid and colleagues (2011) found that compared with a 3s time sampling interval, the use of a 15s, 30s, and 60s epoch length results in 2.9, 9.0, and 16.7 missed minutes of MVPA, respectively. Accurately measuring young children's physical activity levels and sedentary time is necessary for establishing health-related relationships, but also to ascertain the degree to which young children are meeting/missing activity guidelines (Colley et al., 2013). The ongoing challenge of deciding which device to use, as well as which cut-points to apply, makes comparability of activity data across studies challenging and limits researchers' true understanding of how active young children actually are.

### **Health Promotion Program Planning: The PRECEDE-PROCEED Model**

The present dissertation is grounded in the "*Predisposing, Reinforcing and Enabling Constructs in Educational Diagnosis and Evaluation – Policy, Regulatory, and Organizational Constructs in Educational and Environmental Development*", or PRECEDE-PROCEED, model for health promotion program planning (Green & Kreuter, 2005). Consisting of eight phases, this model begins with the identification of the desired health outcome, an examination of what causes the health consequence, followed by the development and evaluation of a program intended to reach the desired health outcome (Green & Kreuter, 2005).

The first four phases of the “PRECEDE” portion of the model include a social assessment and situational analysis (*Phase 1*), an epidemiological assessment (*Phase 2*), an educational and ecological assessment (*Phase 3*), and an administrative and policy assessment and intervention alignment (*Phase 4*). The final four phases of the model which complete the “PROCEED” portion of the model are implementation of the intervention (*Phase 5*) and program evaluation (process, impact, and outcome; *Phases 6, 7, 8*).

With the goal of improving young children’s physical activity levels (specifically, in early learning environments), this dissertation builds on previous work by Tucker et al. (2011) and van Zandvoort and colleagues (2010). Specifically, having already conducted focus groups with childcare providers to elicit their perspectives on the barriers and facilitators to engaging young children in physical activity during care hours (i.e., *Phase 1*; Tucker et al., 2011; van Zandvoort et al., 2010), the next step would be to conduct an epidemiological assessment by way of identifying the activity levels of young children during childcare hours (*Phase 2*). Given that the majority of research to date has focused on the preschool demographic (2.5 to 5 years), additional work is needed to identify the activity levels of toddlers (18-35 months). Study 1 of this dissertation will address this gap, hence improving our understanding of their activity levels and whether additional attention is needed. Study 2 of this dissertation aligns with *Phase 3* of the PRECEDE-PROCEED model. An ecological assessment was conducted to identify which characteristics within various early learning environments encourage, facilitate, and/or sustain physical activity among young children. Such information is required to identify which areas within early learning environments require modification to better support

active behaviours (or deter sedentary ones) while attending these environments. The final study of this dissertation provides information necessary for interpreting the results of the epidemiological assessment (i.e., *Phase 2*). A variety of assessment methods are possible for measuring physical activity levels among young children. However, as a result of these varied measures, comparison between studies has been challenging. As such, Study 3 will highlight the comparability of physical activity scores between the current studies and previous literature – which is key.

### **Research Rationale**

Despite the recent growth in literature examining young children's levels of physical activity and sedentary time, many questions still remain. For example, although there is growing research targeting preschoolers' physical activity and sedentary time, little work has been done to examine these behaviours among toddlers. Even less work has been completed to examine the degree to which this particular population meet CSEP's physical activity guidelines. In light of the devastating impacts of prolonged periods of sedentary behaviours and low levels of physical activity among young children, investigations are warranted to help enhance our understanding of toddlers' activity behaviours.

Due to the prominence of early learning environments in the lives of young children (i.e., large proportion of children in care, spending upwards of 30 hours per week in these settings, etc.), these venues represent an ideal venue to encourage active (and discourage sedentary) behaviours among this population. While certain factors have been identified in the literature as influencing activity levels among young children, additional research is needed to identify specifically which attributes facilitate and/or

hinder physical activity across *different* early learning environments (i.e., centre- and home-based childcare, Full-Day Kindergarten). Specific to Canada, a pilot study conducted by Vanderloo and colleagues (2014) is the only study to date to examine the impact of various characteristics of the centre-based childcare environment on preschoolers' objectively measured physical activity and sedentary time. Consequently, additional data within a Canadian context is needed so that researchers, ECEs, and public health officials are able to promote and support the growth and development of active young children.

With the growing body of evidence surrounding young children's physical activity and sedentary levels, and the dramatically different rates being published, a better understanding of the differences in young children's activity levels measured using various objective tools of assessment, (e.g., accelerometers) is necessary. More specifically, to aid researchers in comparing activity data and understanding the differences in measurement across different devices (and their respective cut-points), work is needed to examine such variations in data collection and processing by the most frequently employed accelerometers used with young children (i.e., Actical and ActiGraph). Such steps are necessary to improve the translatability of data across multiple studies examining physical activity and sedentary time in the early years.

### **Purpose Statement**

The purpose of this dissertation was to explore young children's (age 18 months to 5 years) levels of physical activity and sedentary time, and to consider methodological challenges in capturing these behaviours. Three distinct, yet related, studies were undertaken to achieve this purpose. Study 1 aimed to objectively assess physical activity

and sedentary time among a sample of toddlers from London, Canada using two data processing approaches. Study 2 explored the impact of various early learning environments (i.e., home-/ centre-based childcare facilities and Full-Day Kindergarten) and their respective characteristics (e.g., staff behaviours, portable play equipment, sedentary opportunities, etc.) on preschoolers' activity levels. Study 3 sought to examine differences in two popular tools used to objectively measure young children's physical activity and sedentary time. An integrated-article format was adopted while writing this dissertation, and as such, some material from the introduction will be repeated in subsequent chapters.

## References

- Active Healthy Kids Canada (2010). 2010 Canada's report card on physical activity for children and youth. Retrieved from <http://www.activehealthykids.ca/ReportCard/2010ReportCardOverview.aspx>
- Adolph, A. L., Puyau, M. R., Vohra, F. A., Nicklas, T. A., Zakeri, I. F., & Butte, N. F. (2012). Validation of uniaxial and triaxial accelerometers for the assessment of physical activity in preschool children. *Journal of Physical Activity and Health, 9*, 944-953.
- Australian Government. Department of Health and Ageing. (2010). *Move and play every day. National physical activity recommendations for children 0-5 years*. Belconnen: Commonwealth of Australia, Department of Health and Ageing.
- Bailey, R. C., Olson, J., Pepper, S. L., Porszasz, J., Barstow, T. J., & Cooper, D. M. (1995). The level and tempo of children's physical activities: An observational study. *Medicine & Science in Sports & Exercise, 27*.
- Burdette, H. L., Whitaker, R. C., & Daniels, S. R. (2004). Parental report of outdoor playtime as a measure of physical activity in preschool-aged children. *Archives of Pediatrics and Adolescent Medicine, 158*, 353-357.
- Bushnik, T. (2006). *Child Care in Canada* Statistics Canada.
- Canadian Fitness and Lifestyle Research Institute (2008). Results of the 2000 physical activity monitor. Healthy Active Kids Canada. Retrieved from [http://www.cflri.ca/provincial\\_data/pam2000/canada.php](http://www.cflri.ca/provincial_data/pam2000/canada.php)
- Canadian Society of Exercise Physiology. (2012a). *Canadian Physical Activity Guidelines for the Early Years (0-4 years)*. Canadian Society of Exercise Physiology.



- Canadian Society of Exercise Physiology (2012b). *Canadian physical activity guidelines for children (5-11 years)*. Canadian Society of Exercise Physiology.
- Canadian Society of Exercise Physiology (2012c). *Canadian sedentary behaviour guidelines for the early years (0-4 years)*. Canadian Society of Exercise Physiology.
- Cardon, G., Van Cauwenberghe, E., Labarque, V., Haerens, L., & De Bourdeaudhuij, I. (2008). The contribution of preschool playground factors in explaining children's physical activity during recess. *International Journal of Behavioural Nutrition and Physical Activity*, 5(11), 1-6.
- Cardon, G., Van Cauwenberghe, E., & De Bourdeaudhuij, I. (2011). What do we know about physical activity in infants and toddlers: A review of the literature and future research directions. *Science and Sports*, 26, 127-130.
- Carson, V., Clark, D., Ogden, N., Harber, V., & Kuzik, N. (2015). Short-term influence of revised provincial accreditation standards on physical activity, sedentary behavior, and weight status in Alberta, Canada child care centers. *Early Childhood Education Journal* doi: 10.1007/s10643-015-0688-3.
- Carson, V., Hunter, S., Kuzik, N., Wiebe, S. A., Spence, J. C., Friedman, A. et al. (2016). Systematic review of physical activity and cognitive development in early childhood. *Journal of Science and Medicine in Sport*, 19(7), 573-578. doi: 10.1016/j.jsams.2015.07.011.
- Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: Definitions and distinctions for health-related research. *Public Health Reports*, 100(2), 126-131.

- Cleveland, G., Forer, B., Hyatt, D., Japel, C., & Krashinsky, M. (2008). New evidence about child care in Canada: Use patterns, affordability and quality. *Institute for Research on Public Policies, 14*, 1-44.
- Cliff, D. P., Okely, A. D., Smith, L. M., & McKeen, K. (2009). Relationships between fundamental movement skills and objectively measured physical activity in preschool children. *Pediatric Exercise Science, 21*, 436-449.
- Cliff, D. P., Reilly, J. J., & Okely, A. D. (2009). Methodological considerations in using accelerometers to assess habitual physical activity in children aged 0-5 years. *Journal of Science and Medicine in Sport, 12*, 557-567.
- Colley, R., Garriguet, D., Adamo, K., Carson, V., Janssen, I., Timmons, B. et al. (2013). Physical activity and sedentary behavior during the early years in Canada: a cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity, 10*, 54.
- Cosco, N. G., Moore, R. C., & Islam, M. Z. (2010). Behavior mapping: A method for linking preschool physical activity and outdoor design. *Medicine & Science in Sports & Exercise, 42*(3), 513-519.
- Daniels, S. R. (2006). The consequences of childhood overweight and obesity. *The Future of Children, 16*(1), 47-67.
- De Decker, E., De Craemer, M., De Bourdeaudhuij, I., Wijndaele, K., Duvinage, K., Koletzko, B. et al. (2013). Influencing factors of screen time in preschool children: an exploration of parents' perceptions through focus groups in six European countries. *Obesity Reviews, 13*, 75-84.

Department of Health: Physical Activity and Health Alliance (2011). *Start Active, Stay Active: A report on physical activity for health from the four home countries' Chief Medical Officer.*

Dowda, M., Brown, W. H., McIver, K. L., Pfeiffer, K. A., O'Neill, J. R., Addy, C. L. et al. (2009). Policies and characteristics of the preschool environment and physical activity of young children. *Pediatrics, 123*(2), e261-e266.

Dowda, M., Pate, R. R., Trost, S. G., Almeida, M. J. C., & Sirard, J. R. (2004). Influences of preschool policies and practices on children's physical activity. *Journal of Community Health, 29*, 183-196.

Eastman, W. (1997). Active living: Physical activities for infants, toddlers, and preschoolers. *Early Childhood Education, 24*, 161-164.

Fees, B. S., Fisher, E., Haar, S., & Crowe, L. K. (2015). Toddler activity intensity during indoor free-play: stand and watch. *Journal of Nutrition Education and Behavior, 47*(2), 170-175.

Goldfield, G. S., Harvey, A., Grattan, K., & Adamo, K. B. (2012). Physical activity promotion in the preschool years: A critical period to intervene. *International Journal of Environmental Research and Public Health, 9*, 1326-1342.

Gordon, E. S., Tucker, P., Burke, S. M., & Carron, A. V. (2013). Effectiveness of physical activity interventions for preschoolers: A meta-analysis. *Research Quarterly for Exercise and Sport, 84*, 287-294.

Green, L. W. & Kreuter, M. W. (2005). *Health program planning: An educational and ecological approach.* (4th ed.) New York, New York: McGraw-Hill Higher Education.

- Gubbels, J., Van Kann, D. H. H., & Jansen, M. W. J. (2012). Play equipment, physical activity opportunities, and children's activity levels at childcare. *Journal of Environmental and Public Health*, 2012.
- Gubbels, J. S., Kremmers, S. P., van Kann, D. H., Stafleu, A., Candel, M. J., Dagnelie, C. et al. (2011). Interaction between physical environment, social environment, and child characteristics in determining physical activity at childcare. *Health Psychology*, 30, 84-90.
- Gunter, K. B., Rice, K. R., Ward, D. S., & Trost, S. G. (2012). Factors associated with physical activity in children attending family child care homes. *Preventive Medicine*, 54, 131-133.
- Hannon, J. C. & Brown, B. B. (2008). Increasing preschoolers' physical activity intensities: An activity-friendly preschool playground intervention. *Preventive Medicine*, 6(6), 532-536.
- Hesketh, K. & van Sluijs, E. M. F. (2016). Features of the UK childcare environment and associations with preschooler's in-care physical activity. *Preventive Medicine Reports*, 3(2016), 53-57.
- Hinkley, T., Salmon, J., Okely, A. D., Crawford, D., & Hesketh, K. (2012). Preschoolers' physical activity, screen time, and compliance with recommendations. *Medicine and Science in Sports and Exercise*, 44, 458-465.
- Hnatiuk, J., Ridgers, N. D., Salmon, J., Campbell, K., McCallum, Z., & Hesketh, K. (2012). Physical activity levels and patterns of 19-month-old children. *Medicine & Science in Sports & Exercise*, 44, 1715-1720.

- Hnatiuk, J., Salmon, J., Hinkley, T., Okely, A. D., & Trost, S. G. (2014). A review of preschool children's physical activity and sedentary time using objective measures. *American Journal of Preventive Medicine*, *47*, 487-497. doi:10.1016/j.amepre.2014.05.042.
- Johansson, E., Hagstromer, M., Svensson, V., Ek, A., Forssen, M., Nero, H. et al. (2015). Objectively measured physical activity in two-year-old children: Levels, patterns and correlates. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(3). doi:10.1186/s12966-015-0161-0.
- Jones, R. A., Okely, A. D., Hinkley, T., Batterham, M., & Burke, C. (2015). Promoting gross motor skills and physical activity in childcare: A translational randomized controlled trial. *Journal of Science and Medicine in Sport*. doi: 10.1016/j.jsams.2015.10.006.
- Jones-Taylor, M. (2015). Early care and education settings are vital for childhood obesity prevention. *Childhood Obesity*, *11*, 489-490. doi: 10.1089/chi.2015.0156.
- Kuzik, N., Clark, D., Ogden, N., Harber, V., & Carson, V. (2015). Physical activity and sedentary behaviours of toddlers and preschoolers in child care centres in Alberta, Canada. *Canadian Journal of Public Health*, *106*, e178-e183. doi: 10.17269/CJPH.106.4794.
- Leblanc, A. G., Spence, J. C., Carson, V., Connor Gorber, S., Dillman, C., Janssen, I. et al. (2012). Systematic review of sedentary behaviour and health indicators in the early years (aged 0-4 years). *Applied Physiology, Nutrition, and Metabolism*, *37*, 753-772.

- Malina, R. M. (2001). Physical activity and fitness: Pathways from childhood to adulthood. *American Journal of Human Biology*, 13(2), 162-172.
- Manios, Y. (2006). Design and descriptive results of the "Growth, Exercise and Nutrition Epidemiological Study in preSchoolers": The GENESIS Study. *BMC Public Health*, 6.
- Moore, L. L., Gao, D., Bradlee, M. L., Cupples, L. A., Sundarajan-Ramamurti, A., Proctor, M. H. et al. (2003). Does early physical activity predict body fat change throughout childhood? *Preventive Medicine*, 37, 10-17.
- Obeid, J., Nguyen, T., Gabel, L., & Timmons, B. W. (2011). Physical activity in Ontario preschools: Prevalence and measurement issues. *Applied Physiology, Nutrition and Metabolism*, 36, 291-297.
- Oliver, M., Schofield, G. M., & Kolt, G. S. (2007). Physical activity in preschoolers: Understanding prevalence and measurement issues. *Sports Medicine*, 37, 1045-1070.
- Ontario Ministry of Child and Youth Services. (1990). Day Nurseries Act - R.R.O. 1990, Reg. 262.
- Pate, R. R., McIver, K. L., Dowda, M., Brown, W. H., & Addy, C. (2008a). Directly observed physical activity levels in preschool children. *Journal of School Health*, 78(8), 438-444.
- Pate, R. R., Almeida, M. J., McIver, K. L., Pfeiffer, K. A., & Dowda, M. (2006). Validation and calibration of an accelerometer in preschool children. *Obesity (Silver Spring)*, 14, 2000-2006.

- Pate, R. R., McIver, K., Dowda, M., Brown, W. H., & Addy, C. (2008b). Directly observed physical activity levels in preschool children. *Journal of School Health, 78*, 438-444.
- Pate, R. R., Pfeiffer, K. A., Trost, S. G., Ziegler, P., & Dowda, M. (2004). Physical activity among children attending preschools. *Pediatrics, 114*, 1258-1263.
- Pfeiffer, K. A., McIver, K. L., Dowda, M., Almeida, M. J. C., & Pate, R. R. (2006). Validation and calibration of the Actical accelerometer in preschool children. *Medicine and Science in Sports and Exercise, 38*, 125-157.
- Preboth, M. (2002). Physical activity in infants, toddlers, and preschoolers. *American Family Physician, 65*, 1694-1696.
- Rice, K. R. & Trost, S. G. (2013). Physical activity levels among children attending family day care. *Journal of Nutrition Behaviour and Education, 1-5*.
- Sedentary Behaviour Research Network. (2012). Standardized use of the terms "sedentary" and "sedentary behaviours". *Applied Physiology of Nutrition and Metabolism, 37*, 540-542.
- Sirard, J. R., Trost, S. G., Pfeiffer, K. A., Dowda, M., & Pate, R. R. (2005). Calibration and evaluation of an objective measure of physical activity in preschool children. *Journal of Physical Activity and Health, 2*(3), 345-357.
- Tandon, P. S., Saelens, B. E., Zhou, C., Kerr, J., & Christakis, D. A. (2013). Indoor versus outdoor time in preschoolers at child care. *American Journal of Preventive Medicine, 44*, 85-88.

- Tandon, P. S., Zhou, C., & Christakis, D. A. (2012). The frequency of outdoor play for preschool age children cared for at home-based child care settings. *Academic Pediatrics, 12*, 475-480.
- Taylor, R. W., Murdoch, L., Carter, P., Gerrard, D. F., Williams, S. M., & Taylor, B. J. (2009). Longitudinal study of physical activity and inactivity in preschoolers: The FLAME study. *Medicine & Science in Sports & Exercise, 41*, 96-102.
- Temple, V. A., Naylor, P. J., Rhodes, R. E., & Wharf Higgins, J. (2009). Physical activity of children in family child care. *Applied Physiology of Nutrition and Metabolism, 34*(4), 794-798.
- Timmons, B. W., Leblanc, A. G., Carson, V., Gorber, S. C., Dillman, C., Janssen, I. et al. (2012). Systematic review of physical activity and health in the early years (aged 0-4 years). *Applied Physiology, Nutrition and Metabolism, 37*, 773-792.
- Tonge, K. L., Jones, R. A., & Okely, A. D. (2016). Correlates of children's objectively measured physical activity and sedentary behavior in early childhood education and care services: A systematic review. *Preventive Medicine*. doi: 10.1016/j.ypmed.2016.05.019
- Trost, S. G., Sirard, J. R., Dowda, M., Pfeiffer, K. A., & Pate, R. R. (2003). Physical activity in overweight and nonoverweight preschool children. *International Journal of Obesity, 27*(7), 834-839.
- Tucker, P. (2008). The physical activity levels of preschool-aged children: A systematic review. *Early Childhood Research Quarterly, 23*, 547-558.



- Tucker, P., Van Zandvoort, M. M., Burke, S. M., & Irwin, J. D. (2011). Physical activity at daycare: Childcare providers' perspectives for improvements. *Journal of Early Childhood Research, 9*, 207-219.
- Tucker, P., Vanderloo, L. M., Burke, S. M., Irwin, J. D., & Johnson, A. M. (2015). Prevalence and influences of preschoolers' sedentary behaviors in early learning centers: A cross-sectional study. *BMC Pediatrics, 15*, 128. doi: 10.1186/s12887-015-0441-5
- Vale, S., Santos, R., Soares-Miranda, L., Moriera, C., Ruiz, J., & Mota, J. (2010). Objectively measured physical activity and body mass index in preschool children. *International Journal of Pediatrics, 2010*.
- Van Cauwenberghe, E., Gubbels, J., De Bourdeaudhuij, I., & Cardon, G. (2011). Feasibility and validity of acceleromter measurements to assess physical activity in toddlers. *International Journal of Behavioural Nutrition and Physical Activity, 8*, 67. doi: 10.1186/1479-5868-8-67
- van Zandvoort, M., Tucker, P., Irwin, J. D., & Burke, S. M. (2010). Physical activity at daycare: issues, challenges and perspectives. *Early Years, 30*, 175-188.
- Vanderloo, L. M. (2014). Screen-viewing among preschoolers in childcare: A systematic review. *BMC Public Health, 14*, 205. doi: 10.1186/1471-2431-14-205
- Vanderloo, L. M., Tucker, P., Johnson, A. M., Burke, S. M., & Irwin, J. D. (2015). Environmental influences on preschoolers' physical activity levels in various early learning facilities. *Research Quarterly for Exercise and Sport, 19*, 1-11.
- Vanderloo, L. M., Tucker, P., Johnson, A. M., Van Zandvoort, M. M., Burke, S. M., & Irwin, J. D. (2014). The influence of centre-based bchildcare on preschoolers'

physical activity levels: A cross-sectional study. *International Journal of Environmental Research and Public Health*, *11*, 1794-1802.

Vanderloo, L. M. & Tucker, P. (2015). An objective assessment of toddlers' physical activity and sedentary levels: A cross-sectional study. *BMC Public Health*, *15*(969). doi: 10.1186/s12889-015-2335-8.

Vanderloo, L. M., Tucker, P., Johnson, A. M., & Holmes, J. D. (2013). Physical activity among preschoolers during indoor and outdoor childcare play periods. *Applied Physiology, Nutrition, and Metabolism*, *38*, 1173-1175.

Witjzes, A. L., Kooijman, M. N., Kiefte-de Jong, J. C., de Vries, S. I., Henrichs, J., Jansen, W. et al. (2013). Correlates of physical activity in 2-year-old toddlers: The Generation R study. *Journal of Pediatrics*, *163*, 791-799.

World Health Organization. (1998). Health promotion glossary. Retrieved from [http://who.int/hpr/NPH/docs/hp\\_glossary\\_en.pdf](http://who.int/hpr/NPH/docs/hp_glossary_en.pdf)

## CHAPTER 2

### **An Objective Assessment of Toddlers' Physical Activity and Sedentary Levels: A Cross-Sectional Study<sup>‡</sup>**

Physical activity plays a pivotal role in the overall health and well-being of children. Among young children under the age of 5 years, regular physical activity has been linked to decreases in cardiovascular risk (Sääsklahti et al., 2004), enhancements in motor development (Cliff, Okely, Smith, & McKeen, 2009), and improvements in psychosocial and cognitive factors (Timmons, Naylor, & Pfeiffer, 2007). Unfortunately, and based on recently published literature, there are considerable variability in the prevalence estimates of young children's physical activity (Colley et al., 2013; Tucker, 2008; Vanderloo et al., 2015). In fact, over the past decade, a great deal of research has focused on the physical activity and sedentary levels of preschoolers (i.e., 2.5 to 5 years; Cliff et al., 2009; Tucker, 2008; Vanderloo et al., 2015). Interestingly, investigations into the physical activity and sedentary behaviours of toddlers (i.e., 18 to 29 months) are limited. In actuality, only a small number of studies have been conducted to examine their physical activity behaviours, where one relied on parent proxy report (Manios, 2006), two on direct observation (Fees, Fisher, Haar, & Crowe, 2015; Gubbels et al., 2011), and four on objective measures (Hnatiuk, et al., 2012; Johansson et al., 2015; Van Cauwenberghe, Gubbels, De Bourdeaudhuij, & Cardon, 2011; Witjzes et al., 2013). The single Canadian study assessed toddlers' physical activity and sedentary levels during childcare hours only (Carson, Clark, Ogden, Harper, & Kuzik, 2015).

The Canadian Society of Exercise Physiology (CSEP; 2012a, 2012b) released physical activity and sedentary behaviour guidelines for young children. Consistent with

<sup>‡</sup>A version of this manuscript has been published. Vanderloo, L. M. & Tucker, P. (2015). An Objective Assessment of Toddler's Physical Activity and Sedentary Levels. *BMC Public Health*, 15, 969. doi: 10.1186/s12889-015-2335-8

other international recommendations (Australian Government, 2010; Department of Health: Physical Activity and Health Alliance, 2011), these guidelines stipulate that children between the ages of 1 to 4 years accrue a minimum of 180 minutes of physical activity (at any intensity) per day (CSEP, 2012a), and spend no more than 60 minutes at a time seated or restrained (CSEP, 2012b). With regard to screen viewing, the Canadian sedentary behaviour guidelines (CSEP, 2012b) suggest that children under the age of 2 should not engage in any screen time, and those 2-4 years should be limited to less than 1 hour per day. However, the literature has yet to address the degree to which Canadian toddlers are meeting (or failing to meet) these recommendations. Moreover, little attention has been paid to the sedentary behaviours of toddlers in spite of the evidence suggesting that the majority of young children's waking hours are spent being inactive (Reilly et al., 2004; Vale, Silva, Santos, Soares-Miranda, & Mota, 2010) and in front of screens (Active Healthy Kids Canada, 2010; Vanderwater et al., 2007; Zimmerman, Christaki, & Meltzoff, 2007), thus placing them at risk for developmental delays and poorer overall health status (Active Healthy Kids Canada, 2010, Leblanc, et al., 2012). Given these gaps in the literature, additional attention is required to improve our understanding of Canadian toddlers' activity patterns and behaviours.

Accelerometers represent one popular method for objectively measuring levels of physical activity and sedentary time among young children (Cardon, Van Cauwenberghe, & De Bourdeauhuij, 2011; Cliff, Reilly, & Okely, 2009; Van Cauwenberghe et al., 2011), and may prove useful in determining the activity levels of this age group. However, recent evidence suggests that the use of different accelerometer models and their respective cut-points makes gaining an accurate understanding of young children's

physical activity levels challenging (Vanderloo, Di Cristofaro, Proudfoot, Tucker, & Timmons, 2015). Consequently, data examining the difference in activity levels reported using various thresholds may be warranted to help inform the selection and application of toddler-specific cut-points.

This exploratory study sought to objectively measure the physical activity levels and sedentary time of a sample of toddlers in London, Canada using two sets of cut-points in comparison to the national physical activity guidelines. Because a variety of demographic variables have been identified as influencing young children's activity levels, the impact of sex (Hinkley, Salmon, Okely, & Hesketh, 2012), parental education (Vale et al., 2014), annual family income (Hinkley, Crawford, Salmon, & Okely, 2008), screen-viewing (Taverno Ross, Dowda, Saunders, & Pate, 2013), and childcare enrolment (Pate, Pfeiffer, Trost, Ziegler, & Dowda, 2004) on toddlers' physical activity and sedentary time were reported. Differences in physical activity and sedentary time accumulated on weekdays and weekend days were also examined (Hinkley et al., 2012). Finally, this study aimed to explore toddlers' screen-viewing (i.e., time spent engaged in these activities, weekend versus weekend day variation), and the proportion of participants that met/failed to meet the screen use portion of the national sedentary behaviour guidelines. Overall, it was hypothesized that toddlers would accumulate high levels of sedentary time and low levels of physical activity. It was also anticipated to find that this cohort would engage in high levels of screen-viewing activities.

## **Methods**

**Study sample and recruitment.** Using a cross-sectional study design, English-speaking parents/guardians with toddlers (between the ages of 18-35 months) from

London, Canada were invited to participate. In an effort to target a geographically-representative sample, parents/guardians of participants were recruited at a mother and child expo, at various playgroups offered by the Ontario Early Years Centres (spanning various socio-economic areas), and via posters placed in locations frequented by parents/guardians and young children (e.g., all public libraries, childcare facilities, etc.; Appendix A). Where appropriate, snowball sampling was also utilized as a means of maximizing the reach of our recruitment methods.

**Study protocol.** Data collection occurred between August 2013 and November 2014 (and ceased during the winter months to avoid seasonality effects; Shen, Alexander, Milberger, & Jen, 2013; Tucker & Gilliland, 2007). Participants were asked to wear an accelerometer for seven consecutive days (i.e., five weekdays and two weekend days; Monday to Sunday) during all waking hours; parents/guardians were asked to fit their child with the device upon them waking in the morning, and to remove it prior to their bedtime. In addition to receiving training on how to use the devices, parents/guardians were also asked to keep a log of the on/off times of the accelerometers. Accelerometers and logs were dropped off to participants' parents/guardians a few days prior to the first day of data collection (i.e., on Friday, Saturday, or Sunday, with data collection commencing on Monday). Following the week of data collection, a researcher returned to the participants' homes to collect the accelerometers and logs. Ethical approval for the study protocol and related documents was obtained from the Office of the Research Ethics Board at the University of Western Ontario (Appendix B). Written informed consent was provided by parents/guardians of all participating children (Appendix C & D).

**Measurement.**

***Toddlers' sedentary time and physical activity.*** Toddlers' sedentary time and physical activity levels (i.e., light physical activity [LPA], MVPA, total physical activity [TPA]) were assessed using Actical™ (MiniMitter, Bend, Oregon) accelerometers. These lightweight omnidirectional motion sensors provide detailed data on the duration and intensity of the children's movements (Van Cauwenberghe et al., 2011). A 15s epoch length was applied to capture the sporadic activity and intermittent periods of rest of the young participants (Cliff et al., 2009). Accelerometers were secured to the participants' right hip using an adjustable belt and were programmed to begin collecting activity data on the morning of the first day of data collection (i.e., Monday at 6am). Participants (and their parents/guardians) were blind to all activity data collected while wearing the monitor.

***Toddlers' screen-viewing behaviours.*** Parents/guardians completed a Toddler Screen-Viewing Questionnaire (Appendix E). Informed by the work of Colley et al. (2013), Certain and Khan (2002), Vanderwater et al. (2007), and Zimmerman et al. (2007), this tool was created by the researchers to collect data on participants' screen-viewing. Such items included whether the child used screens and which types (e.g., yes/no; television, computer [i.e., laptops, tablets, smartphones], etc.), the amount of time spent engaged in screen-viewing activities per weekday and weekend day (presented in ranges and in line with Canada's sedentary behaviour guidelines; i.e., no television/screen use, less than 30 minutes, 30-59 minutes, 60-89 minutes, 90-120 minutes, more than 120 minutes), reasons for engaging in screen-viewing activities (check all that apply; i.e., for education/entertainment purposes, to mind the child during household errands,

babysitting, etc.), and/or whether the parents/guardians participated in these behaviours with their toddler. Efforts were undertaken to ensure face validity was achieved by having an expert in the field review the questionnaire.

***Participant characteristics.*** Parents/guardians of participating children completed a demographic questionnaire (Appendix F), which was distributed in the study package along with the letter of information and consent form. This questionnaire solicited data on toddlers' sex, age, ethnicity, childcare enrolment status, as well as various family variables (e.g., annual family income, family status, parental education, etc.).

***Statistical analysis.*** Accelerometer data were downloaded using Actical-specific software (version 3.10). Comparable to the procedures described by Esliger, Copeland, Barnes, and Tremblay (2005) and Esliger and Tremblay (2007), the raw activity data were analyzed using custom software *KineSoft* version 3.3.62 (KineSoft, Loughborough, UK) to generate a series of standardized outcome variables. Consistent with Van Cauwenberghe and colleagues' (2011) process, decision rules from the preschool literature were used to reduce the collected toddlers' accelerometry data. Specifically, non-wear-time was defined as 60 minutes of consecutive zeroes (which was cross-referenced with participants' wear-time logs) and only participants who accumulated at least 4 valid days (3 weekdays and 1 weekend day; with a minimum wear time of 8 hours per day) were retained for analysis. Naps were considered non-wear time. Participants not meeting this requirement were removed from the data set ( $n = 7$ ). As a result, 85.1% (i.e., 40/47) participants' data passed these quality control criteria, and were thus retained for analyses.



Using the *KineSoft* program, the accelerometry data were compared against Trost and colleagues' (2010) toddler- and device-specific cut-points (sedentary time [ $\leq 114$  counts $\cdot 15$  s $^{-1}\cdot$ epoch $^{-1}$ ], LPA [ $\geq 115 \leq 697$  counts $\cdot 15$  s $^{-1}\cdot$ epoch $^{-1}$ ], and MVPA [ $\geq 698$  counts $\cdot 15$  s $^{-1}\cdot$ epoch $^{-1}$ ], and TPA [ $\geq 115$  counts $\cdot 15$  s $^{-1}\cdot$ epoch $^{-1}$ ]) to determine the amount of activity accumulated at various intensity levels – this was achieved by entering the cut-points into the program and then processing the included data files to produce a number of outcome variables (i.e., LPA, MVPA, TPA) using these thresholds. Thresholds for LPA were derived by researchers using the sedentary and MVPA cut-points.

Because the toddler population has only recently begun to receive attention regarding physical activity levels, combined with evidence that suggests that different accelerometers and/or their respective cut points can influence the outcome data (Vanderloo et al., 2015), it was deemed important to apply a second set of population-specific cut-points for comparison. As such, and in line with the Canadian Health Measures Survey (CHMS), the following cut-points (all divided by four to match the time sampling interval used in the present study) were also applied to the collected accelerometer data: sedentary activity ( $\leq 24.75$  counts $\cdot 15$  s $^{-1}\cdot$ epoch $^{-1}$ ; Wong, Colley, Connor Gorber, & Tremblay, 2011), LPA ( $\geq 25 \leq 287.25$  counts $\cdot 15$  s $^{-1}\cdot$ epoch $^{-1}$ ), MVPA ( $\geq 287.5$  counts $\cdot 15$  s $^{-1}\cdot$ epoch $^{-1}$ ), and TPA ( $\geq 25$  counts $\cdot 15$  s $^{-1}\cdot$ epoch $^{-1}$ ; Adolph et al., 2012).

The data provided in *KineSoft*'s output report were transferred to SPSS (version 22) for descriptive analyses (means and standard deviations). To account for variances in monitoring periods, activity variables were reported as hourly rates (mins/hr) and percentage of wear-time. Similar to the approach undertaken by Colley et al. (2013), participants were classified as meeting the physical activity guidelines if they achieved

180 minutes of activity at any intensity on any valid days. Independent samples *t*-tests were conducted to explore whether toddlers' rates of physical activity and sedentary time differed based on sex and childcare enrolment (i.e., yes/no; where children who attended home- and centre-based care were combined). Paired samples *t*-tests were also carried out to explore whether this group's activity levels differed based on cut-points and between weekdays and weekend days. Consequently, for the paired samples *t*-test, alpha was adjusted to account for multiple comparison bias (0.05/2). Linear regression analyses were also carried out to explore the relationship between sedentary time and physical activity (all intensities; using both sets of cut-points) and multiple variables like sex, childcare attendance, parental education, annual family income, and total screen-viewing on weekdays/weekend days.

Descriptive analyses were conducted to evaluate the findings from the Toddler Screen-Viewing Questionnaire. Linear regression was used to examine whether toddlers' levels of sedentary time were predicted by parent-reported screen-viewing behaviours (i.e., *does your child watch television? [how many minutes per week(end) day?]*, and *does your child spend time on a computer? [how many minutes per week(end) day?]*). To determine the number of participants that met/failed to meet the screen-use portion of the sedentary behaviour guidelines (i.e., no screens for children under the age of 2, and limited to one hour per day for children 2-4 years), an approach undertaken by other Canadian researchers was followed (Colley et al., 2013). Specifically, the mid-points of the previous categories were used to derive time spent watching television and using the computer on both weekdays and weekend days (i.e., 0, 15mins, 45mins, 75mins, 105mins, and 120mins). The amount of time on weekdays and weekend days were

summed for the related questions to ascertain whether participants were meeting/failing to meet screen-time recommendations. Refer to Colley et al. (2013) for additional details regarding this process.

## Results

**Sample description.** Demographic characteristics of the 40 toddlers included in the study are presented in Table 1. The average age of the sample was 25.7 months ( $SD = 5.9$ ) and 55.0% were female. The included sample's mean accelerometry wear-time for valid days was 606.79 minutes ( $SD = 38.76$ ) or 10.11 hours, and ranged from 536.50 to 731.70 minutes or 8.94 to 12.20 hours.

**Toddlers' levels of sedentary time and physical activity.** Refer to Table 2 for toddlers' sedentary time and physical activity rates. Specifically, sedentary time ranged from 37.27 to 49.40 mins/hr, LPA from 9.79 to 18.78 mins/hr, MVPA from 0.82 to 3.95 mins/hr, and TPA from 10.60 to 22.73 mins/hr. Rates of sedentary time ( $t[39] = 37.81, p < .001$ ), LPA ( $t[39] = -21.99, p < .001$ ), MVPA ( $t[39] = -14.87, p < .001$ ), and TPA ( $t[39] = -37.81, p < .001$ ) were found to significantly differ based on cut-points applied. Using an average wear-time of 10.11 hours, these values translate roughly to 376.80 and 499.43 mins/day of sedentary time, 98.97 and 189.87 mins/day of LPA, 8.29 to 39.93 mins/day of MVPA, and 107.17 to 229.80 mins/day of TPA when the Trost et al. (2010) and the CHMS (Adolph et al., 2012; Wong et al., 2011) cut-points were applied, respectively. Seven participants (i.e., 17.5% of sample) met and/or exceeded the Canadian physical activity guidelines on at least one valid day when Trost et al.'s cut-

Table 1.

*Toddler and Family Demographic Information (n = 40)*

	<i>N</i>	<i>%</i>
Sex of Toddler		
Male	18	45.0
Female	22	55.0
Type of Early Learning Environment		
Home-based childcare	7	17.5
Centre-based childcare	17	42.5
Other	2	5.0
Not in care	14	35.0
Ethnicity		
Caucasian	35	87.5
Latin American	1	2.5
Asian	1	2.5
Other	2	5.0
Family Situation		
Single-parent	2	5.0
Double-parent	38	95.0
Highest Level of Parent/Guardian Education		
College	8	20.0
University	13	32.5
Graduate school	17	42.5
Prefer not to answer	1	2.5
Approximate Annual Household Income		
Less than \$20,000	2	5.0
\$20,000 - \$39,999	4	10.5
\$40,000 - \$59,999	3	7.5
\$60,000 - \$79,999	4	10.0
\$80,000 - \$99,999	4	10.0
\$100,000 - \$119,999	7	17.5
\$120,000-\$149,000	4	10.0
More than \$150,000	9	22.5
Prefer not to answer	3	7.5

*Note.* Demographic information is reported for participants who provided sufficient activity data (i.e., a minimum of 4 valid days, with 8 hours of wear time/day) – 3 participants did not meet these criteria, and were therefore removed. All values shown may not add up to 100% or  $n = 40$  as some individuals chose not to answer certain questions.

Table 2

*Toddlers' Mean (Standard Deviation) Physical Activity and Sedentary Time (Mins/Hr and Percentage of Monitoring Time) Based on Two Different Cut-Points*

Intensity			Trost et al.	CHMS <sup>†</sup>	
			Mean (SD)	Mean (SD)	
Combined (n = 40)	Sedentary	Mins/Hr	49.40 (3.29)*	37.27 (3.97)*	
		% wear time	82.33 (5.49)	62.12 (6.62)	
	LPA	Mins/Hr	9.79 (2.90)*	18.78 (3.22)*	
		% wear time	16.31 (4.83)	31.30 (5.37)	
	MVPA	Mins/Hr	0.82 (0.72)*	3.95 (1.93)*	
		% wear time	1.36 (1.20)	6.59 (3.22)	
	TPA	Mins/Hr	10.60 (3.29)*	22.73 (3.97)*	
		% wear time	17.67 (5.49)	37.88 (6.62)	
	Male (n = 18)	Sedentary	Mins/Hr	48.93 (3.85)	37.25 (3.85)
			% wear time	81.56 (6.41)	62.09 (6.41)
LPA		Mins/Hr	10.09 (3.31)	18.39 (3.00)	
		% wear time	16.82 (5.52)	30.64 (5.01)	
MVPA		Mins/Hr	0.98 (0.90)	4.36 (2.38)	
		% wear time	1.62 (1.50)	7.27 (3.97)	
TPA		Mins/Hr	11.07 (3.85)	22.74 (3.85)	
		% wear time	18.44 (6.41)	37.91 (6.42)	
Female (n = 22)		Sedentary	Mins/Hr	49.78 (2.80)	37.28 (4.16)
			% wear time	82.96 (4.66)	62.14 (6.94)
	LPA	Mins/Hr	9.54 (2.57)	19.10 (3.42)	
		% wear time	15.89 (4.28)	31.83 (5.70)	
	MVPA	Mins/Hr	0.69 (0.52)	3.62 (1.44)	
		% wear time	1.15 (0.87)	6.03 (2.40)	
	TPA	Mins/Hr	10.22 (2.80)	22.72 (4.16)	
		% wear time	17.04 (4.66)	37.86 (6.94)	

*Note.* No significant differences in levels of physical activity and sedentary time based on sex were reported ( $p > .05$ ). \* = A statistically significant difference was apparent between activity levels using the two different cut-points ( $p < .001$ ). CHMS = Canadian Health Measures Survey; LPA = light physical activity; MVPA = moderate-to-vigorous physical activity; TPA = total physical activity; SD = standard deviation; <sup>†</sup> = Wong et al. (2011) for sedentary cut-point and Adolph et al. (2012) for MVPA cut-points.

points were applied, whereas 39 participants (i.e., 97.5% of sample) met and/or exceeded these guidelines when the CHMS cut-points were used. Figure 1 displays the number of days that participants met and/or exceeded the daily physical activity recommendations.

While boys accumulated less sedentary time and more MVPA and TPA (but not LPA) than their female counterparts, independent sample *t*-tests did not report any statistically significant differences in sedentary time ( $t[38] = -.082, p = .43$ ), LPA ( $t[38] = 0.60, p = .55$ ), MVPA ( $t[38] = 1.21, p = .24$ ), or TPA ( $t[38] = 0.80, p = .43$ ) based on the Trost et al. cut-points. Likewise, when using the thresholds employed in the CHMS; sedentary time ( $t[38] = -.02, p = .98$ ), LPA ( $t[38] = 0.69, p = .49$ ), MVPA ( $t[38] = 1.16, p = .26$ ), and TPA ( $t[38] = 0.02, p = .98$ ) did not significantly differ based on sex.

Childcare attendance was only found to have a statistically significant effect on participants' rates of LPA (CHMS cut-points only:  $t[36] = 3.07, p = .004$ ). When comparing weekdays to weekend days, it was found that toddlers' rates of sedentary time ( $t[39] = 17.11, p < .001$ ), LPA ( $t[39] = 13.61, p < .001$ ), MVPA ( $t[39] = 5.14, p < .001$ ), and TPA ( $t[39] = 12.78, p < .001$ ) were statistically significantly higher during the week than on the weekends using Trost et al. cut-points]. Similar statistically significant trends were noted for rates of sedentary time ( $t[39] = 14.80, p < .001$ ), LPA ( $t[39] = 17.34, p < .001$ ), MVPA ( $t[39] = 8.48, p < .001$ ), and TPA ( $t[39] = 16.15, p < .001$ ) using CHMS cut-points.

Linear regression analyses exploring the impact of sex, childcare attendance, screen viewing, and parental factors (income and education) on sedentary time and physical activity are presented in Tables 3 (Trost et al. cut-points) and 4 (CHMS cut-points). Overall, only those models using activity rates derived using the CHMS cut-points were statistically significant ( $p < .05$ ).

Figure 1

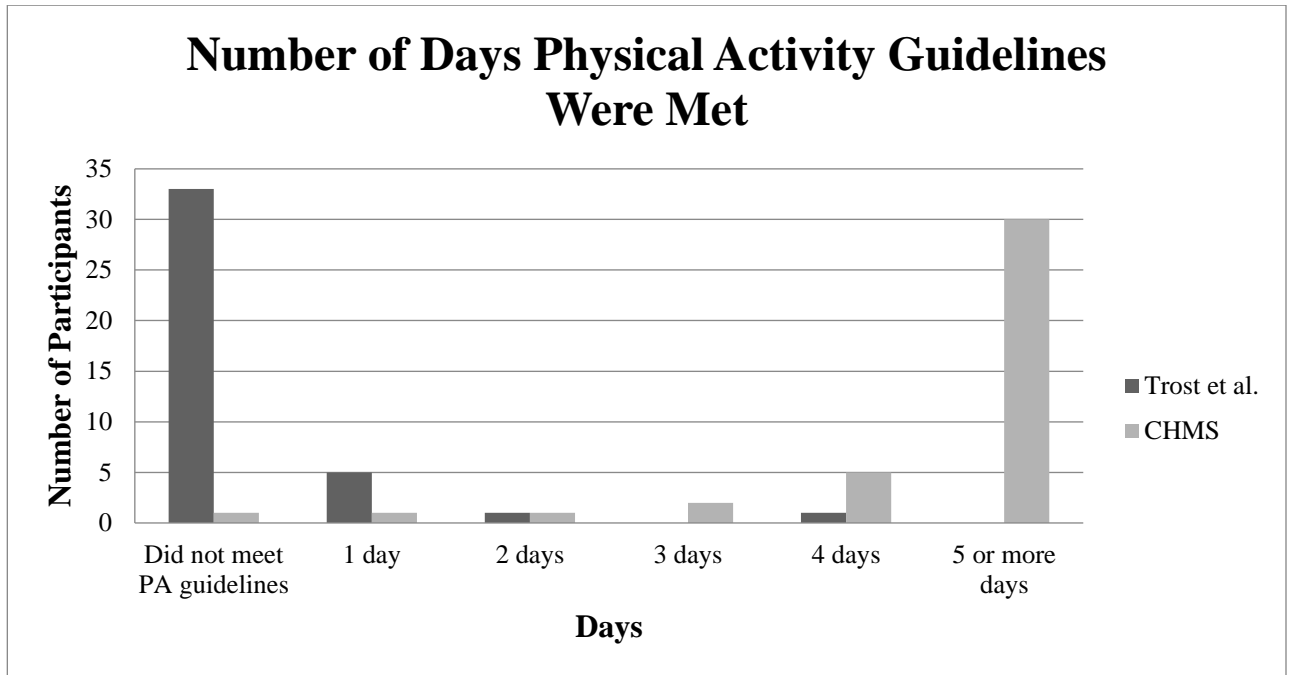


Table 3

*Summary of Coefficients, t-Values, p-Values, and Partial Correlations for Toddlers'*

*Sedentary Time and Physical Activity using Trost et al. Cut-Points*

	Variable	B	<i>t</i>	<i>p</i>	Partial Correlations
Sedentary	Sex	0.64	0.63	0.54	0.11
	Childcare attendance	0.92	1.00	0.33	0.17
	Annual family income	0.30	1.40	0.17	0.24
	Parental education	0.51	0.79	0.44	0.14
	Total SV - weekdays	0.05	1.80	0.08	0.30
	Total SV - weekends	-0.07	-2.58	0.02	-0.41
LPA	Sex	-0.37	-0.40	0.69	-0.07
	Childcare attendance	-0.89	-1.08	0.29	-0.19
	Annual family income	-0.25	-1.31	0.20	-0.23
	Parental education	-0.45	-0.78	0.44	-0.14
	Total SV - weekdays	-0.06	-2.10	0.04	-0.35
	Total SV - weekends	0.06	2.51	0.02	0.41
MVPA	Sex	-0.27	-1.41	0.17	-0.24
	Childcare attendance	-0.03	-0.16	0.87	-0.03
	Annual family income	-0.05	-1.21	0.23	-0.21
	Parental education	-0.06	-0.48	0.64	-0.08
	Total SV - weekdays	0.00	0.37	0.71	0.07
	Total SV - weekends	0.01	1.65	0.11	0.28
TPA	Sex	-0.64	-0.63	0.54	-0.11
	Childcare attendance	-0.92	-1.00	0.33	-0.17
	Annual family income	-0.30	-1.40	0.17	-0.24
	Parental education	-0.51	-0.79	0.44	-0.14
	Total SV - weekdays	-0.05	-1.80	0.08	-0.30
	Total SV - weekends	0.70	2.56	0.02	0.41

*Note.* LPA = light physical activity; MVPA = moderate-to-vigorous physical activity; TPA = total physical activity; SV = screen-viewing. Model accounts for 11.9%, 9.5%, 29.3% and 11.9% of the variability in toddlers' sedentary time, LPA, MVPA, and TPA, respectively.



Table 4.

*Summary of Coefficients, t-Values, p-Values, and Partial Correlations for Toddlers'*

*Sedentary Time and Physical Activity using the CHMS Cut-Points*

	Variable	B	<i>t</i>	<i>p</i>	Partial Correlations
Sedentary	Sex	-0.24	-0.21	0.84	-0.04
	Childcare attendance	1.54	1.46	0.16	0.25
	Annual family income	0.20	0.82	0.42	0.14
	Parental education	0.67	0.90	0.38	0.16
	Total SV - weekdays	0.10	2.96	0.01	0.46
	Total SV - weekends	-0.10	-3.26	0.00	-0.50
LPA	Sex	0.87	0.94	0.35	0.16
	Childcare attendance	-1.24	-1.49	0.15	-0.26
	Annual family income	-0.01	-0.04	0.97	-0.01
	Parental education	-0.43	-0.73	0.47	-0.13
	Total SV - weekdays	-0.09	-3.16	0.00	-0.49
	Total SV - weekends	0.06	2.59	0.01	0.42
MVPA	Sex	-0.62	-1.15	0.26	-0.20
	Childcare attendance	-0.30	-0.62	0.54	-0.11
	Annual family income	-0.20	-1.70	0.10	-0.29
	Parental education	-0.24	-0.70	0.49	-0.12
	Total SV - weekdays	-0.02	-1.04	0.31	-0.18
	Total SV - weekends	0.04	2.64	0.01	0.42
TPA	Sex	0.24	0.21	0.84	0.04
	Childcare attendance	-1.54	-1.46	0.16	-0.25
	Annual family income	-0.20	-0.82	0.42	-0.14
	Parental education	-0.67	-0.90	0.38	-0.16
	Total SV - weekdays	-0.10	-2.96	0.01	-0.46
	Total SV - weekends	0.10	3.26	0.00	0.50

*Note.* LPA = light physical activity; MVPA = moderate-to-vigorous physical activity; TPA = total physical activity; SV = screen-viewing. Model accounts for 19.4%, 22.7%, 25.7% and 19.4% of the variability in toddlers' sedentary time, LPA, MVPA, and TPA, respectively.

**Screen-viewing among toddlers.** Descriptive statistics from the screen-viewing questionnaire revealed that 93.2% of participants watched television (Figure 2), while 56.8% of participants utilized computers (which included laptops, tablets, and smartphones; Figure 3). Only 6.82% of parents/guardians reported that their toddler did not engage in any form of screen-based activity on weekdays or weekend days.

When asked what the main reasons (i.e., check all that apply) were for why their toddler engaged in screen-viewing activities, parents/guardians indicated: 52.3% for educational purposes, 65.9% for entertainment purposes, 70.5% to occupy the child while completing household errands, and 6.8% during babysitting/childcare minding hours. Of those who responded, approximately 18.2% of parents/guardians indicated that they *always* sit with their child while he/she watches television, while 68.2% and 4.5% responded that they *sometimes* or *never* sit with their child while he/she watches television, respectively. Only 9% of parents/guardians reported that the television is *always* left on in the background while their child plays; 47.7% and 43.2% reported that it was *sometimes* or *never* left on in the background, respectively.

Regression analyses revealed that *television viewing* significantly predicted toddlers' sedentary time using the CHMS cut-points ( $F[2, 33] = 5.27, p = 0.01, \text{adj } R^2 = .01$ ), but not those by Trost et al. ( $F[2, 33] = 2.13, p = 0.14, \text{adj } R^2 = .06$ ). Upon examination of the unique contributions to this model (and based on the CHMS thresholds), it was found that *television viewing* significantly predicted 48.7% ( $r = 0.487, p < .001$ ) and 47.9% ( $r = -0.479, p < .001$ ) of the variation in sedentary time on weekdays and weekend days, respectively. *Computer use* was not found to significantly

Figure 2

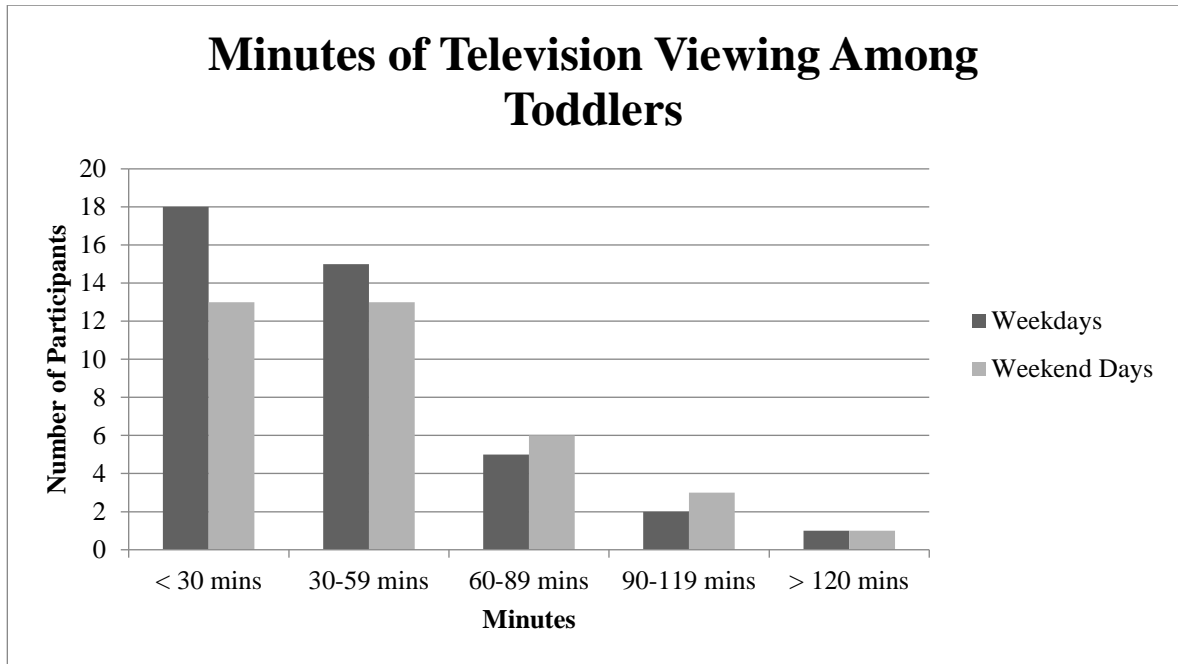
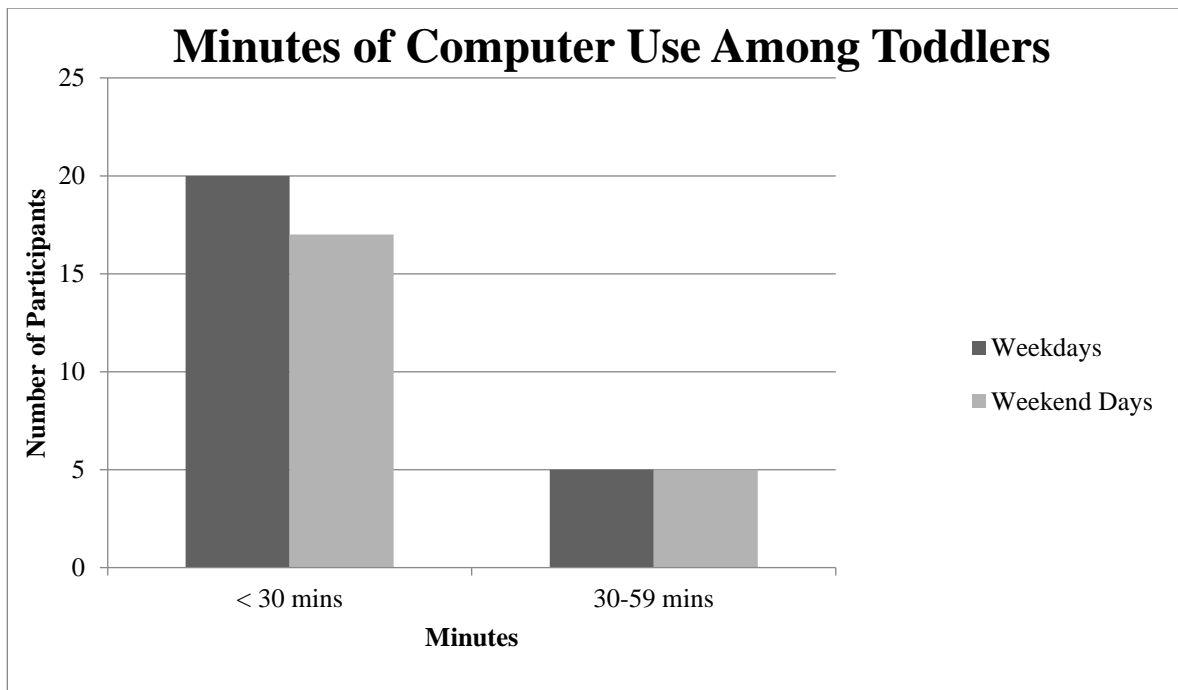


Figure 3



predict sedentary time based on either set of cut-points (Troost et al.:  $F[1, 19] = 0.22, p = .64, \text{adj } R^2 = -.04$ ; CHMS:  $F[1, 19] = .27, p = .61, \text{adj } R^2 = -.04$ ).

When considering the Canadian sedentary behaviour guidelines, only 18.8% and 25.0% of children under 2 years and 70.8% and 62.5% of 2-3 years olds met the screen-use recommendation of the sedentary behaviour guidelines, on weekdays and weekend days, respectively.

## **Discussion**

This is the first Canadian study tasked with objectively measuring full-day physical activity and sedentary time among toddlers, with consideration of different cut-points, various demographic variables (i.e., sex, childcare enrolment, parental income, and education), and weekday/weekend variation. While levels of LPA, MVPA, and TPA were significantly variable (contingent on cut-points used; i.e., 9.79 to 18.78 mins/hr, 0.82 to 3.95 mins/hr, and 10.60 to 22.73 mins/hr for Troost et al. and CHMS, respectively), sedentary levels were high among this sample (i.e., 37.27 to 49.40 mins/hr). Overall, it was found that in comparison to the CHMS cut-points (Adolph et al., 2012; Wong et al., 2011), the toddler-specific thresholds derived by Troost et al. (2010) yield lower levels of LPA, MVPA, and TPA as well as higher levels of sedentary time.

By applying Troost et al.'s cut-points, the findings reveal that the majority (i.e., 82.5%) of toddlers are insufficiently active to meet current national physical activity guidelines. Interestingly, when the cut-points used in the CHMS were applied to the activity data, it was found that 97.5% of participants met the physical activity guidelines on one or more days. Consequently, these findings highlight the challenges of accurately interpreting Canadian toddlers' activity levels. Despite this large difference in adherence

to national standards, this discrepancy may not be surprising given how much lower the CHMS cut-points are in comparison to those by Trost et al. (2010); consequently, many more minutes of collected data were likely classified as LPA rather than sedentary time. Regardless of the inconsistency in time spent in LPA, what may prove challenging in the future, from a public health perspective, is that, regardless of which cut-points were applied, toddlers in the present study accumulated very little MVPA. While current guidelines for young children do not stipulate that physical activity at a particular intensity must be achieved (CSEP, 2012a), higher intensity activities will become increasingly important once children reach 5 years of age (Timmons et al., 2012, CSEP, 2012c).

In line with the findings using Trost et al.'s (2010) cut-points, low levels of physical activity have been echoed elsewhere in the literature among toddlers in other developed countries (Manios, 2006). According to a proxy questionnaire, Manios (2006) reported that participants spent very little time in light to vigorous physical activity (12-24 months:  $1.45 \pm 3.15$  hrs/week for males and  $1.05 \pm 2.29$  hrs/week for females; 25-36 months:  $1.51 \pm 2.63$  hrs/week for males and  $1.21 \pm 2.41$  hrs/week for females). During childcare hours, and consistent with the noted trends of this work, researchers have also reported that sedentary levels are high among this population (Carson et al., 2015; Fees et al., 2015; Van Cauwenberghe et al., 2011). The findings by Carson et al. (2015) mirror very closely the LPA (i.e., 18.1 mins/hr) and sedentary levels (i.e., 37.8 mins/hr) of the toddlers in the current study.

The low levels of MVPA among participating toddlers were similar to Gubbels et al.'s (2011; where 5.5% of indoor observations and 21.2% of outdoor observations were

classified as MVPA as directly observed using the Observational System for Recording Physical Activity in Children–Preschool Version; mean age = 2.6 years) and Witjzes et al.'s (2013; where 4.8% and 5.2% of objectively monitored time via ActiGraph accelerometers was reported as MVPA on weekdays and weekend days, respectively) work which also reported time spent in MVPA (albeit low) among their toddler samples. Young children from Carson et al.'s (2015) paper also reported some MVPA (i.e., 4.0 mins/hr) during childcare hours using Actical accelerometers. Participants in Hnatiuk and colleagues' (2012; mean age = 19.1 [ $SD = 2.3$ ] months) and Johansson and colleagues' (2015; mean age = 2.03 [ $SD = 0.1$ ] years) research participated in slightly higher levels of MVPA; 1.96 mins/hr and 3.5 mins/hr (measured via ActiGraph accelerometers), respectively.

Discrepancies in values observed across studies could be a result of measurement differences encountered using ActiGraph versus Actical accelerometers, and their associated cut-points (Vanderloo, Di Cristofaro, Proudfoot, Tucker, & Timmons, 2016). In fact, a recent paper by Vanderloo et al. (2016) found that in comparison to Actical accelerometers, ActiGraph accelerometers reported higher levels of physical activity and lower levels of sedentary time among young children. Further to this point, and specific to the toddler population, the cut-points derived by Trost's team differ significantly for Actical (Trost et al., 2010; used in the present study) and ActiGraph (Trost, Fees, Haar, Murray, & Crowe, 2012; used in previous studies; Hnatiuk et al., 2012; Johansson et al., 2015; Witjzes et al., 2013) devices using 15s epochs: 0-114 counts versus 0-48 counts for sedentary time, 115-697 counts versus 49-418 counts for LPA, and >697 counts versus >418 counts for MVPA; respectively. Another possible explanation for the lower levels of

MVPA accumulated by this sample may be the choice of accelerometer cut-points applied to this data. To the authors' knowledge, the cut-points derived by Trost and colleagues (2010) are the only thresholds that have been identified for use with Actical accelerometers among this young population. It is possible that the cut-points used to interpret the activity data may have resulted in the misclassification of MVPA into LPA and/or of LPA into sedentary time. As such, additional validation work is needed to develop universally accepted cut-points that define various intensity levels among toddlers. To further investigate this issue, researchers employed a similar method to Colley and colleagues' (2013) cross-sectional investigation of preschoolers' physical activity levels (who reported MVPA levels ranging from 17 to 68 minutes depending on cut-points used), and applied a second set of cut-points (Adolph et al., 2012; Wong et al., 2011) to the data in order to explore differences in activity levels. Evidently, these findings may draw attention to the fact that accelerometers *alone* may not provide a complete picture of toddlers' physical activity behaviours; additional contextual information is needed to help subsidize the objective data.

Comparable to Gubbel et al.'s (2011), Fees et al.'s (2015), Hnatiuk et al.'s (2012), and Johansson et al.'s (2015) work, but in contrast to Witjzes et al.'s (2013) paper, levels of physical activity did not significantly differ based on sex. Interestingly, while the impact of sex on toddlers' physical activity levels may not be entirely clear, it is possible that this biological factor may play a greater role in children's activity behaviours as they age (i.e., preschool- and school-age years). While not overly unexpected that the toddlers in this study accumulated low levels of physical activity, it was somewhat surprising to see such low numbers among a sample where the majority were from families with

higher socio-economic statuses (which is typically linked to higher rates of physical activity among children; Ford et al., 1991). This finding may suggest that even toddlers from higher income homes are not immune to inactivity.

Participants from this study were found to engage in high levels of sedentary time (i.e., approximately 81.72% and 62.54% of monitoring time based on Trost et al. and CHMS cut-points, respectively). Given the many negative health outcomes associated with sedentary behaviours (Leblanc et al., 2012), these findings are alarming and unfortunately, not unique. Gubbels and colleagues (2011; where approximately 59.4% of the indoor and 31.2% of the outdoor observations were classified as sedentary), Johansson et al. (2015; where approximately 55% of monitoring time was sedentary), and Witjzes and colleagues (2013; where approximately 85% of monitoring time on both weekdays and weekend days were sedentary) also reported high levels of sedentary time among their toddler samples. Witjzes et al. (2013) also reported that female toddlers engaged in significantly more sedentary time than their male counterparts; however, this was not the case in the present study.

One behaviour that might account for a large proportion of this sample's sedentary time could be their high levels of television and computer use. This paper marks one of the first explorations of screen-viewing among toddlers in Canada and revealed that on weekdays and weekend days respectively, 81.2% and 75.0% of children under 2 years and 29.2% and 37.5% of 2-3 years olds failed to adhere to the screen-use portion of Canada's sedentary behaviour guidelines for young children. Similarly, a brief review by Cardon et al. (2011) found that screen use is very common among young children; these findings are concerning as it is possible that screen-viewing time may be



displacing physical activity (particularly at light intensities; Rennie, Johnson, & Jebb, 2005). Unfortunately, our finding that toddlers are spending large amounts of time viewing screens aligns with the research-based recognition that next to sleeping, the time children spend engaged in screen-viewing exceeds that of any other in which they would typically participate (Christakis, Ebel, Rivara, & Zimmerman, 2013). Consequently, given current guidelines which recommend that young children should not spend more than 60 minutes sitting or being restrained (CSEP, 2012b), combined with the fact that sedentary behaviours tend to persist throughout the lifespan (Kelly et al., 2007), increased research efforts are also needed to address *why* toddlers are spending significant amounts of time engaging in screen-viewing activities during this critical developmental period. Garnering such information would prove useful in developing and instilling mechanisms to help parents limit their toddlers' engagement in screen-viewing activities.

Due to the young age of the participants, compliance in wearing the belts throughout the entire data collection period was, at times, challenging (as noted by parents/guardians in the wear-time logs). Despite this, the majority of participants had adequate wear-time to be included in all analyses. Also in light of the young age of participants, future research with toddlers may consider defining non-wear time as 20 minutes of consecutive zeros (rather than 60 minutes) as it may be more reasonable to consider this age group remaining still for 20 minutes (rather than 60 minutes). Although efforts were made to achieve a geographically-diverse sample, the generalizability of these results may be limited by the small sample size used. This is the first study to apply the Trost and colleagues (2010) cut-points to Actical accelerometer data which makes comparisons with previous studies challenging. However, given that these are the only

available cut-points that are both toddler- and Actical-specific, the authors felt it was important to utilize these thresholds in the present paper. Lastly, while the Toddler Screen-Viewing Questionnaire was informed by previous studies (Certain et al., 2002; Colley et al., 2013; Vanderwater et al., 2007; Zimmerman et al., 2007), its psychometric properties have not been assessed, and as such, its validity has not been established.

### **Conclusion**

The findings from this work suggest the challenge of accurately interpreting toddlers' levels of physical activity and sedentary time, which consequently makes comparisons to national guidelines challenging. In comparison to the CHMS cut-points (Adolph et al., 2012; Wong et al., 2011), it was found that the toddler-specific cut-points derived by Trost et al. (2010) produce much lower levels of physical activity and higher levels of sedentary time. Despite this noted challenge, this study highlights the high levels of sedentary behaviours in which toddlers are participating – this aligns with previous studies with this population. Finally, this work presents the first depiction of screen-viewing behaviours, and their alignment with national standards among this young cohort. In light of the growing interest in toddlers' physical activity and sedentary time, additional research is required to confirm these findings as well as to explore mechanisms for promoting active behaviours among this group (and minimizing sedentary ones) to ensure healthy growth and development.

## References

- Active Healthy Kids Canada. (2010). *Canada's report card on physical activity for children and youth*. Retrieved from:  
<http://www.activehealthykids.ca/ReportCard/2010ReportCardOverview.aspx>.
- Adolph, A.L., Puyau, M.R., Vohra, F.A., Nicklas, T.A., Zakeri, I.F., & Butte, N.F. (2012). Validation of uniaxial and triaxial accelerometers for the assessment of physical activity in preschool children. *Journal of Physical Activity & Health, 9*, 944-953. Retrieved from <http://journals.humankinetics.com/jpah>
- Australian Government. Department of Health and Ageing. (2010). *Move and play every day. National physical activity recommendations for children 0-5 years*. Retrieved from: <http://www.health.gov.au/internet/main/publishing.nsf/Content/health-pubhlth-strateg-phys-act-guidelines>.
- Canadian Society of Exercise Physiology (2012a). *Canadian physical activity guidelines for the early years (0-4 years)*. Retrieved from:  
[http://www.csep.ca/CMFiles/Guidelines/CSEP\\_PAGuidelines\\_early-years\\_en.pdf](http://www.csep.ca/CMFiles/Guidelines/CSEP_PAGuidelines_early-years_en.pdf).
- Canadian Society of Exercise Physiology (2012b). *Canadian sedentary behaviour guidelines for the early years (0-4 years)*. Retrieved from:  
[http://www.csep.ca/CMFiles/Guidelines/CSEP\\_SBGuidelines\\_early-years\\_en.pdf](http://www.csep.ca/CMFiles/Guidelines/CSEP_SBGuidelines_early-years_en.pdf).
- Canadian Society of Exercise Physiology (2012c). *Canadian physical activity guidelines for children (5-11 years)*. Canadian Society of Exercise Physiology.
- Cardon, G., Van Cauwenberghe, E., & De Bourdeaudhuij, I. (2011). What do we know about physical activity in infants and toddlers: A review of the literature and future

research directions. *Science and Sports*, 26, 127-130. doi:

10.1016/j.scispo.2011.01.005

Carson, V., Clark, D., Ogden, N., Harber, V., & Kuzik, N. (2015). Short-term influence of revised provincial accreditation standards on physical activity, sedentary behavior, and weight status in Alberta, Canada child care centres. *Early Childhood Education Journal*, 43, 459- 465. doi: 10.1007/s10643-015-0688-3.

Certain, L.K., & Kahn, R.S. (2002). Prevalence, correlates, and trajectory of television viewing among infants and toddlers. *Pediatrics*, 109, 634-642. doi:

10.1542/peds.109.4.634

Christakis, D.A., Ebel, B.E., Rivara, F.P., & Zimmerman, F.J. (2004). Television, video, and computer game usage in children under 11 years of age. *Journal of Pediatrics*, 145, 652-656. doi: 10.1016/j.jpeds.2004.06.078

Cliff, D.P., Okely, A.D, Smith, L.M., & McKeen, K. (2009). Relationships between fundamental movement skills and objectively measured physical activity in preschool children. *Pediatric Exercise Science*, 21, 436-49. Retrieved from <http://journals.humankinetics.com/pes>

Cliff, D.P., Reilly, J.J., & Okely, A.D. (2009). Methodological considerations in using accelerometers to assess habitual physical activity in children aged 0-5 years.

*Journal of Science and Medicine and Sport*, 12, 557-567. doi:

10.1016/j.jsams.2008.10.008

Colley, R., Garriguet, D., Adamo, K., Carson, V., Janssen, I., Timmons, B., & Tremblay, M. S. (2014). Physical activity and sedentary behaviour during the early years in

Canada: A cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity*, 10, 54. doi: 10.1186/1479-5868-10-54

Department of Health: Physical Activity and Health Alliance. (2011). *Start active, stay active: A report on physical activity for health from the four home countries' Chief Medical Officers*. Retrieved from:

[https://www.sportengland.org/media/388152/dh\\_128210.pdf](https://www.sportengland.org/media/388152/dh_128210.pdf).

Esliger, D.W., Copeland, K.A., Barnes, J., & Tremblay, M.S. (2005). Standardizing and optimizing the use of accelerometer data for free-living physical activity monitoring. *Journal of Physical Activity and Health*, 2, 366-383. Retrieved from <http://journals.humankinetics.com/jpah>

Esliger, D.W., & Tremblay, M.S. (2007). Physical activity and inactivity profiling: The next generation. *Canadian Journal of Public Health*, 98, s195-s207. doi: 10.1139/H07-107

Fees, B.S., Fisher, E., Haar, S., & Crowe, L.K. (2015). Toddler activity intensity during indoor free-play: Stand and watch. *Journal of Nutrition Education and Behavior*, 47, 170-175. doi: 10.1016/j.jneb.2014.08.015

Ford, E.S., Merrit, R.K., Heath, G.W., Powell, K.E., Washburn, R.A., & Kriska, A. (1991). Physical activity behaviors in lower and higher socioeconomic status populations. *American Journal of Epidemiology*, 133, 1246-1256. doi: <http://aje.oxfordjournals.org>

Gubbels, J.S., Kremmers, S.P., van Kann, D.H., Stafleu, A., Candel, M.J., Dagnelie, C., Thijs, C., & de Vries, N.K. (2011). Interaction between physical environment,

social environment, and child characteristics in determining physical activity at childcare. *Health Psychology, 30*, 84-90. doi: 10.1037/a0021586

Hinkley, T., Crawford, D., Salmon, J., Okely, A.D., & Hesketh, K. (2008). Preschool children and physical activity. A review of correlates. *American Journal of Preventive Medicine, 34*(5), 435-441. doi: 10.1016/j.amepre.2008.02.001

Hinkley, T., Salmon, J., Okely, A.D., Hesketh, K., & Crawford, D. (2012). Correlates of preschool children's physical activity. *American Journal of Preventive Medicine, 43*(2), 159-167. doi: 10.1016/j.amepre.2012.04.020

Hnatiuk, J., Ridgers, N.D., Salmon, J., Campbell, K., McCallum, Z., & Hesketh, K. (2012). Physical activity levels and patterns of 19-month-old children. *Medicine & Science in Sports and Exercise, 44*, 1715-1720. doi: 10.1249/MSS.0b013e31825825c4

Johansson, E., Hagstromer, M., Svensson, V., Ek, A., Forssen, M., Nero, H., & Marcus, C. (2015). Objectively measured physical activity in two-year-old children: Levels, patterns and correlates. *International Journal of Behavioral Nutrition and Physical Activity, 12*, 3. doi:10.1186/s12966-015-0161-0

Kelly, L.A., Reilly, J.J., Jackson, D.M., Montgomery, C., Grant, S., & Paton, J.Y. (2007). Tracking physical activity and sedentary behaviour in young children. *Pediatric Exercise Science, 19*, 51-60. Retrieved from <http://journals.humankinetics.com/pes>

Leblanc, A.G., Spence, J.C., Carson, V., Connor Gorber, S., Dillman, C., Janssen, I., Kho, M.E., Stearns, J.A., Timmons, B.W., & Tremblay, M.S. (2012). Systematic review of sedentary behaviour and health indicators in the early years (aged 0-4

years). *Applied Physiology, Nutrition, and Metabolism*, 37, 753-772. doi:  
10.1139/h2012-063

Manios, Y. (2006). Design and descriptive results of the "Growth, Exercise and Nutrition Epidemiological Study in preSchoolers": The GENESIS Study. *BMC Public Health*, 6, 32. doi: 10.1186/1471-2458-6-32

Pate, R.R., Pfeiffer, K.A., Trost, S.G., Ziegler, P., & Dowda, M. (2004). Physical activity among children attending preschools. *Pediatrics*, 114(4), 1258-1263. Retrieved from <http://pediatrics.aappublications.org/content/137/3?current-issue=y>

Reilly, J.J., Jackson, D.M., Montgomery, C., Kelly, L.A., Slater, C., Grant, S., & Paton, J.Y. (2004). Total energy expenditure and physical activity in young Scottish children: Mixed longitudinal study. *Lancet*, 363(9404), 211-212. doi:  
10.1016/S0140-6736(03)15331-7

Rennie, K.L., Johnson, L., & Jebb, S.A. (2005). Behavioural determinants of obesity. *Best Practice & Research Clinical Endocrinology & Metabolism*, 19, 343-358. doi:10.1016/j.beem.2005.04.003

Saakslähti, A., Numminen, P., Varstala, V., Helenius, H., Tammi, A., Viikari, J., & Valimäki, I. (2014). Physical activity as a preventive measure for coronary heart disease risk factors in early childhood. *Scandinavian Journal of Medicine and Science in Sports*, 14(3), 143-149. doi: 10.1111/j.1600-0838.2004.00347.x.

Shen, B., Alexander, G., Milberger, S., & Jen, K-L. C. (2013). An exploratory study of seasonality and preschoolers' physical activity engagement. *Journal of Physical Activity and Health*, 10(7), 993-999. Retrieved from <http://journals.humankinetics.com/jpah>

- Taverno Ross, S., Dowda, M., Saunders, R.P., & Pate, R.R. (2013). Double dose: The cumulative effect of TV viewing at home and in preschool on children's activity patterns and weight status. *Pediatric Exercise Science*, 25(2), 262–272. Retrieved from <http://journals.humankinetics.com/pes>
- Timmons, B.W., Leblanc, A.G., Carson, V., Connor Gorber, S., Dillman, C., Janssen, I., Kho, M.E., Spence, J.C., Stearns, J.A., & Tremblay, M.S. (2012). Systematic review of physical activity and health in the early years (aged 0-4 years). *Applied Physiology, Nutrition, and Metabolism*, 37(4),773-792. doi: 10.1139/h2012-070
- Timmons, B.W., Naylor, P.J., & Pfeiffer, K.A. (2007). Physical activity for preschool children - How much and how? *Canadian Journal of Public Health*, 98, S122-S134. doi: 10.1139/H07-112
- Trost, S.G., Fees, B.S., Haar, S.J., Murray, A.D., & Crowe, L.K. (2012). Identification and validity of accelerometer cut-points for toddlers. *Obesity (Silver Springs)*, 20(11), 2317-2319. doi: 10.1038/oby.2011.364
- Trost, S.G., Loprinzi, P.D., & Fees, B.S. (2010). *Objective measurement of physical activity and sedentary behaviours in young children*. Conference proceedings from the International Society of Behavioral Nutrition and Physical Activity. Minneapolis, MN.
- Tucker P. (2008). The physical activity levels of preschool-aged children: A systematic review. *Early Childhood Research Quarterly*, 23, 547-558. doi: 10.1016/j.ecresq.2008.08.005



- Vale, S., Ricardo, N., Soares-Miranda, L., Santos, R., Moreira, C., & Mota, J. (2014). Parental education and physical activity in pre-school children. *Child: Care, Health, and Development*, 40(3), 446-452. doi: 10.1111/cch.12041
- Vale, S., Silva, P., Santos, R., Soares-Miranda, L., & Mota, J. (2010). Compliance with physical activity guidelines in preschool children. *Journal of Sports Science*, 28, 603-608. doi: 10.1080/02640411003702694
- Van Cauwenberghe E, Gubbels J, De Bourdeaudhuij I, Cardon G. (2011). Feasibility and validity of accelerometer measurements to assess physical activity in toddlers. *International Journal of Behavioral Nutrition and Physical Activity*, 8, 67. doi: 10.1186/1479-5868-8-67.
- Vanderloo, L.M., Tucker, P., Johnson, A.M., Van Zandvoort, M.M., Burke, S.M., & Irwin, J.D. (2014). The influence of centre-based childcare on preschoolers' physical activity levels: A cross-sectional study. *Internal Journal of Environmental Research and Public Health*, 11, 1794-802. doi: 10.3390/ijerph110201794
- Vanderloo, L.M., Di Cristofaro, N.A., Proudfoot, N.A., Tucker, P., & Timmons, B.W. (2016). Comparing the Actical and ActiGraph approach to measuring young children's physical activity levels and sedentary time. *Pediatric Exercise Science*, 28(1), 133-142. doi: 10.1123/pes.2014-0218
- Vandewater, E.A., Rideout, V.J., Wartella, E.A., Huang, X., Lee, J.H., & Shim, M.S. (2007). Digital childhood: Electronic media and technology use among infants, toddlers, and preschoolers. *Pediatrics*, 119, e1006-e1015. Retrieved from <http://pediatrics.aappublications.org/content/137/3?current-issue=y>

- Witjzes, A.L., Kooijman, M.N., Kieft-de Jong, J.C., de Vries, S.I., Henrichs, J., Jansen, W., Jaddoe, V.H., Hofman, A., Moll, H.A., & Raat, H. (2013). Correlates of physical activity in 2-year-old toddlers: The Generation R Study. *Journal of Pediatrics*, *163*, 791-799. doi: 10.1016/j.jpeds.2013.02.029
- Wong, S.L., Colley, R.C., Connor Gorber, S., & Tremblay, M.S. (2011). Actical accelerometer sedentary activity thresholds for adults. *Journal of Physical Activity and Health*, *8*, 587-591. Retrieved from <http://journals.humankinetics.com/jpah>
- Zimmerman, F., Christakis, D.A., & Meltzoff, A.N. (2007). Television and DVD/video viewing in children younger than 2 years. *Archives of Pediatric and Adolescent Medicine*, *161*, 473-479. doi: 10.1001/archpedi.161.5.473

### CHAPTER 3

#### **Environmental Influences on Preschoolers' Physical Activity Levels in Various Early Learning Facilities<sup>‡</sup>**

Recently, the landscape of early learning environments in Ontario has transformed dramatically. Specific to this province, the three main types of early learning arrangements include: (a) centre-based childcare; (b) home-based childcare; and (c) Full-Day Kindergarten (FDK). Centre-based childcare provides care to a large number of children (approximately 16 per classroom for the preschool cohort) on a full- or part-time basis, is typically offered through organization-like institutions, and is highly regulated (Tucker et al., 2013). Care and supervision are generally provided in a school-like setting (Vanderloo, Tucker, Ismail, & Van Zandvoort, 2012). In contrast, home-based childcare provides care to a much smaller number of children (typically no more than 5 plus the provider's own children) across various age groups (e.g., 1-11 years; Temple, Naylor, Rhodes, & Wharf Higgins, 2009). Home-based childcare facilities are usually privately owned and operated by the childcare provider (Lawlis, Mikhailovich, & Morrison, 2009), and can operate as either licensed or unlicensed establishments. In 2010, the Government of Ontario announced its decision to implement FDK for all children 4-5 years (including 3-year-olds who turn 4 by the end of the year; Ontario Ministry of Education, 2010). The reasoning provided for this new early learning program is to optimize emotional, academic, social, and physical development among young children in the school system (Ontario Ministry of Education, 2010). Compared to the previous kindergarten structure in Ontario (i.e., full-days on alternating days, or half-days every day), children attending kindergarten programming are required to attend all day, every week day (i.e., Monday to

<sup>‡</sup>A version of this manuscript has been published. Vanderloo, L. M., Tucker, P., Johnson, A., Burke, S. M., & Irwin, J. D. (2015). Environmental influences on preschoolers' physical activity levels in early learning facilities. *Research Quarterly for Exercise and Sport*, 86 (4), 360-370. doi: 10.1080/02701367.2015.105310

Friday from approximately 9am to 3pm), and receive instruction from both a teacher (i.e., responsible for student learning, elementary curriculum, and formal evaluation and reporting) and an ECE (i.e., responsible for healthy child development, observation, and assessment). In light of the various venues in which early learning can be afforded to young children, and to best appreciate the impact of the venues' characteristics on children, it is important that the context of these unique environments be understood. This is especially critical if these settings are expected to support and maintain healthy child development, a goal that has been suggested previously by both parents of preschoolers and researchers alike (Tucker et al., 2013; Goldfield, Harvey, Grattan, & Adamo, 2012).

The early years mark a critical time for growth and development. It is during this time that many children establish health-related behaviours, including physical activity practices (Malina, 2001). Developing strong physical activity habits early in life is crucial given the positive benefits of regular activity, and the frequently demonstrated negative correlation between activity levels and increasing age (Salmon, Timperio, Cleveland, & Venn, 2005; Taylor et al., 2009). Specific to the preschool population (i.e., children 2.5-5 years), regular participation in physical activity has been linked to a number of physical- and cognitive-related health benefits (Cliff, Okely, Smith, & McKeen, 2009; Timmons, Naylor, & Pfeiffer, 2007). However, contrary to popular belief that preschoolers are highly active by nature (Goldfield et al., 2012), there is substantial research to suggest that sedentary behaviours are high within this age group (Alhassan, Sirars, & Robinson, 2007; Cliff et al., 2009; Pate, Pfeiffer, Trost, Ziegler, & Dowda, 2004). Consequently, additional research is warranted not only to help establish how active (and sedentary) Canadian preschoolers are, but also to determine how the learning environment may be

improved to ensure that this particular population is reaping the health benefits associated with physical activity.

The appropriateness of intervening in early learning environments to target preschoolers' physical activity has been well established (Bower et al., 2008; Goldfield et al., 2012; Pate et al., 2004). Specifically, various attributes within these settings, including portable play equipment (e.g., balls, hula hoops, tricycles, etc.), staff training and engagement (e.g., role modeling, physical activity-specific training/education) and adequate space (e.g., indoor and outdoor), have been noted as playing an important role in fostering active behaviours among this age group (Dowda, Pate, Trost, Almeida, & Sirard, 2004; Gordon, Tucker, Burke, & Carron, 2013; Gubbels, Van Kann, & Jansen, 2012; Gunter, Rice, Ward, & Trost, 2012; Van Cauwenberghe, Labarque, Gubbels, De Bourdeaudhuij, & Cardon, 2012; Vanderloo et al., 2014). Interestingly, despite the identification of the above-noted influential factors within this unique setting, little is known regarding the degree to which they support or hinder preschooler's activity levels and/or whether these characteristics vary across different early learning environments. In fact, in Canada, only one study to date has considered the early learning environments' influence on preschoolers' activity levels – a pilot study of the current investigation, conducted in centre-based childcare only (Vanderloo et al., 2014). The paucity of Canadian data available in this area, combined with the fact that preschoolers' activity levels within early learning venues tend to be quite low (Vanderloo et al., 2014; Brown et al., 2009; Pate et al., 2004), underscores the strong need to establish evidence-informed 'healthful' environments in support of preschoolers' physical activity behaviours.

No research to date has examined preschoolers' physical activity levels across different types of early learning facilities, or potential environmental influences on physical activity in these settings. In light of the heterogeneous environments available, along with the recent (and understudied) introduction of FDK in the province of Ontario, it was deemed necessary to assess the differences in activity levels based on setting type. Furthermore, given the variability in physical activity-related resources, infrastructure, and programming across centre-based childcare, home-based childcare, and FDK, it is imperative that these differences (and the manner in which they influence preschoolers' activity levels) be examined. Finally, subsequent to recent research showing that children who attend centre-based childcare are at an increased risk for gains in adiposity in comparison to those who receive parental care (Geoffroy et al., 2012), increased attention is required to understand the context in which physical activity occurs while in early learning environments.

### **Study Purpose**

The purpose of this study was two-fold: 1. to compare the physical activity levels (i.e., MVPA, TPA) of preschoolers in three different early learning environments (i.e., centre-based childcare, home-based childcare, and FDK); and, 2. to assess which characteristics (i.e., play equipment, policies, staff behaviour and training, outdoor play periods, sedentary behaviours/opportunities) within these early learning environments are associated with preschoolers' physical activity.

## Methods

**Research design.** The preschool children who participated in the current study were part of the *Learning Environments Activity Potential in Preschoolers* (LEAPP) study, a 2-year descriptive cross-sectional investigation. Study procedures and materials were pilot tested by the research team in 2010 (Vanderloo et al., 2014), and data collection took place between September 2011 and June 2012. An in-depth methodological account of this study is described elsewhere (Tucker et al., 2013). All study procedures and documents received institutional ethical approval from its respective Office of Research Ethics Board (Appendix G).

**Participants.** Preschool children (2.5-5 years) from three different early learning environments (centre-based, home-based, and FDK) were invited to participate. Tailored recruitment strategies were used to enlist participants from each of the three environments (Tucker et al., 2013). Specifically, purposeful sampling was used to recruit the FDK classrooms as the schools in London were implementing the new program in a staggered fashion. Centre-based childcare facilities were recruited (based on geographic location) from a municipal document which published a list of licensed childcare facilities in the city. Lastly, various methods were used to recruit the home-based facilities as there was no single directory which listed all the home-based facilities throughout the city (e.g., Facebook™, Kijiji Classified Canada™, parent and caregiver magazine and blogs, non-profit organizations geared at early childhood, etc.; Tucker et al., 2013). All eligible children who received written informed parent/guardian consent (Appendix H) were invited to take part in the study.

**Procedures and tools of measurement.** This study utilized two direct assessment tools, Actical™ accelerometers (MiniMitter, Bend, Oregon) and the Environment and Policy Assessment and Observation instrument (EPAO; Ball et al., 2005; Appedix I). A demographic questionnaire (Appendix J) for parents/guardians was also administered.

Physical activity duration and intensity were assessed via Actical™ accelerometers fastened over the right hip of participating children, using a 15s epoch length. Participants were asked to wear the accelerometers for 5 consecutive days during early learning hours only. Trained childcare staff secured the devices on the children as they arrived in the morning, and removed them prior to departure at end of day. Staff recorded the on/off times of the devices for each child in a log (Appendix K). During the week of accelerometry data collection, two researchers independently administered the EPAO instrument at each site (to help reduce potential researcher variability). Divided into two sub-sections (a day-long observation of the environment followed by a review of all physical activity-related documents and policies), the physical activity portion of this tool was used to conduct an objective evaluation of each early learning venue (mean agreement between observer pairs was 87.26% and 79.29% for the observation and document review, respectively, and kappa scores ranged from 0.17 to 0.63; Ball et al., 2005; Benjamin et al., 2007; Bower et al., 2008). Specifically, eight physical activity subscales were examined during each one-day observation period: 1. Sedentary Opportunities; 2. Sedentary Environment; 3. Active Opportunities; 4. Staff Behaviours; 5. Physical Activity Training and Education; 6. Physical Activity Policies; 7. Portable Play Environment; and 8. Fixed Play Environment (Ball et al., 2005; Ward et al., 2008). Bower et al. (2008) presented a complete description of the physical activity subscales



(Appendix L). The EPAO tool was also used in the research team's feasibility study (Vanderloo et al., 2014).

**Statistical analyses.** Actical-specific software was used to download accelerometry data. Given the lack of consensus surrounding minimum accelerometer wear time among preschoolers, custom software *KineSoft* version 3.3.62 (KineSoft, Loughborough, UK) was used to conduct reliability analyses. This, in turn, was used to determine the number of hours/days necessary to provide accurate activity data, and thus guided the inclusion of participants in the analysis. Parameters applied to the data within this program were as follows: non-wear time was defined as 60 minutes of consecutive zeroes (which accounted for nap time, where applicable; Colley, Connor Gorber, & Tremblay, 2010); 5 hours of wear time constituted a valid day (Colley, Harvey, Grattan, & Adamo, 2014); and participants with 3 or more valid days were retained for analyses (Colley et al., 2014; Konstabel et al., 2014). Based on these parameters, 218 participants (73%) provided sufficient data. Using *KineSoft* to analyze the raw accelerometer data, a number of various standardized outcome variables were generated. Pfeiffer and colleagues' (2006) preschooler-specific cut-points were applied to the collected activity data. Average daily activity levels for all intensities were calculated by dividing the total sum of minutes of activity on valid days by the number of valid days. In line with previous research (Temple et al., 2009; Vanderloo et al., 2014), physical activity per hour of wear time was calculated to account for the varying lengths of time participants spent in care or school.

All analyses were performed using SPSS (version 21). An alpha level of .05 was used for all statistical tests. Means and standard deviations were calculated to describe the

sample. For the purpose of these analyses, early learning facilities were entered as *strata* and individual classrooms (within these facilities) as *clusters*. Unstandardized residual scores were created from running a regression analysis of age onto MVPA and TPA in order to account for the effect of age on activity levels. These residual scores were used in subsequent linear mixed model ANCOVA calculations which were carried out to determine the differences in activity levels based on type of early learning environment. A separate model was run for both MVPA and TPA (where each activity intensity was entered as the dependent variable). The main effects and interaction effect for the following fixed factors were included in the model: type of early learning environment (i.e., centre-based childcare, home-based childcare, FDK) and sex (i.e., boy, girl). Classrooms clustered within early learning facilities were considered random effects in the present models. Post-hoc comparisons using Tukey's HSD were conducted to determine where differences in activity levels existed across the three early learning environments.

To objectively identify which attributes within the early learning environments impact preschoolers' physical activity, instrument-specific guidelines and a scoring tool were used to calculate the results of the EPAO's eight physical activity subscales (Appendix M; Ward et al., 2008). A Total Physical Activity Environment EPAO score (ranging from 0 to 20, where lower scores indicate a less supportive physical activity environment) was calculated for each site by averaging the scores across all eight subscales. All items within the physical activity portion of the EPAO tool were coded by two reviewers, and intraclass correlation coefficients (ICCs) were calculated to examine inter-rater reliability across the subscales as well as the Total Physical Activity

Environment EPAO score. ICCs were calculated using an absolute agreement definition. Four subscales (i.e., Active Opportunities, Physical Activity Policy, Physical Activity Training and Education, Sedentary Environment) had perfect correlation on the composite scores between the two reviewers, and as such, ICCs were not calculated. The ICC (95% confidence interval) for the Total Physical Activity Environment EPAO score was .990 (.980-.995), and ICCs for Sedentary Opportunities, Portable Play Environment, Fixed Play Environment, and Staff Behaviours were .996 (.993-.998), .994 (.988-.997), .906 (.817-.952), and .992 (.984-.996), respectively. Given that all subscales represent composite scores, average measures of the ICC were used.

Direct entry regression analyses were performed to describe the relationships between time spent in MVPA ( $\geq 715$  counts $\cdot 15$  s $^{-1}\cdot$ epoch $^{-1}$ ; dependent variable) and TPA ( $\geq 50$  counts $\cdot 15$  s $^{-1}\cdot$ epoch $^{-1}$ ; dependent variable), and the EPAO physical activity subscales (independent variable) and the Total PA Environment EPAO score (independent variable). Coefficients of determination ( $R^2$ ) were derived by examining the adjusted  $R^2$  values for each model.

## Results

A total of 9 centre-based childcare facilities ( $n = 117$  preschoolers), 11 home-based childcare facilities ( $n = 31$  preschoolers), and 8 FDK schools ( $n = 149$  preschoolers) agreed to participate in the study. A total of 297 preschoolers participated in the current study, for a response rate for each type of early learning arrangement of 50%, 93%, and 29%, respectively. Only those children with valid physical activity data (i.e., 3 days with 5 hours or more) were included in the present analysis ( $n = 218$  children). The mean age of participants was 4.18 years ( $SD = 0.97$ ; 53.2% female).

Average daily accelerometer wear time was 406.21 minutes ( $SD = 53.75$ ). Of the centre- and home-based childcare facilities that had nap times scheduled, average daily naptime was measured (via accelerometers) at 73.17 minutes ( $SD = 44.29$ ). As per their curriculum, children attending FDK did not take naps. See Table 1 for complete demographic information.

**Preschoolers' physical activity levels across the different early learning environments.** Means and standard deviations of participants' hourly rates of MVPA and TPA are presented in Table 2. Male preschoolers accumulated statistically significantly more ( $t[216] = 4.11, p < .05, \eta^2 = 0.07$ ) TPA than their female counterparts; the difference in MVPA levels across the two sexes approached statistical significance ( $t[216] = 1.90, p = .06, \eta^2 = 0.02$ ). Results of the omnibus ANCOVA test indicated that type of early learning environment had a statistically significant effect on preschoolers' levels of MVPA ( $F[2, 215] = 62.76, p < .05, \eta^2_{\text{par}} = 0.06$ ) and TPA ( $F[2, 215] = 6.22, p < .05, \eta^2_{\text{par}} = 0.37$ ; Table 2). Post hoc analyses revealed that in comparison to FDK, levels of MVPA were found to be significantly lower among those attending home- ( $p < .05$ ) and centre-based ( $p < .05$ ) childcare. TPA levels were found to be significantly higher among children attending FDK versus those in centre-based childcare ( $p < .05$ ).

**EPAO physical activity subscales and MVPA.** The average EPAO physical activity subscale scores and Total PA Environment EPAO score for each type of early learning environment are presented in Table 3. Due to a lack of significant correlations among the Physical Activity Policy subscale scores, this variable was removed from the analyses for home-based childcare facilities and FDK for both MVPA and TPA.

Table 1.

*Preschooler and Family Demographic Information (n = 218)*

	<i>N</i>	<i>%</i>
Sex of Preschooler		
Male	102	46.8
Female	116	53.2
Type of Early Learning Environment		
Home-based childcare	20	9.2
Centre-based childcare	71	32.6
Full-Day Kindergarten	127	58.3
School/Childcare Status		
Part-time	23	10.5
Full-time	193	88.1
Preschooler's Racial Background		
Caucasian	176	80.6
African Canadian	1	0.3
Aboriginal	2	0.7
Arab	5	2.0
Latin American	2	1.0
Asian	10	4.0
Other	12	6.7
Highest Level of Parent/Guardian Education		
Secondary school	32	14.6
College	68	31.1
University	66	30.1
Graduate school	44	20.1
Approximate Yearly Household Income		
Less than \$20,000	14	6.4
\$20,000 - \$39,999	17	7.8
\$40,000 - \$59,999	20	9.1
\$60,000 - \$79,999	19	8.7
\$80,000 - \$99,999	28	12.8
\$100,000 - \$119,999	23	10.5
More than \$120,000	48	21.9

*Note.* Demographic information is reported for participants who provided sufficient physical activity data (i.e., a minimum of 3 valid days, with 5 hours of data/day). All values shown may not add up to 100% or  $n = 218$  as some individuals chose not to answer certain questions.

Table 2.

*Means (Standard Deviations) of Preschoolers' Physical Activity Levels in Minutes Per Hour by Early Learning Environment Type*

Physical Activity Intensity	Centre-Based Childcare		Home-Based Childcare		Full-Day Kindergarten	
	<i>M (SD)</i>	95% CI	<i>M (SD)</i>	95% CI	<i>M(SD)</i>	95% CI
MVPA	1.58 (.74) <sup>±</sup>	[1.40, 1.75]	1.75 (.96)	[1.31, 2.20]	3.33 (1.30)	[3.10, 3.56]
TPA	18.36 (3.39) <sup>±</sup>	[17.55, 19.16]	19.28 (6.34) <sup>∞</sup>	[16.32, 22.25]	20.31 (3.85)	[19.71, 20.10]

*Note.* CI = confidence interval; MVPA = moderate-to-vigorous physical activity; TPA = total physical activity (light, moderate and vigorous combined). <sup>±</sup> = significant difference in physical activity levels between centre-based childcare and FDK ( $p < .05$ ); <sup>∞</sup> = significant difference in physical activity levels between home-based childcare and FDK ( $p < .05$ ).

Table 3.

*Mean (Standard Deviation) Physical Activity Subscale Scores and Total Physical Activity EPAO Score for Participating Early Learning Environments*

EPAO Physical Activity Subscales	Centres	95% CI [lower bound, upper bound]	Homes	95% CI [lower bound, upper bound]	FDK	95% CI [lower bound, upper bound]
Active Opportunities	12.63 (5.00)	[11.47, 13.79]	8.83 (5.21)	[6.54, 11.12]	14.09 (3.37)	[13.5, 14.68]
Sedentary Opportunities	13.33 (2.52)	[12.57, 13.92]	12.83 (4.49)	[10.86, 14.80]	8.90 (4.37)	[8.14, 9.66]
Sedentary Environment	8.36 (3.69)	[7.5, 9.22]	7.00 (3.40)	[5.51, 8.40]	3.89 (3.30)	[3.32, 4.46]
Portable Play Environment	17.26 (1.70)	[16.86, 17.66]	16.00 (4.29)	[14.12, 17.88]	12.67 (2.21)	[12.29, 13.05]
Fixed Play Environment	12.99 (1.82)	[12.57, 13.41]	10.81 (3.25)	[9.39, 12.23]	11.88 (1.38)	[11.64, 12.12]
Staff Behaviours	14.59 (6.24)	[13.14, 16.04]	15.60 (4.28)	[13.72, 17.48]	14.52 (4.93)	[13.66, 15.38]
Physical Activity Training & Education	3.17 (5.07)	[2.57, 3.77]	.50 (1.54)	[-0.17, 1.17]	7.17 (2.49)	[6.74, 7.6]
Physical Activity Policies	.14 (1.19)	[-0.14, 0.42]	.00 (.00)	--	10.00 (.00)	--
Total Physical Activity EPAO Score	10.39 (1.03)	[10.15, 10.63]	8.95 (1.12)	[8.46, 9.44]	10.28 (1.05)	[10.1, 10.46]

*Note.* All scores range from 0 to 20, with 20 suggesting a highly supportive environment with regard to physical activity; Total Physical Activity EPAO Score was calculated by averaging all physical activity subscales; CI = confidence interval; EPAO = Environment and Policy Assessment and Observation; FDK = Full-Day Kindergarten.

Direct entry linear regression analyses revealed that the model for centre-based childcare comprised of: Active Opportunities, Sedentary Opportunities, Sedentary Environment, Fixed Play Environment, Portable Play Environments, Staff Behaviours, Staff Training and Education and Physical Activity Policy. The model for home-based childcare and FDK comprised of: Active Opportunities, Sedentary Opportunities, Sedentary Environment, Fixed Play Environment, Portable Play Environments, Staff Behaviours, and Staff Training and Education.

As per the adjusted  $R^2$  estimates, it was found that 5.7%, 38.8%, and 23.8% of the variability in MVPA was accounted for by centre-based childcare, home-based childcare, and FDK respective models. Only the model for *FDK* was found to be statistically significant,  $F(7,119) = 12.42$ ,  $p < .05$ . Upon examination of the unique contribution of each variable to the model accounting for variation in MVPA within the FDK classrooms, it was found that the Active Opportunities (positive), Sedentary Opportunities (positive), Sedentary Environment (negative), and Fixed Play Environment (positive) subscales explained approximately 5.3%, 8.4%, 13.7%, and 5.8% of the variability, respectively. Within centre-based childcare, 9.0% of the variability of time spent in MVPA was accounted for by the Sedentary Environment subscale (negative), with the Physical Activity Training and Education subscale approaching statistical significance ( $p = .07$ ). See Table 4 for related statistics for each physical activity subscale included in these models.



Table 4.

*Summary of Coefficients, Confidence Intervals, t-Values, p-Values, and Correlations for the EPAO Physical Activity Subscales and Daily MVPA*

Environment Type	Physical Activity Subscale	B	95% CI [lower bound, upper bound]	t	p	Correlations	
						Zero-order	Partial
Home <sup>a</sup>	Active Opportunities	-.00	[-.15, .15]	-.05	.96	.19	.02
	Sedentary Opportunities	.06	[-.05, .17]	1.12	.29	.24	.31
	Sedentary Environment	-.07	[-.29, .15]	-.60	.56	.41	-.17
	Portable Play Environment	-.12	[-.47, .23]	-.67	.52	-.60	-.19
	Fixed Play Environment	.08	[-.02, .28]	.81	.44	.09	.23
	Staff Behaviours	-.09	[.15, -.33]	-.72	.49	-.58	-.20
	PA Training and Education	.09	[-.43, .61]	.34	.74	-.23	.10
	PA Policy	---	---	---	---	---	---
	Centre <sup>b</sup>	Active Opportunities	-.01	[-.06, .04]	-.39	.70	-.18
	Sedentary Opportunities	.09	[-.02, .20]	1.50	.14	.04	.19
	Sedentary Environment	-.09	[-.16, -.02]	-2.46	.02*	-.04	-.30
	Portable Play Environment	.00	[-.17, .17]	.05	.96	-.16	.01
	Fixed Play Environment	.08	[-.06, .22]	1.13	.26	.15	.14
	Staff Behaviours	-.04	[-.10, .03]	-1.10	.27	.20	-.14
	PA Training and Education	-.09	[-.018, .00]	-1.82	.07	-.26	-.23
	PA Policy	.09	[-.10, .28]	.92	.36	.02	.12
FDK <sup>c</sup>	Active Opportunities	.12	[.03, .21]	2.59	.01*	.53	.23
	Sedentary Opportunities	.07	[.03, .11]	3.35	.00*	.11	.29
	Sedentary Environment	-.19	[-.27, -.11]	-4.35	.00*	-.48	-.37
	Portable Play Environment	-.01	[-.11, .09]	-.22	.82	.32	-.02
	Fixed play	.23	[.07, .39]	2.74	.01*	.04	.24

Environment						
Staff Behaviours	-.01	[-.06, .04]	-.32	.75	.35	-.03
PA Training and Education	-.03	[-.12, .06]	-.60	.60	-.16	-.06
PA Policy	---	---	---	---	---	---

*Note.* Physical activity presented as a daily rate (mins/day); <sup>a</sup>Model accounts for 38.8% of the variability in MVPA; <sup>b</sup>Model accounts for 5.7% of the variability in MVPA; <sup>c</sup>Model accounts for 23.8% of the variability in MVPA; CI = confidence interval; PA = physical activity; EPAO = Environment and Policy Assessment and Observation; FDK = Full-Day Kindergarten; PA = physical activity; \* = significant subscale ( $p < .05$ ). There are no values for the PA Policy subscale for: home-based childcare because these facilities did not have any activity-specific policies, and FDK classrooms because it was considered a constant in some cases.

**EPAO physical activity subscales and TPA.** Based on direct entry linear regression analyses, the model for *centre-based childcare* comprised of: Active Opportunities, Sedentary Opportunities, Sedentary Environment, Fixed Play Environment, Portable Play Environments, Staff Behaviours, Staff Training and Education, and Physical Activity Policy. The model for home-based childcare and *FDK* was comprised of: Active Opportunities, Sedentary Opportunities, Sedentary Environment, Fixed Play Environment, Portable Play Environments, Staff Behaviours, and Staff Training and Education. Adjusted  $R^2$  estimates suggested that 8.0%, 14.0%, and 31.0% of the variability in TPA was accounted for by centre-based childcare, home-based childcare, and FDK models, respectively. Only the model for *FDK* was statistically significant,  $F(7,119) = 3.92, p < .05$ . Upon reviewing the unique contribution of each variable on TPA within the FDK classrooms, it was found that the Active Opportunities (negative), Sedentary Opportunities (positive), Sedentary Environment (negative), and Fixed Play Environment subscales explained approximately 3.6%, 5.8%, 13.7%, and 8.4% of the variability, respectively. Within centre-based childcare, 6.3% of the variability of time spent in TPA was accounted for by the Sedentary Environment subscale (positive). Related statistics for each physical activity subscale included in these models are presented in Table 5.

**Total physical activity environment EPAO score and MVPA and TPA.** By exploring time spent in MVPA and TPA and the Total Physical Activity Environment EPAO score for each environment type, again, direct entry regression analyses were completed. The 2.0% ( $\text{adj } R^2 = -.020$ ), 0.4% ( $\text{adj } R^2 = .004$ ), and 18.0% ( $\text{adj } R^2 = .180$ ) of the variability seen in MVPA was accounted for by home-based childcare, centre-based

Table 5.

*Summary of Coefficients, Confidence Intervals, t-Values, p-Values, and Correlations for the EPAO Physical Activity Subscales and Daily Total Physical Activity (TPA)*

Environment Type	Physical Activity Subscale	B	95% CI [lower bound, upper bound]	t	p	Correlations	
						Zero-order	Partial
Home <sup>a</sup>	Active Opportunities	-.06	[-.99, .87]	-.13	.90	.15	-.04
	Sedentary Opportunities	.43	[-.24, 1.1]	1.26	.23	.16	.34
	Sedentary Environment	-1.02	[-2.4, .36]	-1.45	.17	.28	-.39
	Portable Play Environment	-.29	[-2.53, 1.95]	-.25	.81	-.59	-.07
	Fixed Play Environment	.02	[-1.25, 1.29]	.03	.98	-.16	.01
	Staff Behaviours	-1.37	[-2.91, .17]	-1.75	.11	-.62	-.45
	PA Training and Education	.31	[-3.0, 3.62]	.19	.86	-.16	.05
	PA Policy	---	---	---	---	---	---
	TPA						
Centre <sup>b</sup>	Active Opportunities	-.14	[-.35, .07]	-1.26	.21	-.22	-.16
	Sedentary Opportunities	.53	[.02, 1.04]	2.05	.04*	.25	.25
	Sedentary Environment	-.25	[-.59, .09]	-1.48	.14	.01	-.19
	Portable Play Environment	-.55	[-.21, .21]	-1.42	.16	-.21	-.18
	Fixed Play Environment	.47	[-.15, 1.09]	1.47	.15	.05	.18
	Staff Behaviours	-.06	[-.34, .22]	-.41	.67	.22	-.05
	PA Training and Education	-.01	[-.43, 0.41]	-.03	.98	-.19	-.00
	PA Policy	.14	[-.71, .99]	.32	.75	-.04	.04
	TPA						
FDK <sup>c</sup>	Active Opportunities	-.31	[-.60, -.02]	-2.11	.04*	-.09	-.19
	Sedentary Opportunities	.16	[.06, .32]	2.75	.01*	.16	.24
	Sedentary Environment	-.57	[-.84, -.30]	-4.19	.00*	-.17	-.36
	Portable Play Environment	-.06	[-.37, .26]	-.35	.73	.03	-.03
	Fixed Play	.86	[.34, 1.38]	3.26	.00*	.10	.29

Environment						
Staff Behaviours	-.05	[-.20, .10]	-.69	.50	.03	-.06
PA Training and Education	-.05	[-.35, .25]	-.32	.75	.16	-.03
PA Policy	---	---	---	---	---	---

*Note.* Physical activity presented as a daily rate (mins/day); <sup>a</sup>Model accounts for 31% of the variability in TPA; <sup>b</sup>Model accounts for 8% of the variability in TPA; <sup>c</sup>Model accounts for 14.0% of the variability in TPA; CI = confidence interval; PA = physical activity; EPAO = Environment and Policy Assessment and Observation; FDK = Full-Day Kindergarten; PA = physical activity; \* = significant subscale ( $p < .05$ ). There are no values for the PA Policy subscale for: home-based childcare because these facilities did not have any activity-specific policies, and FDK classrooms because it was considered a constant in some cases.

childcare, and FDK respective models. Only the FDK model was statistically significant,  $F(1,125) = 28.66, p < .05$ . In the case of TPA; 11.0% (adj  $R^2 = .110$ ), 1.1% (adj  $R^2 = -.011$ ), and 0.10% (adj  $R^2 = .001$ ) of the variability in TPA was accounted for by home-based childcare, centre-based childcare, and FDK models, respectively. No models were statistically significant. See Table 6 for statistics pertaining to the Total physical activity Environment EPAO score.

### **Discussion**

The purpose of this study was to compare the physical activity levels of preschoolers attending three different early learning environments: centre-based childcare, home-based childcare, and FDK. An additional purpose was to assess which attributes of these environments (e.g., play equipment, policies, staff behaviour and training, outdoor play periods, sedentary behaviours, etc.) impact preschoolers' physical activity.

Low levels of MVPA were accumulated by the preschoolers regardless of the type of early learning environment attended. These findings were similar, albeit slightly lower, to those reported in studies by Vanderloo et al. (2014; centre-based childcare) and Temple et al. (2009; home-based childcare). Despite the low levels of MVPA observed during the week of data collection, participants accumulated high levels of TPA. Similar rates were observed in the Vanderloo et al. (2014) and Temple et al. (2009) studies, wherein approximately 17.42 and 20.51 mins/hr of TPA were accumulated among their preschool-aged samples, respectively.

Preschoolers in the current study who were enrolled in FDK classrooms accumulated significantly more MVPA than those attending centre-based childcare

Table 6.

*Summary of Coefficient, Confidence Interval, t-Values, p-Values, and Partial Correlations for Total Physical Activity EPAO Score and MVPA and TPA*

	Environment Type	B	95% CI [lower bound, upper bound]	t	p	Correlations	
						Zero-order	Partial
MVPA	Centre <sup>a</sup>	-.07	[-.24, .10]	-.87	.39	-.10	-.10
	Home <sup>b</sup>	-.16	[-.55, .23]	-.79	.44	-.18	-.18
	FDK <sup>c</sup>	.54	[.34, .74]	5.35	.00*	.43	.43
TPA	Centre <sup>d</sup>	-.19	[-.96, .58]	-.49	.62	-.06	-.06
	Home <sup>e</sup>	-2.24	[-4.64, 0.16]	-1.83	.08	-.40	-.40
	FDK <sup>f</sup>	.31	[-.26, .88]	1.06	.29	.10	.10

*Note.* <sup>a</sup>Model accounts for 2.0% of the variability in MVPA; <sup>b</sup>Model accounts for 0.4% of the variability in MVPA; <sup>c</sup>Model accounts for 18.0% of the variability in MVPA; <sup>d</sup>Model accounts for 1.1% of the variability in TPA; <sup>e</sup>Model accounts for 11.0% of the variability in TPA; <sup>f</sup>Model accounts for 0.1% of the variability in TPA; CI = confidence interval; EPAO = Environment and Policy Assessment and Observation; FDK = Full-Day Kindergarten; \* = significant ( $p < .05$ ).

facilities, and significantly more TPA than children attending both centre- and home-based childcare facilities. One explanation for these differences could be the fact that preschoolers attending FDK do not take a nap (or have designated “quiet periods”) during the day; therefore, affording additional time to be active (the average nap time for preschoolers attending centre- and home-based childcare in this study was 73 minutes as measured via the accelerometers). An additional explanation could be a result of the newly revised FDK curriculum which specifically targets ‘health and physical activity’ therein (Ontario Ministry of Education, 2010). In fact, this curriculum aims to assist teachers and early childhood educators in increasing children’s health literacy and improving gross and fine motor movement via play-based learning (Ontario Ministry of Education, 2010).

Perhaps the most surprising finding was that, with the exception of the Sedentary Environment subscale (which was found to be statistically significant within centre-based facilities), the EPAO physical activity subscales did not significantly impact the physical activity levels of preschoolers in centre- or home-based childcare. This finding contradicts previous research, even among preschoolers in centre-based childcare in the same city, which found the Fixed Play Environment (inverse relationship) and Portable Play Environment subscales to be significantly supportive of MVPA levels (Vanderloo et al., 2014). However, specific to the individual EPAO physical activity subscales and centre-based care, and similar to Bower et al.’s (2008) findings, a significant inverse relationship was noted between this particular setting and the Sedentary Environment subscale. This suggests that the more items in the centre that promote sedentary behaviours (e.g., TVs and video game consoles), the less active the children will be (for



both MVPA and TPA). Also of note is the inverse relationship observed between the Physical Activity Training & Education subscale and time spent by preschoolers in physical activity; although only approaching significance, this finding stands in contrast to the majority of literature which suggests that the more educated and trained a teacher/childcare provider is with regard physical activity, the more active the children under their care will be (O'Connor & Temple, 2005). Given that the EPAO tool was not designed for home-based childcare, it is not surprising that no significant relationships were observed between the subscales and physical activity in these settings. Further, in comparison to FDK and centre-based childcare, home-based childcare venues differ dramatically in space, resources, and regulations (typically having less; Tandon, Garrison, & Christakis, 2012).

Only the model for FDK was found to be significant with regard to time preschoolers spent in MVPA and TPA. Specifically, the Active Opportunities, Sedentary Opportunities, Sedentary Environment, and Fixed Play Environment subscales were significantly related to both MVPA and TPA. Because these models were significant for FDK only, the following sections will focus solely on the subscales which impacted physical activity within this particular environment.

Perhaps the most counter-intuitive finding relates to the discovery of a positive relationship between the Sedentary Opportunities subscale and physical activity levels in FDK; our results would suggest that having more opportunities available for children to engage in activities that discourage active behaviours (e.g., sitting for more than 30 minutes, watching TV, playing computer/video games) is positively associated with physical activity among preschool-aged children. While it is unclear why this relationship

was found, one possible explanation could be that while the preschoolers in FDK have more curriculum to cover (which likely entails more sitting), it is possible that when occasions to be active arise (e.g., recess, physical education classes), the children take advantage of these gross motor opportunities. This finding could also be a result of the increased use of technology (which by nature, tend to be more sedentary) for educational purposes (Christakis & Garrison, 2009). Not surprising, however, was the inverse relationship found between the Sedentary Environment subscale and time spent in physical activity by preschoolers in FDK; the more items present in the classroom that discourage physical activity (e.g., television and/or computer present in the classroom), the less active the preschool sample. Interestingly, similar results have been noted among preschoolers in both centre- and home-based childcare as well (Taverno Ross, Dowda, Saunders, & Pate, 2013; Vanderloo et al., 2014). In an attempt to minimize sitting among preschoolers during hours spent in FDK, efforts should be made to limit and/or remove sedentary-inducing items, like TVs and computers, from the classroom.

Finally, it is noteworthy that preschoolers enrolled in FDK accumulated higher levels of physical activity when provided with fixed play equipment (e.g., climbers and slides). Given some high-level similarities between the FDK and centre-based childcare environments (i.e., both taking place in a structured setting), the authors anticipated finding an inverse relationship between fixed play equipment and preschoolers' activity levels within the FDK environment, as was the case in two previous studies focused on centre-based childcare (Bower et al., 2008; Vanderloo et al., 2014). One possible explanation for this study's unique finding is that the children in FDK tended to occupy the higher end of the preschool-age range, and may have therefore, required less

supervision and assistance in climbing/playing on these fixed structures as a result of their improved gross motor control. Another reason could be that, unlike children in centre-based childcare, preschoolers in FDK may not have had access to large amounts of portable play equipment (items typically reserved for physical education classes) while outdoors, and therefore, relied more heavily on fixed play equipment to entertain themselves and/or play games with peers during outdoor play periods.

The Total Physical Activity Environment EPAO Scores for centre-based childcare, home-based childcare, and FDK facilities were 10.39, to 8.95, to 10.28, respectively. Out of a possible score of 20 where higher scores indicate more supportive venues, these numbers suggest that the facilities participating in this study did not particularly encourage physical activity among young children. These findings are discouraging given the long duration preschoolers spend in these facilities (Goldfield et al., 2012), coupled with the strong influence of this particular setting on the activity levels of this group (Pate et al., 2004). In light of the fact that the EPAO tool was created for centre-based facilities only, there is no other available research to compare the results from the present study for FDK classrooms and home-based childcare facilities (however, no tool is currently available for these specific settings). In the case of centre-based childcare, the current study's findings align closely with the EPAO score of 10.15 found by Bower and colleagues (2008), and were higher than the 8.33 found in the pilot study by Vanderloo et al. (2014). Overall, these low scores highlight the need for novel programs that better support preschoolers' activity behaviours.

The regression analyses conducted between the Total Physical Activity EPAO Score and MVPA suggested that only the model for FDK was statistically significant.

This was unexpected given that the tool was not created for this environment, and considering previous research that has identified a significant impact of the total EPAO score on preschoolers' activity in centre-based childcare (Vanderloo et al., 2014). With regard to the Total Physical Activity EPAO Score and TPA, all models for the included environment types failed to achieve significance. Similar to the case of MVPA, this finding may not be surprising given that none of the individual physical activity subscales (as they related to time spent in TPA) were found to be significantly different among the three environments. In light of the newly released guidelines that recommend that children in early years should strive for 180 minutes of daily physical activity at *any* intensity (CSEP, 2012), it may prove worthwhile for early learning specialists and public health officials to modify these particular environments to better support physical activity among preschoolers.

The primary limitation of this study was the use of the EPAO tool for the FDK and home-based childcare environment. Traditionally developed and validated for use in centre-based childcare settings (Ball et al., 2005; Ward et al., 2008), it is possible that this tool may not have accurately captured the physical activity environment in the other environments. As a result of the challenges in recruiting home-based childcare facilities, only a small sample of this type of facility (and subsequently preschoolers enrolled in this form of care) was incorporated in the present study. Despite the finding of homogeneous variances between groups, the differential study response rates (notably the low response rate among the FDK group) may also be of concern and may impact the interpretation the results. Further, while many of the noted associations were found in the FDK environment, this may be attributed to power as this setting accounted for a large

proportion of the preschool participants. These issues may have limited the strength of the present study's findings with regard to the comparisons made across various early learning environments. Lastly, given that teachers and childcare staff were responsible for recording the on/off times of the accelerometers (i.e., when the children were fitted with the devices and when they were removed prior to departure), it is possible that some instances of inaccurate and/or under-reporting may have occurred.

This was the first study to compare the objectively measured physical activity levels of preschoolers attending three different early learning environments. Findings highlight the ongoing need for improving the activity levels of preschoolers in these environments to ensure this population is achieving the daily recommended physical activity. Early years stakeholders and health promotion specialists may be able to leverage this increased understanding of the variation that exists in preschoolers' activity levels in the development of interventions that are tailored to the childcare environment.

## References

- Alhassan, S., Sirars, J. R., & Robinson, T. N. (2007). The effects of increasing outdoor play time on physical activity in Latino preschool children. *International Journal of Pediatric Obesity*, 2, 153-158. doi: 10.1080/17477160701520108
- Ball, S. C., Benjamin, S. E., Hales, D. P., Marks, J., McWilliams, C. P., & Ward, D. S. (2005). *The Environment and Policy Assessment and Observation (EPAO) child care nutrition and physical activity instrument*. Chapel Hill, NC: Centre for Health Promotion and Disease Prevention, University of North Carolina at Chapel Hill.
- Benjamin, S. E., Ammerman, A., Sommers, J., Dodds, J., Neelon, B., & Ward, D. S. (2007). Nutrition and physical activity self-assessment for child care (NAP SACC): Results from a pilot intervention. *Journal of Nutrition Education and Behavior*, 39, 142-149. doi:10.1016/j.jneb.2006.08.027
- Bower, J. K., Hales, D. P., Tate, D. F., Rubin, D. A., Benjamin, S. E., & Ward, D. S. (2008). The childcare environment and children's physical activity. *Journal of Preventive Medicine*, 34(1), 23-29. doi: 10.1016/j.amepre.2007.09.022
- Brown, W. H., Pfeiffer, K. A., McIver, K. L., Dowda, M., Addy, C. L., & Pate, R. R. (2009). Social and environmental factors associated with preschoolers' nonsedentary physical activity. *Child Development*, 80(1), 45-58. doi: 10.1111/j.1467-8624.2008.01245.x
- Canadian Society of Exercise Physiology. (2012). Canadian Physical Activity Guidelines for the Early Years: 0-4 years. Retrieved from <http://www.csep.ca/CMFiles/Guidelines/CSEP-InfoSheets-early-years-ENG.pdf>

- Christakis, D. A. & Garrison, M. M. (2009). Preschool-aged children's television viewing in child care settings. *Pediatrics*, *124*, 1627-1632. doi:10.1542/peds.2009-0862
- Cliff, D. P., Okely, A. D., Smith, L. M., & McKeen, K. (2009). Relationships between fundamental movement skills and objectively measured physical activity in preschool children. *Pediatric Exercise Science*, *21*, 436-449. doi: 10.1016/j.jsams.2008.10.008
- Colley, R. C., Connor Gorber, S., & Tremblay, M. S. (2010). Quality control and data reduction procedures for accelerometry-derived measures of physical activity (Statistics Canada Catalogue no. 82-003-X). *Health Reports*, *21*, 1-8.
- Colley, R. C., Garriguet, D., Adamo, K. B., Carson, V., Janssen, I., Timmons, B. W., & Tremblay, M. S. (2014). Physical activity and sedentary behavior during the early years in Canada: A cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity*, *10*, 54. doi:10.1186/1479-5868-10-54.
- Colley, R. C., Harvey, A., Grattan, K., & Adamo, K. B. (2014). Impact of accelerometer epoch length on physical activity and sedentary behaviour outcomes for preschool-aged children (Statistics Canada, Catalogue no. 82-003-X). *Health Reports*, *25*, 3-9.
- Dowda, M., Pate, R. R., Trost, S. G., Almeida, M. J. C., & Sirard, J. R. (2004). Influences of preschool policies and practices on children's physical activity. *Journal of Community Health*, *29*, 183-196. doi: 10.1023/B:JOHE.0000022025.77294.af
- Geoffroy, M. C., Power, C., Touchette, E., Dubois, L., Boivin, M., Seguin, J. R. et al. (2012). Childcare and overweight or obesity over 10 years of follow-up. *The Journal of Pediatrics*, *162*, 753-758. doi: 10.1016/j.jpeds.2012.09.026.

- Goldfield, G. S., Harvey, A., Grattan, K., & Adamo, K. B. (2012). Physical activity promotion in the preschool years: A critical period to intervene. *International Journal of Environmental Research and Public Health*, *9*, 1326-1342. doi: 10.3390/ijerph9041326
- Gordon, E. S., Tucker, P., Burke, S. M., & Carron, A. V. (2013). Effectiveness of physical activity interventions for preschoolers: A meta-analysis. *Research Quarterly for Exercise and Sport*, *84*, 287-294. Retrieved from <http://www.aahperd.org/rc/publications/rqes/>
- Gubbels, J., Van Kann, D. H. H., & Jansen, M. W. J. (2012). Play equipment, physical activity opportunities, and children's activity levels at childcare. *Journal of Environmental and Public Health*, *2012*, 8. doi: 10.1155/2012/326520
- Gunter, K. B., Rice, K. R., Ward, D. S., & Trost, S. G. (2012). Factors associated with physical activity in children attending family child care homes. *Preventive Medicine*, *54*, 131-133. doi: 10.1016/j.ypmed.2011.12.002
- Konstabel, K., Veidebaum, T., Verbestel, V., Moreno, L. A., Bammann, K., Tornaritis, M. et al. (2014). Objectively measured physical activity in European children: The IDEFICS study. *International Journal of Obesity*, *38*, S135-S143. doi:10.1038/ijo.2014.144
- Lawlis, T., Mikhailovich, K., & Morrison, P. (2009). Physical activity programs in long day care and family day care settings. *Australasian Journal of Early Childhood*, *33*(2), 27-31. Retrieved from [http://www.earlychildhoodaustralia.org.au/australian\\_journal\\_of\\_early\\_childhood.html](http://www.earlychildhoodaustralia.org.au/australian_journal_of_early_childhood.html)



- Malina, R. M. (2001). Physical activity and fitness: Pathways from childhood to adulthood. *American Journal of Human Biology, 13*(2), 162-172. doi: 10.1002/1520-6300(200102/03)
- O'Connor, J. P. & Temple, V. A. (2005). Constraints and facilitators for physical activity in family day care. *Australian Journal of Early Childhood, 30*(4), 1-9. Retrieved from [http://www.earlychildhoodaustralia.org.au/australian\\_journal\\_of\\_early\\_childhood](http://www.earlychildhoodaustralia.org.au/australian_journal_of_early_childhood)
- Ontario Ministry of Education. (2010). *Backgrounder: The full-day early learning kindergarten program*. Retrieved from <http://www.edu.gov.on.ca/eng/document/nr/10.01/bg0112.html>
- Pate, R. R., Pfeiffer, K. A., Trost, S. G., Ziegler, P., & Dowda, M. (2004). Physical activity among children attending preschools. *Pediatrics, 114*, 1258-1263. doi: 10.1542/peds.2003-1088-L
- Pfeiffer, K. A., McIver, K. L., Dowda, M., Almeida, M. J. C., & Pate, R. R. (2006). Validation and calibration of the Actical accelerometer in preschool children. *Medicine and Science in Sports and Exercise, 38*, 125-157. doi:10.1249/01.mss.0000183219.44127.e7
- Salmon, J., Timperio, A., Cleland, V., & Venn, A. (2005). Trends in children's physical activity and weight status in high and low socio-economic status areas of Melbourne, Victoria, 1985-2001. *Australian and New Zealand Journal of Public Health, 29*(4), 337-342. doi: 10.1111/j.1467-842X.2005.tb00204.x

- Tandon, P. S., Garrison, M. M., & Christakis, D. A. (2012). Physical activity and beverages in home- and centre-based child care program. *Journal of Nutrition Education and Behavior, 44*(4), 355-358. doi: 10.1016/j.jneb.2011.10.009
- Taverno Ross, S., Dowda, M., Saunders, R., & Pate, R. (2013). Double dose: the cumulative effect of TV viewing at home and in preschool on children's activity patterns and weight status. *Pediatric Exercise Science, 25*, 262-272. Retrieved from <http://journals.humankinetics.com/pes>
- Taylor, R. W., Murdoch, L., Carter, P., Gerrard, D. F., Williams, S. M., & Taylor, B. J. (2009). Longitudinal study of physical activity and inactivity in preschoolers: The FLAME study. *Medicine & Science in Sports & Exercise, 41*(1), 96-102. doi: 10.1249/MS.0b013e3181849d81
- Temple, V. A., Naylor, P. J., Rhodes, R. E., & Wharf Higgins, J. (2009). Physical activity of children in family child care. *Applied Physiology of Nutrition and Metabolism, 34*(4), 794-798. doi: 10.1139/H09-061
- Timmons, B. W., Naylor, P. J., & Pfeiffer, K. A. (2007). Physical activity for preschool children - How much and how? *Canadian Journal of Public Health, 98*(2), S122-S134. doi: 10.1139/H07-112
- Tucker, P., Vanderloo, L., Newnham-Kanas, C., Burke, S. M., Irwin, J. D., Johnson, A. M. et al. (2013). Learning Environments' Activity Potential for Preschoolers (LEAPP): Study rationale and design. *Journal of Public Health Research, 2*, 113-117. doi:10.4081/jphr.2013.e19
- Van Cauwenberghe, E., Labarque, V., Gubbels, J., De Bourdeaudhuij, I., & Cardon, G. (2012). Preschooler's physical activity levels and associations with lesson context,

teacher's behavior, and environment during preschool physical education. *Early Childhood Research Quarterly*, 27, 221-230. doi: 10.1016/j.ecresq.2011.09.007

Vanderloo, L. M., Tucker, P., Johnson, A. M., Van Zandvoort, M. M., Burke, S. M., & Irwin, J. D. (2014). The Influence of Centre-Based Childcare on Preschoolers' Physical Activity Levels: A Cross-Sectional Study. *International Journal of Environmental Research and Public Health*, 11, 1794-1802.

doi:10.3390/ijerph110201794

Vanderloo, L. M., Tucker, P., Ismail, A., & Van Zandvoort, M. M. (2012). Physical activity opportunities in Canadian childcare facilities: A provincial/territorial review of legislation. *Journal of Physical Activity and Health*, 9, 461-472. Retrieved from <http://journals.humankinetics.com/jpah>

Ward, D., Hales, D., Haverly, K., Marks, J., Benjamin, S., Ball, S. et al. (2008). An instrument to assess the obesogenic environment of child care centres. *American Journal of Health Behavior*, 32(4), 380-386. Retrieved from <http://www.ajhb.org/>

**CHAPTER 4****Comparing the Actical and ActiGraph Approach to Measuring Young Children's Physical Activity Levels and Sedentary Time<sup>‡</sup>**

Physical activity plays a crucial role in optimizing young children's health including the affordance of many physiological (Barnett, van Beurden, Morgan, Brooks, & Beard, 2009; Marcus et al., 2010; Timmons, Naylor, & Pfeiffer, 2007; Timmons, et al., 2012) and psychosocial benefits (Timmons et al., 2007; 2012). Similarly, high levels of sedentary behaviours have been linked to increased adiposity and decreased cognitive development and psychosocial health (Leblanc et al., 2012). Because children form many health habits early in life (Goldfield, Harvey, Grattan, & Adamo, 2012; Reilly, 2008), it is important that active behaviours are established among young children, and that sedentary behaviours minimized wherever possible. In light of the growing body of research focusing on preschoolers' physical activity levels and sedentary time (Hinkley, Salmon, Okely, Crawford, & Hesketh, 2012; Hinkley, Salmon, Okely, Hesketh, & Crawford, 2012; Hinkley, Hinkley Salmon, Okely, & Trost, 2010; Leblanc et al., 2012; Obeid, Nguyen, & Gabel, 2011; Reilly, 2008; Temple, Naylor, Rhodes, & Wharf Higgins, 2009; Timmons et al., 2010; Timmons et al., 2012; Tucker, 2008; Tucker & Irwin, 2008; Tucker, Vanderloo, Newnham-Kanas, Burke, Irwin, Johnson, & van Zandvoort, 2013; Vanderloo, et al., 2014), there appears to be mixed reviews concerning whether preschoolers are truly engaging in adequate levels of physical activity. In fact, some studies have purported that preschoolers are sufficiently active (Colley et al., 2013; Obeid et al., 2011) while others report that this group is insufficiently active (Hinkley et al., 2012, Hnatiuk, Salmon, Hinkley, Okely, & Trost, 2014; Tucker, 2008; Vale, Silva,

Santos, Soares-Miranda, & Mota, 2010) to meet current daily physical activity guidelines of 180 minutes (any intensity; Australian Government – Department of Health, 2010; CSEP, 2012; Department of Health: Physical Activity and Health Alliance, 2011). Such discrepancies in TPA levels could be attributed to a difference in tools used to assess these particular behaviours. Consequently, as a means of better comparing and understanding the differences in physical activity levels and sedentary time observed among this young cohort, additional exploration is warranted to ease the translatability of findings across multiple studies.

Accelerometers have been recognized as the gold standard for measuring physical activity among preschoolers (Cliff, Reilly, & Okely, 2009; Pfeiffer, McIver, Dowda, Almeida, & Pate, 2006). Actical™ (Bend, OR) and ActiGraph™ (Fort Walton Beach, FL) accelerometers are two of the most frequently used devices internationally (Troost, 2007), with the latter recently gaining more prominence in the literature (Cain, Sallis, Conway, Van Dyck, & Calhoun, 2013). Despite the growing popularity and appropriateness of these two accelerometers, the variation in data output and cut-points makes comparing preschoolers' physical activity levels and sedentary time challenging, and adds an additional layer of complexity to the already difficult task of quantifying children's physical activity levels (Troost, 2007). While a growing body of literature suggests that the physical activity levels of preschoolers vary dramatically across studies (Colley et al., 2013; Hinkley et al., 2012; Obeid et al., 2011; Pate, McIver, Dowda, Brown, & Addy, 2008; Pate, Pfeiffer, Troost, Ziegler, & Dowda, 2004; Rice & Torst, 2014; Temple et al., 2009; Vanderloo et al., 2014); such discrepancies *could* be attributed to the use of different accelerometers (Obeid et al., 2011). For instance, in two studies

comparing the physical activity levels of preschoolers in childcare, Temple et al. (2009; home-based) and Vanderloo et al. (2014; centre-based) reported that their samples accumulated approximately 1.76 ( $SD = 0.90$ ) mins/hr and 1.54 ( $SD = 1.41$ ) mins/hr of MVPA via Actical accelerometry, respectively. In comparison, a study by Gunter et al. (2012) which examined home-based childcare using ActiGraph accelerometers, found that preschoolers' achieved upwards of 9.48 ( $SD = 4.3$ ) mins/hr of MVPA. Consequently, the need to understand the comparability across data collected by these two devices is warranted (Cliff et al., 2009; Paul, Kramer, Moshfegh, Baer, & Rumpler, 2007; Straker & Campbell, 2012). Among adult populations, previous work by Paul et al. (2007; uniaxial ActiGraph) and Straker and Campbell (2012; triaxial ActiGraph) have compared Actical and ActiGraph activity monitors, along with creating translation equations (which underscored the linear relationship between the two devices, and thus the ability to convert between them). The findings from their papers both report more activity counts measured via the ActiGraph model, and note that the comparability between these devices is challenging. However, no studies to date have examined this measurement issue specific to the early year's population when using Actical and ActiGraph accelerometers. Exploring this population is important as young children (e.g., preschoolers) have very unique activity patterns which are characterized by sporadic and intermittent bouts of activity, with frequent rest periods (Oliver, Schofield, & Kolt, 2007). As such, exploring the utility and comparability of these two commonly used accelerometers with this young cohort is necessary. Doing so would increase researchers' ability to compare and interpret young children's physical activity levels and sedentary time across multiple studies and gather a more accurate depiction of these behaviours.

Further complicating the issue is the fact that different cut-points across the *same* device can produce varied physical activity levels and sedentary time. For example, with regard to MVPA, preschool-specific cut-points can range from  $> 287.5$  counts (Actical; Adolph et al., 2012), to  $> 420$  counts (ActiGraph; Pate et al., 2006), to  $\geq 585$  counts (ActiGraph; Van Cauwenberghe, Labarque, Trost, De Boudeaudhuij, & Cardon, 2010), to  $\geq 715$  counts (Actical; Pfeiffer et al., 2006), and even to  $\geq 891$  counts (ActiGraph; Sirard, Trost, Pfeiffer, Dowda, & Pate, 2005) per 15s epoch. The effect of different cut-points on activity levels was demonstrated in recent unpublished data by Rice (2012) which indicated that participating preschoolers' levels of MVPA (measured using ActiGraph accelerometers) was approximately 10.1 ( $SD = 4.2$ ) mins/hr when analyzed with Pate et al.'s cut-points (2006) but decreased to 5.8 ( $SD = 3.2$ ) mins/hr when analyzed with van Cauwenberghe et al. cut-points (Rice & Trost, 2014; Van Cauwenberghe et al., 2010). Also of note, differences in *how* accelerometers are calibrated may account for some of the variance in cut-points. However, research has been undertaken to try and minimize such effects by validating different devices using similar protocols. For instance, Pfeiffer et al.'s (2006) and Pate et al.'s (2006) cut-points for Actical and ActiGraph accelerometers, respectively, were both calibrated in a similar manner using  $VO_2$  measures, structured activities, and were cross-validated with unstructured activities. These calibration techniques endorsed both the Actical and ActiGraph accelerometer as a reliable and appropriate method for measuring physical activity among young children. Despite this, the ongoing challenge of deciding which cut-points to apply continues to make measuring physical activity problematic. Consequently, such limitations in

comparability between studies render it difficult to truly understand the prevalence of physical activity and sedentary time among young children.

As stated by Colley et al. (2013), the accurate measurement of young children's physical activity levels and sedentary time is required to not only ascertain any health-related linkages, but to establish the degree to which this particular cohort is meeting/missing newly released physical activity and sedentary behaviour guidelines. Consequently, in the interest of aiding researchers in comparing findings between studies and understanding the differences in measurement across devices, it is important to examine the variation in physical activity data collected and processed by the frequently used Actical and ActiGraph accelerometers. The ability to accurately measure, analyze, and contrast the activity levels and behaviours of young children (regardless of device used) is imperative to increasing the translation and usability of such data. And yet, despite the popularity and wide acceptance of accelerometers, the use of different devices, multiple cut-points, and various sampling intervals leads to grossly different estimates of physical activity levels and sedentary time. Moreover, given that cut-points are specific and solely appropriate for the devices for which they were validated, it is not only the associated accelerometers that need to be compared, but rather the accelerometers *with* their associated protocol.

Physical activity measurement should be viewed as a compendium, in that such data are not only measured by a particular device, but are currently also processed and analyzed specific to the device used. Accelerometers and their respective cut-points should be viewed as a 'package' or protocol to assessing and understanding activity levels. As such, the overarching purpose of this study was to compare two frequently



adopted measurement techniques undertaken to quantify young children's physical activity and sedentary time. Specifically, young children's physical activity and sedentary time were simultaneously measured using the Actical method (i.e., Actical accelerometer and Pfeiffer et al.'s cut-points) versus the ActiGraph method (i.e., ActiGraph accelerometer and Pate et al.'s cut-points) at both 15s and 60s epochs, and to explore possible differences between these two measurement approaches. The intent of this paper was not to compare the impact of applying standardized cut-points to physical activity data measured via two different devices, because in practice, researchers use cut-points that have been validated specifically for their respective devices.

Although Actical and ActiGraph are two of the most popular brands of accelerometers used during the early years, no study to date has compared these measurement approaches among young children. While both monitors have been validated using 15s epochs, exploring activity classification at a 60s epoch is also of interest as this will help determine whether differences in measuring young children's physical activity and sedentary time using two devices exist, and whether these differences remained true across various epoch lengths. The use of 60s epochs will also aid in increasing the generalizability of the present study's findings, as those who have measured preschoolers' activity levels at 60s [e.g., Canadian Health Measures Survey (CHMS) data] can consider this relationship when interpreting their own data.

## **Methods**

**Study design and recruitment.** To examine the physical activity levels and sedentary time of young children using two different measurement approaches (i.e., two brands of accelerometer and their respective cut-points), a cross-sectional study was

undertaken. Specifically, this study was carried out in conjunction with the Health Outcomes and Physical Activity in Preschoolers (HOPP) study; Canada's first longitudinal investigation to explore the relationship between physical activity and health in preschool-aged children (Timmons, Proudfoot, MacDonald, Bray, & Cairney, 2012). In partnership with Ontario Early Years Centres across Hamilton, a community-based recruitment strategy was used to enlist participants for the longitudinal investigation. Included in the present study was a convenience sample of a portion of HOPP participants (age 4 or 5 years) during one of their follow-up appointments. All study procedures and related documents were approved by the Hamilton Health Sciences Centre/Faculty of Health Sciences Research Ethics Board (Appendix N) and parents/guardians of participating children provided written informed consent for all data collection procedures (Appendix O).

**Tools.** Actical™ accelerometers (B series) are omnidirectional (Troost, 2007), and have demonstrated high specificity and sensitivity in estimating young children's activity intensities (Pfeiffer et al., 2006). Slightly smaller and lighter than the ActiGraph™ (28 mm x 27 mm x 10 mm; 17g), these devices detect movement across the 0.5-3 Hz range. In comparison, ActiGraph accelerometers are the most readily available monitor on the market (Troost, 2007), and have repeatedly exhibited high validity in measuring preschoolers' physical activity (Cliff et al., 2009; Pfeiffer, 2006; Sirard et al., 2005). The ActiGraph GT3X+ (38 mm x 37 mm x 18 mm; 27g) functions on a frequency range of 0.25-2.5 Hz.

**Data collection.** Data collection took place between July and August 2013 in Hamilton, Ontario and surrounding area. At their appointment, each participant was fit

with their assigned accelerometers; both the Actical and ActiGraph devices were placed side-by-side on the same elastic neoprene belt. Parents/guardians were instructed to place the accelerometers around their child's waist (i.e., right hip) upon waking in the morning, and to remove them prior to going to sleep, swimming, and bathing for seven consecutive days. All wear-time related information was recorded by the parents/guardians in a daily log (Appendix P). Participants' ages (based on date of birth) as well as their height and weight were measured by trained researchers at the appointment and recorded in a data sheet (Appendix Q). The children's height were measured using a Seca 214 "Road Rod" Portable stadiometer (recorded to nearest 0.1 cm) and their weights using a Tanita 700-TBF300GS Body Fat Analyzer digital scale (recorded to nearest 0.1 kg).

**Data analysis.** To allow for comparability with the Actical, raw ActiGraph data (which was recorded at 30Hz) were re-integrated into 15s and 60s epochs. In combination with the wear-time logs, *KineSoft* (version 3.3.67; KineSoft, Loughborough, UK) was used to conduct reliability analyses (for both Actical and ActiGraph data files) in an effort to determine the number of hours/days necessary to provide accurate activity data, and thus helped direct the inclusion of participants in the analysis. Parameters applied to the present data were: non-wear time was defined as 60 minutes of consecutive zeroes (Colley, Harvey, Grattan, & Adamo, 2014); 8 hours of wear time constituted a valid day; and participants with three or more valid days (i.e., at least two weekdays and one weekend day) were retained for analyses. Only children who met the inclusion parameters for both devices on the same days were retained for analyses.

Physical activity intensity and sedentary time were determined by the application of age-and device-appropriate cut-points. Using the *KineSoft* program, Actical data were

analyzed using Pfeiffer et al.' (2006) cut-points and ActiGraph data (vertical plane only) using Pate et al. (2006) cut-points. Specifics regarding the cut-points for sedentary time and LPA can be seen elsewhere [i.e., Temple et al. (2009) for Actical and Hnatiuk et al. (2014) for ActiGraph]. Given that both sets of cut-points are specific to 15s epochs, these thresholds were multiplied by four to allow for comparison with the 60s epoch. Based on the common use of these cut-points in the literature (Beets, Bornstein, Dowda, & Pate, 2011; Obeid et al., 2011; Pfeiffer et al., 2006; Temple et al., 2009; Vale et al., 2010; Vanderloo et al., 2014), combined with the fact that they were developed using similar (if not the exact same) techniques by the same lab group (Pate et al., 2006; Pfeiffer et al., 2006), the selection of Pfeiffer et al.'s and Pate et al.'s thresholds were thought to be the most appropriate in aiding investigators to compare research using both devices. While Pate et al.'s (2006) cut-points were originally validated for the MT1 ActiGraph, Robusto and Trost (2012) concluded in a recent paper that cut-points developed in the vertical axis of this model can be applied to data collected by the GT3X+ ActiGraph. See Table 1 for applied cut-points.

All data were analyzed in SPSS (version 22). Frequencies, means, and standard deviations were calculated to describe the sample. While both monitors were initiated to start collecting data at the same time, and were worn adjacently on the same belt, a slight "drift" in one of the device's internal clocks was noted following visual inspection [similar to Paul et al.'s (2007) work]. Consequently, data starting at the first full hour of the day until the last full hour of the day was examined. To account for participants' varied adherence to the measurement protocol; MVPA, TPA, and sedentary time were expressed as hourly rates. Percentage of monitoring time spent at the various intensity

levels were also calculated. Six paired *t*-tests were conducted to determine the differences in young children's MVPA, TPA, and sedentary time (mins/hr) measured using both devices, at 15s and 60s epochs. A Bonferonni correction was applied to control for multiple comparison bias and to maintain an experiment-wise alpha of .05; consequently, all effects were reported at a level of significance of .008. Bland-Altman plots were used to assess agreement between Acticals and ActiGraphs for MVPA, TPA, and sedentary time. The difference was set as Actical minus ActiGraph for each intensity. To examine the apparent systematic bias within plots A, B, and F (Figure 1), bivariate correlations between the values on the x-axis and the y-axis were undertaken.

Table 1

*Applied Preschooler-Specific Cut-Points for Actical and ActiGraph Accelerometers at 15s and 60s Epochs*

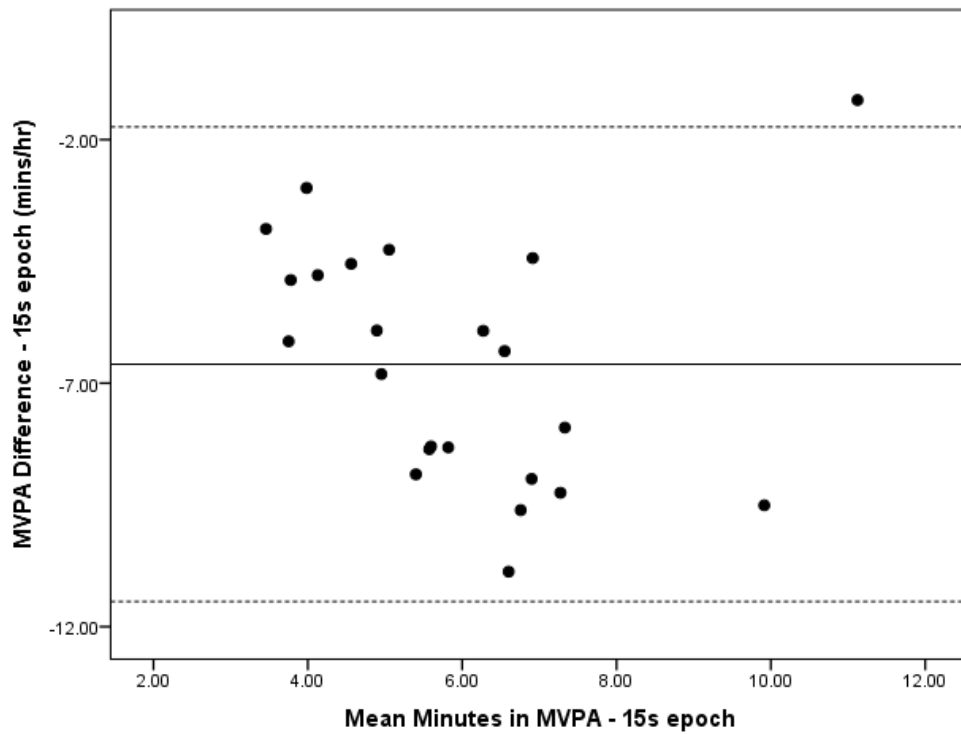
		Actical (Pfeiffer et al., 2006)			ActiGraph (Pate et al., 2006)		
		Sedentary	MVPA	TPA	Sedentary	MVPA	TPA
Epoch	15s	<50 counts	≥715 counts	≥50 counts	<38 counts	≥420 counts	≥38 counts
	60s	< 200 counts	≥ 2860 counts	≥ 200 counts	< 152 counts	≥ 1680 counts	≥ 152 counts

*Note.* MVPA = moderate-to-vigorous physical activity; TPA = total physical activity.

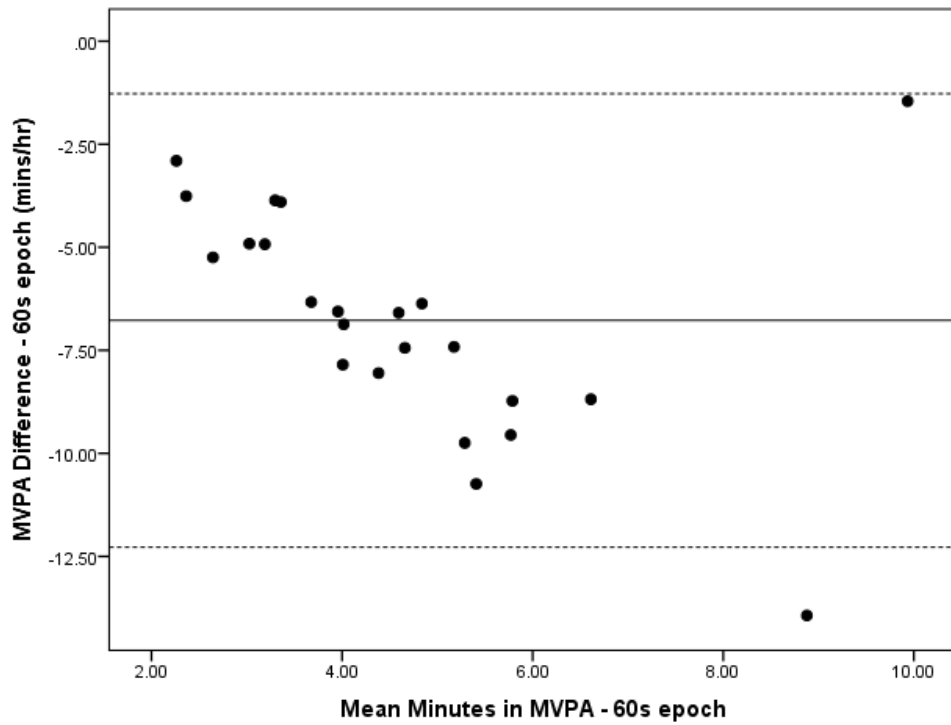
Figure 1

Bland-Altman plots showing differences in activity (mins/hr) between accelerometer protocols (Actical minus ActiGraph) plotted against mean activity rates for (A) MVPA with 15s epoch, (B) MVPA with 60s epochs, (C) TPA with 15s epochs, (D) TPA with 60s epochs, (E) sedentary time with 15s epochs, and (F) sedentary time with 60s epochs. Solid lines represent the mean difference (bias) and dashed lines the 95% limits of agreement. MVPA = moderate-to-vigorous physical activity; TPA = total physical activity.

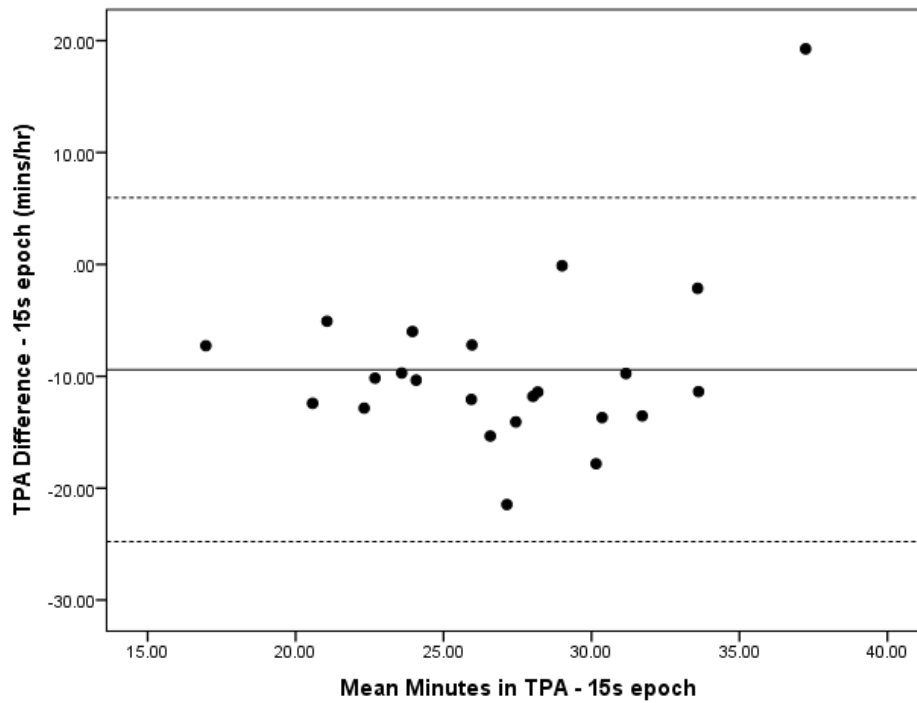
A



B

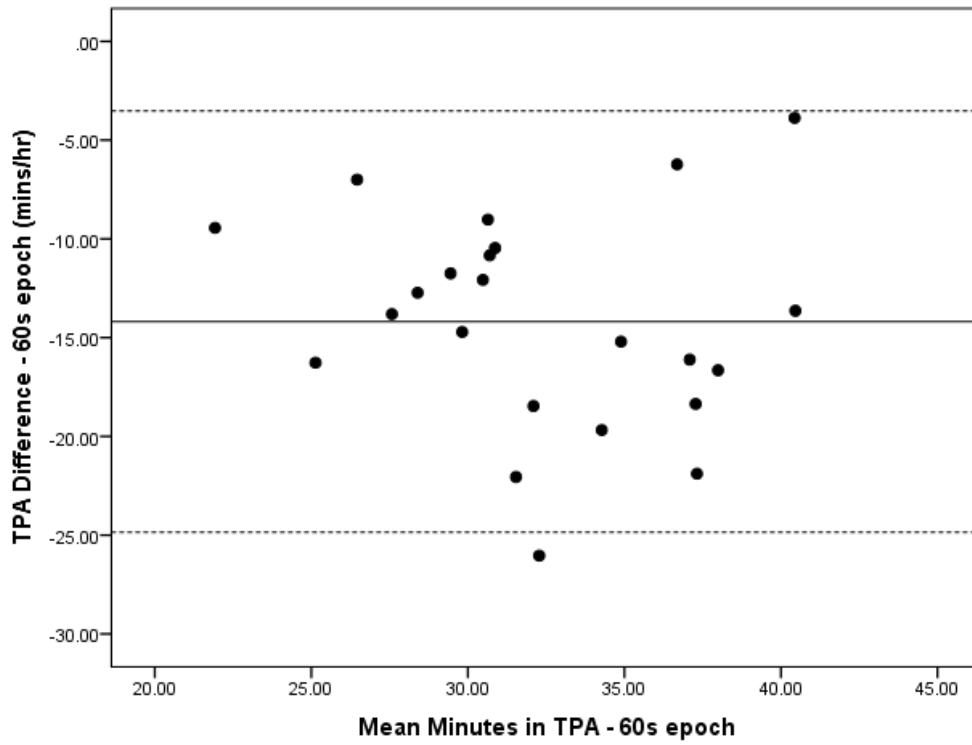


C

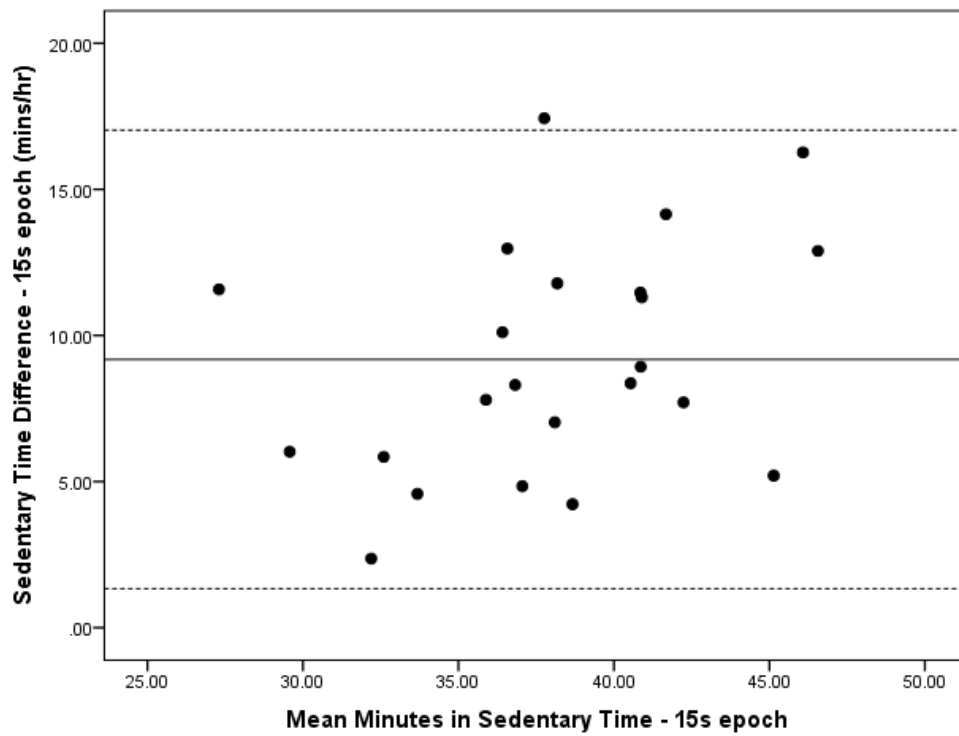




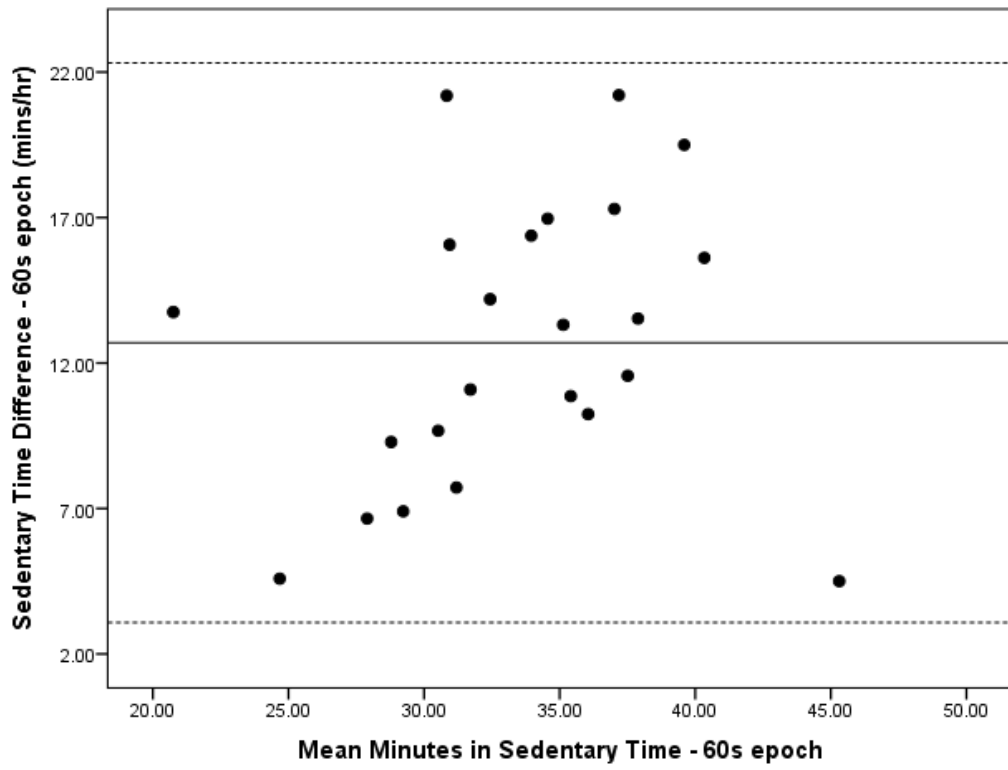
D



E



F



## Results

**Participant demographics.** Twenty-eight 4 and 5 year olds (12 boys and 16 girls) participated in this study. Their average age, height, weight, and BMI percentile were 5.08 ( $SD = 0.7$ ) years, 111.5 ( $SD = 6.6$ ) cm, 19.4 ( $SD = 3.0$ ) kg, and 51.11 ( $SD = 27.76$ ), respectively. After wear-time parameters were applied, only 23 participants were retained for analyses. Average daily accelerometer wear-time was 10.82 hours ( $SD = 0.97$ ).

**Rates of physical activity and sedentary time using a 15s epoch.** Paired  $t$ -test results revealed that participants accumulated significantly lower rates of both MVPA ( $t[22] = -12.75, p < .00$ , Cohen's  $d = -2.93$ ) and TPA ( $t[22] = -5.75, p < .00$ , Cohen's  $d = -1.52$ ) as measured with the Actical method compared to the ActiGraph using a 15s epoch. A significantly higher level of sedentary time was noted via the Actical method in comparison to ActiGraph method ( $t[22] = 11.00, p < .00$ , Cohen's  $d = 1.73$ ). See Table 2 for exact values.

**Rates of physical activity and sedentary time using a 60s epoch.** Paired  $t$ -test analyses identified that participants accumulated significantly lower rates of both MVPA ( $t[22] = -11.57, p < .00$ , Cohen's  $d = -2.87$ ) and TPA ( $t[22] = -12.50, p < .00$ , Cohen's  $d = -2.54$ ) as measured via the Actical method in comparison to the ActiGraph. A significantly higher level of sedentary time was noted with the Actical method in comparison to the ActiGraph method ( $t[22] = 12.41, p < .00$ , Cohen's  $d = 2.14$ ; Table 2).

**Comparing rates of physical activity and sedentary time – limits of agreement analysis.** Bland-Altman plots for physical activity levels and sedentary time are shown in Figure 1. Specifics regarding limits of agreement (bias  $\pm 2 SD$ ) between the

Table 2

*Mean (Standard Deviation) Physical Activity and Sedentary Time (Mins/Hr and Percentage of Wear Time) and Ranges of Physical Activity and Sedentary Time for Actical and ActiGraph Methodological Approaches at 15s and 60s Epochs*

Epoch Length			15s				60s			
			Actical		ActiGraph		Actical		ActiGraph	
			Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range
Intensity Level	Sedentary	Rate	42.66 (5.94)	32.58- 54.21	33.48 (4.58)	21.51- 42.53	39.78 (6.42)	26.97- 49.34	27.08 (5.41)	13.88- 43.06
		% of wear time	71.10 (9.90)	54.31- 90.35	55.80 (7.64)	35.86- 70.89	66.30 (10.70)	44.95- 82.23	45.14 (9.01)	23.13- 71.76
	MVPA	Rate	2.63 (2.06)	0.68- 10.53	9.24 (2.44)	5.37- 14.67	1.27 (1.83)	0.02- 9.21	8.04 (2.79)	3.71- 15.84
		% of wear time	4.39 (3.43)	1.13- 17.55	15.41 (4.06)	8.96- 24.45	2.12 (3.05)	0.04- 15.34	13.41 (4.64)	6.19- 26.41
	TPA	Rate	22.31 (7.11)	13.33- 46.87	31.72 (5.15)	20.60- 39.30	25.24 (5.26)	17.00- 38.50	39.43 (5.90)	26.64- 48.26
		% of wear time	37.18 (11.85)	22.22- 78.12	52.86 (8.58)	34.33- 65.50	42.07 (8.77)	28.33- 64.17	65.72 (9.83)	44.41- 80.44

*Note.* A significant difference ( $p < .008$ ) in activity rates was found between Actical and ActiGraph data at all intensities for both 15s and 60s epochs; MVPA = moderate-to-vigorous physical activity; TPA = total physical activity; SD = standard deviation.

Table 3

*Mean Differences and Limits of Agreement of Physical Activity and Sedentary Time in Mins/Hr as Measured by Actical and ActiGraph Methodological Approaches at 15s and 60s Epochs (Bias  $\pm$  2 SD)*

Epoch Length	Intensity Level		
	Sedentary	MVPA	TPA
15s	9.18 $\pm$ 7.84	-6.61 $\pm$ 4.87	-9.41 $\pm$ 15.37
60s	12.70 $\pm$ 9.62	-6.78 $\pm$ 5.50	-14.19 $\pm$ 10.67

*Note.* MVPA = moderate-to-vigorous physical activity; TPA = total physical activity.

two accelerometers are in Table 3. It was noted that 95.7% ( $n = 22$  of 23), 95.7% ( $n = 22$  of 23), 95.7% ( $n = 22$  of 23), 95.7% ( $n = 22$  of 23), 95.7% ( $n = 22$  of 23), and 100% ( $n = 23$  of 23) of the values were within 2 *SD* of the difference between the Actical and ActiGraph method for MVPA at 15s and 60s, TPA at 15s and 60s, and sedentary time at 15s and 60s, respectively. The systematic bias in Figure 4 (plots A, B, and F), were explored and a significant relationship ( $r = -.41$ ,  $p = .049$ ) was only noted for the points in plot B (i.e., MVPA – 60s epoch).

### **Discussion**

The primary objective of this study was to compare young children's physical activity levels and sedentary time when simultaneously measured via Actical and ActiGraph accelerometers, and their associated protocols, to explore possible differences using these two approaches. Despite being previously identified as appropriate tools for measuring preschoolers' physical activity and sedentary time, a lack of published comparability studies renders the results of such work challenging to interpret.

The findings of this study suggest a wide discrepancy in rates of physical activity and sedentary time as measured by both techniques at 15s and 60s epochs. More specifically, the ActiGraph method captured significantly higher rates of MVPA and TPA (regardless of epoch length) in comparison to the Actical method (i.e., 15s epoch: an approximate difference of 6.61 and 9.41 mins/hr of MVPA and TPA, respectively; 60s epoch: an approximate difference of 6.78 and 14.19 mins/hr of MVPA and TPA, respectively). In contrast, the Actical method reported a significantly higher rate of sedentary time among the sample at both 15s and 60s epochs (i.e., an approximate difference of 9.18 and 12.70 mins/hr at 15s and 60s epochs, respectively). These findings

are in line with the preschool literature which has noted higher rates of MPVA and TPA, and lower rates of sedentary time, when using the ActiGraph approach as compared to that of the Actical (e.g., Colley et al., 2013; Obeid et al., 2011; Temple et al., 2009; Vanderloo et al., 2014).

Inspection of the Bland-Altman plots suggest that the limits of agreement (i.e., bias  $\pm 2 SD$ ) at each intensity level for both 15s and 60s epochs are quite wide. These differences are important to consider, and may suggest that both measurement approaches do not equally capture young children's physical activity and sedentary time. By reviewing the plots for MVPA at 15s and 60s (Figure 4: A and B), it can be noted that as the time spent in MVPA increases, the difference between the Actical and ActiGraph methods gets larger. Similar trends can be seen in the plots for TPA (C and D) and sedentary time (E and F); as the amount of time spent in TPA and sedentary activity increases, as does the difference between both measurement approaches. When comparing congruency in measurement, the two devices and their respective data processing protocols show the most similarity for TPA at a 15s epoch (Figure 4: C). While there appears to be a form of systematic bias present in plots A, B, and F, only plot B (MVPA – 60s epoch) was found to be statistically significant. This may suggest that as time spent in MVPA increases, as does the difference between the two measurement approaches. These results are salient and shed light on the present accelerometry-related interpretation issues.

Given that the children in this study were shown to have consistently accumulated higher rates of MVPA and TPA and a lower rate of sedentary time with the ActiGraph method, it can be postulated that there are differences in measurement across the two

methodological approaches. As per the high correlations between count output from the two monitors reported in previous studies (Paul et al., 2007; Straker, et al., 2012), these results may actually reflect differences in the processing/conversion of data into various intensity levels (rather than the devices themselves). Specifically, the variation in values across the two accelerometer methods might be a result of differences in thresholds applied to the collected data [i.e., Pate et al.'s (2006) cut-points were lower than those created by Pfeiffer et al. (2006)], which is consistent with interpretations of Kahan et al.'s (2013) work. As a result, it is possible that more activity counts were considered 'active' and less considered 'sedentary' in light of the ActiGraph cut-points applied, rather than the activity measured by this device. While the cut-points used for each device in this study were different, these cut-points were established using similar protocols, and are widely accepted in practice. Despite this, there are still large differences in activity. These results are noteworthy, as for the first time, the same children have worn both device models and a large discrepancy in activity levels and sedentary time was observed.

This work highlights the need to be cautious when interpreting previous studies. For instance, the CHMS (Colley et al., 2013), which used Actical accelerometers to carry out data collection, have reported that approximately 84% of Canadian preschoolers (aged 3-4 years) are meeting the physical activity guidelines of 180 minutes of active play per day (at any intensity). However, when a different set of cut-points were applied to the same data [i.e., Pfeiffer et al.'s (2006); the same cut-points that were used in the present study], Colley and colleagues (2013) noted a drastic decrease in activity counts classified as MVPA (from 14% to 0.5% of 5 year-old children meeting physical activity guidelines for this age group). Interestingly, based on the present findings of this paper



and in light of the Actical/ActiGraph discrepancies, many more Canadian preschoolers may have met daily guidelines had activity data been recorded using the ActiGraph method [with Pate et al.'s (2006) cut-points]. This research further reinforces the notion that various cut-points for the same device also impact the accuracy of assessing young children's activity levels and sedentary time.

The findings of this work are important because, to date, no study has provided the degree to which these two devices differ on activity levels and sedentary time. As a consequence of this study, researchers can now consider how their participants' activity levels or sedentary time, in conjunction with the findings from the present study, fit with the literature. Specifically, researchers using the Actical method [with Pfeiffer et al.'s (2006) cut-points] can now compare (with caution, particularly in light of the wide limits of agreement) their participants' activity levels with those previously reported using the ActiGraph method [with Pate et al.'s (2006)], and know that a rough discrepancy of approximately 6.74 mins/hr of MVPA and 9.52 mins/hr of TPA is anticipated at a 15s time sampling interval, or 6.91 mins/hr of MVPA and 14.34 mins/hr of TPA at a 60s time sampling interval.

This study identified a large discrepancy between devices which suggests that consistency in devices and cut-points is necessary for comparability data. This study also confirms that long-term measurements of physical activity and sedentary time need to occur using the same device so that measurement error does not compound any changes. While it can be argued that these devices vary simply as a consequence of the difference in technology and sensitivity, this paper provides further insight into how much they differ as a consequence of their associated protocols (including specific cut-points and

sampling interval) which will allow researchers to account for differences in their study results when compared to the literature. Should researchers use Acticals with Pfeiffer et al.'s cut-points (2006), they can anticipate a much lower rate of MVPA and TPA when comparing to studies which have used ActiGraphs with Pate et al.'s (2006) cut-points.

When considering the mean rates of MVPA measured at both 15s and 60s epochs, more activity was captured using a shorter time sampling interval. This was not a surprising finding; given young children's sporadic activity behaviours, such large variances between epoch lengths could result in major differences in daily rates of MVPA. These findings are consistent with the investigations by Hislop et al. (2012) and Vale et al. (2009). Similarly, Obeid and colleagues (2011) suggested that the number of missed minutes of MVPA increased as the applied time sampling interval lengthened (e.g., a daily average of 2.9, 9.0, and 16.7 missed minutes of MVPA resulted when a sampling interval of 15s, 30s, and 60s was applied to preschoolers' activity data in comparison to a 3s epoch, respectively). Shorter epoch lengths also resulted in significantly more minutes of activity being classified as sedentary, but less as TPA. This is potentially troublesome as preschoolers may be seen as less active than previously thought when shorter epoch lengths are used to assess their activity levels.

**Limitations.** One limitation was the lack of an observation component and/or VO<sub>2</sub> measurements within this study; 'validated' activities of different intensities of physical and sedentary activity were not carried out, thus we do not know which device is better and/or closer to capturing 'more accurate' values of physical activity and sedentary time. As a means of improving the interpretability of accelerometry data across studies, future work should focus on finding ways to enhance the comparability of physical

activity data collected using different devices and cut-points. This is particularly important given that no one set of cut-points has been identified as the ‘gold standard’, and the application of different cut-points makes comparisons challenging. Lastly, given that only participants who met the inclusion criteria for both devices were included, it is possible that participants with sufficient data on only one device (i.e., Actical *or* ActiGraph) were excluded from analysis.

### **Conclusion**

This is the first study to examine the differences in young children’s physical activity levels and sedentary time measured via Actical and ActiGraph accelerometers, and their associated protocols, simultaneously. Given the unique activity patterns of this population, coupled with the challenge of measuring and converting physical activity data, the results of this work have important implications for physical activity researchers interested in interpreting the activity levels of their participants, in the context of previous research. Moreover, the present study’s findings have highlighted that physical activity levels are reported as significantly lower and sedentary time as significantly higher when measured using Actical accelerometers, as compared with the ActiGraph model, in this age group. While this information is insightful for drawing conclusions on various studies using the two approaches, until a unified tool with corresponding cut-points is accepted in the literature, the challenge of interpreting reported physical activity levels and sedentary time will continue.

## References

- Adolph, A.L., Puyau, M.R., Vohra, F.A., Nicklas, T.A., Zakeri, I.F., & Butte, N.F. (2012). Validation of uniaxial and triaxial accelerometers for the assessment of physical activity in preschool children. *Journal of Physical Activity and Health, 9*, 944-953. Retrieved from <http://journals.humankinetics.com/jpah>
- Australian Government. Department of Health and Ageing. (2010). *Move and play every day. National physical activity recommendations for children 0-5 years*. Belconnen: Commonwealth of Australia, Department of Health and Ageing.
- Barnett, L., van Beurden, E., Morgan, P., Brooks, L., & Beard, J. (2009). Childhood motor skill proficiency as a predictor of adolescent physical activity. *Journal of Adolescent Health, 44*, 252-259. doi: 10.1016/j.jadohealth.2008.07.004
- Beets, M.W., Bornstein, D., Dowda, M., & Pate, R.R. (2011). Compliance with national guidelines for physical activity in U.S. preschoolers: Measurement and interpretation. *Pediatrics, 127*, 658-664. doi: 10.1542/peds.2010-2021
- Cain, K.L., Sallis, J.F., Conway, T.L., Van Dyck, D., & Calhoun, L. (2013). Using accelerometers in youth physical activity studies: A review of methods. *Journal of Physical Activity and Health, 10*(3),437-450. Retrieved from <http://journals.humankinetics.com/jpah>
- Canadian Society of Exercise Physiology. (2012). *Canadian physical activity guidelines for the early years: 0-4 years*. Ottawa: Canadian Society of Exercise Physiology.
- Cliff, D.P., Reilly, J.J., & Okely, A.D. (2009). Methodological considerations in using accelerometers to assess habitual physical activity in children aged 0-5 years.

*Journal of Science and Medicine in Sport*, 12(5), 557-567. doi:

10.1016/j.jsams.2008.10.008

Colley, R., Garriguet, D., Adamo, K., Carson, V., Janssen, I., Timmons, B.W., & Tremblay, M. (2013). Physical activity and sedentary behavior during the early years in Canada: A cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity*, 10, 54. doi: 10.1186/1479-5868-10-54

Colley, R.C., Harvey, A., Grattan, K., & Adamo, K.B. (2014). Impact of accelerometer epoch length on physical activity and sedentary behaviour outcomes for preschool-aged children. *Health Reports*, 25, 3-9. (Catalogue no. 82-003-X).

Department of Health: Physical Activity and Health Alliance. (2011). *Start Active, Stay Active: A report on physical activity for health from the four home countries' chief medical officers*. London (UK): Department of Health.

Goldfield, G.S., Harvey, A., Grattan, K., & Adamo, K.B. (2012). Physical activity promotion in the preschool years: A critical period to intervene. *International Journal of Environmental Research and Public Health*, 9,1326-1342. doi: 10.3390/ijerph9041326

Gunter, K.B., Rice, K.R., Ward, D.S., & Trost, S.G. (2012). Factors associated with physical activity in children attending family child care homes. *Preventive Medicine*, 54, 131-133. doi: 10.1016/j.ypmed.2011.12.002

Hinkley, T., Salmon, J., Okely, A.D., Crawford, D., & Hesketh, K. (2012). Preschoolers' physical activity, screen time, and compliance with recommendations. *Medicine and Science in Sports and Exercise*, 44,458-465. doi: 10.1249/MSS.0b013e318233763b

- Hinkley, T., Salmon, J., Okely, A.D., Hesketh, K., & Crawford, D. (2012). Correlates of preschool children's physical activity. *American Journal of Preventive Medicine, 43*, 159-167. doi: 0.1016/j.amepre.2012.04.020
- Hinkley, T., Salmon, J., Okely, A.D., & Trost, S.G. (2010). Correlates of sedentary behaviours in preschool children: A review. *International Journal of Behavioral Nutrition and Physical Activity, 7*, 6. doi: 10.1186/1479-5868-7-66
- Hislop, J.F., Bulley, C., Mercer, T.H., & Reilly, J.J. (2012). Comparison of epoch and uniaxial versus triaxial accelerometers in the measurement of physical activity in preschool children: A validation study. *Pediatric Exercise Science, 24*, 450-460. doi: <http://journals.humankinetics.com/pes>
- Hnatiuk, J.A., Salmon, J., Hinkley, T., Okely, A.D., & Trost, S.T. (2014). A review of preschool children's physical activity and sedentary time using objective measures. *American Journal of Preventive Medicine, 47*(4), 487-497. doi: 10.1016/j.amepre.2014.05.042
- Kahan, D., Nicaise, V., & Reuben, K. (2013). Convergent validity of four accelerometer cutpoints with direct observation of preschool children's outdoor physical activity. *Research Quarterly in Exercise and Sport, 84*, 59-67. doi: 10.1080/02701367.2013.762294
- Leblanc, A.G., Spence, J.C., Carson, V., Connor Gorber, S., Dillman, C., Janssen, I., Kho, M.E., Stearns, J.A., Timmons, B.W., & Tremblay, M.S. (2012). Systematic review of sedentary behaviour and health indicators in the early years (aged 0-4 years). *Applied Physiology, Nutrition, and Metabolism, 37*, 753-772. doi: 10.1139/h2012-063

- Marcus, B.H., Dubbert, P.M., Forsyth, L.H., McKenzie, T.L., Stone, E.J., Dunn, A.L., & Blair, S.N. (2010). Physical activity behavior change: issues in adoption and maintenance. *Health Psychology, 19*(1 Suppl),32-41. doi:  
<http://www.apa.org/pubs/journals/hea/>
- Obeid, J., Nguyen, T., Gabel, L., & Timmons, B.W. (2011). Physical activity in Ontario preschools: Prevalence and measurement issues. *Applied Physiology, Nutrition, and Metabolism, 36*, 291-297. doi: 10.1139/h11-002
- Oliver, M., Schofield, G.M., & Kolt, G.S. (2007). Physical activity in preschoolers: understanding prevalence and measurement issues. *Sports Medicine, 37*(12), 1045-170. Retrieved from <http://link.springer.com/journal/40279>
- Pate, R.R., McIver, K.L., Dowda, M., Brown, W.H., & Addy, C. (2008). Directly observed physical activity levels in preschool children. *Journal of School Health, 78*(8), 438-444. doi: 10.1111/j.1746-1561.2008.00327.x.
- Pate, R.R., Almeida, M.J., McIver, K.L., Pfeiffer, K.A., & Dowda, M. (2006). Validation and calibration of an accelerometer in preschool children. *Obesity (Silver Spring), 14*(11), 2000-2006. doi: 10.1038/oby.2006.234
- Pate, R.R., Pfeiffer, K.A., Trost, S.G., Ziegler, P., & Dowda, M. (2004). Physical activity among children attending preschools. *Pediatrics, 114*,1258-1263. Retrieved from <http://pediatrics.aappublications.org/content/137/3?current-issue=y>
- Paul, D.R., Kramer, M., Moshfegh, A.J., Baer, D.J., & Rumpler, W.V. (2007). Comparison of two different physical activity monitors. *BMC Medical Research Methodology, 7*, 26. doi: 10.1186/1471-2288-7-26

- Pfeiffer, K.A., McIver, K.L., Dowda, M., Almeida, M.J.C., & Pate, R.R. (2006). Validation and calibration of the Actical accelerometer in preschool children. *Medicine & Science in Sports & Exercise*, 38,125-157. doi: 10.1249/01.mss.0000183219.44127.e7
- Reilly, J.J. (2008). Physical activity, sedentary behaviour and energy balance in the preschool child: opportunities for early obesity prevention. *Proceedings of the Nutrition Society*,67(3),317-325. doi: 10.1017/S0029665108008604
- Rice, K.R. (2012). *Physical activity in children attending family child care homes* [dissertation]. Corvallis (OR): Oregon State University.
- Rice, K.R., & Trost, S.G. (2014). Physical activity levels among children attending family day care. *Journal of Nutrition Education and Behavior*, 46(3), 197-202. doi: 10.1016/j.jneb.2013.09.001
- Robusto, K.M., & Trost, S.G. (2012). Comparison of three generations of ActiGraph activity monitors in children and adolescents. *Journal of Sports Sciences*, 30(13),1429-1435. doi: 10.1080/02640414.2012.710761
- Sirard, J.R., Trost, S.G., Pfeiffer, K.A., Dowda, M., & Pate, R.R. (2005). Calibration and evaluation of an objective measure of physical activity in preschool children. *Journal of Physical Activity and Health*, 3(2), 345-357. Retrieved from <http://journals.humankinetics.com/jpah>
- Straker, L.M., & Campbell, A. (2012). Translation equations to compare ActiGraph GT3X and Actical accelerometers activity counts. *BMC Medical Research Methodology*, 12,54. doi: 10.1186/1471-2288-12-54



- Temple, V.A., Naylor, P.J., Rhodes, R.E., & Wharf Higgins, J. (2009). Physical activity of children in family child care. *Applied Physiology, Nutrition, and Metabolism*, 34(4),794-798. doi: 10.1139/H09-061
- Timmons, B.W., Proudfoot, N., MacDonald, M., Bray, S., & Cairney, J. (2012). The health outcomes and physical activity in preschoolers (HOPP) study: Rationale and design. *BMC Public Health*, 12,284. doi: 10.1186/1471-2458-12-284
- Timmons, B.W., Leblanc, A.G., Carson, V., Connor Gorber, S., Dillman, C., Janssen, I., Kho, M.E., Spence, J.C., Stearns, J.A., & Tremblay, M.S. (2012). Systematic review of physical activity and health in the early years (aged 0-4 years). *Applied Physiology, Nutrition, and Metabolism*, 37, 773-792. doi: 10.1139/h2012-070
- Timmons, B.W., Naylor, P.J., & Pfeiffer, K.A. (2007). Physical activity for preschool children - How much and how? *Applied Physiology, Nutrition, and Metabolism*, 32, S122–S34. doi: 10.1139/H07-112
- Trost, S.G. (2007). Measurement of physical activity in children and adolescents. *American Journal of Lifestyle Medicine*, 1(4), 299-314. doi: 10.1177/1559827607301686
- Tucker, P. (2008). The physical activity levels of preschool-aged children: A systematic review. *Early Childhood Research Quarterly*, 23(4), 547-558. doi: 10.1016/j.ecresq.2008.08.005
- Tucker, P., & Irwin, J.D. (2008). Physical activity behaviours during the preschool years. *Child Health Education*, 2(1), 134-145. Retrieved from <http://www.creche.sfu.ca/early-childhood-research/child-health-and-education.html>

- Tucker, P., Vanderloo, L.M., Newnham-Kanas, C., Burke, S.M., Irwin, J.D., Johnson, A.M., & van Zandvoort, M.M. (2013). Learning Environments' Activity Potential for Preschoolers (LEAPP): Study rationale and design. *Journal of Public Health Research, 2*, 113-117. doi: 10.4081/jphr.2013.e19
- Vale, S., Santos, R., Silva, P., Soares-Miranda, L., & Mota, J. (2009). Preschool children physical activity measurement: Importance of epoch length choice. *Pediatric Exercise Science, 21*, 413-420. Retrieved from <http://journals.humankinetics.com/pes>
- Vale, S., P. Silva, R. Santos, L. Soares-Miranda, & Mota, J. (2010). Compliance with physical activity guidelines in preschool children. *Journal of Sports Sciences, 28*, 603-608. doi: 10.1080/02640411003702694
- Van Cauwenberghe, E., Labarque, V., Trost, S.G., De Bourdeaudhuij, I., & Cardon, C. (2010). Calibration and comparison of accelerometer cut points in preschool children. *International Journal of Pediatric Obesity, 6*, e582-e589. doi: 10.3109/17477166.2010.526223
- Vanderloo, L.M., Tucker P., Johnson, A.M., van Zandvoort, M.M., Burke, S.M., & Irwin, J.D. (2014). The influence of centre-based childcare on preschoolers' physical activity levels: A cross-sectional study. *International Journal of Environmental Research and Public Health, 11*, 1794-1802. doi: 10.3390/ijerph110201794

## CHAPTER 5

### Summary, Discussion of Implications, and Future Directions

#### Summary

The overarching purpose of this dissertation was to increase our understanding of levels of physical activity and sedentary time, as well as challenges to measuring these behaviours among young children. To achieve this goal, three independent investigations were conducted. Study 1 involved measuring objectively a sample of toddlers' ( $n = 40$ ) physical activity levels and sedentary time in London, Ontario using two sets of cut-points to assess the degree to which this population was meeting national guidelines (Vanderloo & Tucker, 2015). Toddlers' screen-viewing habits, and the proportion of participants that met/failed to meet the screen use portion of national sedentary behaviour guidelines were also examined. The results of this work indicate the difficulty in accurately measuring this population's activity levels, thus complicating any comparisons to Canada's physical activity guidelines. Specifically, it was found that Trost's et al.'s (2010) cut-points reported lower levels of physical activity and higher levels of sedentary time than the CHMS (Adolph et al., 2012; Wong, Colley, Connor Gorber, & Tremblay, 2011) cut-points. This study also highlighted that regardless of which cut-points were used, and in conjunction with large amounts of screen-viewing noted among the toddlers in this study, sedentary time is high. This study provides one of the first Canadian pictures of activity behaviours among toddlers (during waking hours), and represents an important contribution to the field of paediatric exercise science as this first step of documenting behaviours is necessary to identify if health promotion interventions for this young cohort are warranted.

Study 2 involved carrying out an ecological assessment of various early learning environments to identify which attributes within these settings influence levels of physical activity and sedentary time (Vanderloo, Tucker, Johnson, Burke, & Irwin, 2015). Preschoolers enrolled in FDK accumulated significantly more MVPA than those in centre- and home-based childcare, and significantly more TPA than those in centre-based childcare. For FDK, the Active Opportunities, Sedentary Opportunities, Sedentary Environment, and Fixed Play Environment subscales of the EPAO tool were found to significantly impact rates of MVPA and TPA. For centre-based childcare, only the Sedentary Environment subscale was found to impact rates of MVPA and TPA. No EPAO subscales were found to influence participants' MVPA or TPA rates in home-based childcare. This study provides much insight into the variance of physical activity levels among young children enrolled in different early learning environments, as well as which characteristics within each of these environments can be changed, added, or removed to better support active behaviours during early learning hours.

Finally, Study 3 focused on comparing the differences between the Actical method (i.e., Actical accelerometer and Pfeiffer et al.'s cut-points) and the ActiGraph method (i.e., ActiGraph accelerometer and Pate et al.'s cut-points) in measuring young children's physical activity and sedentary time, at both 15s and 60s epochs (Vanderloo, Di Cristofaro, Proudfoot, Tucker, & Timmons, 2016). The results of this study show that in comparison to Actical accelerometers, ActiGraph accelerometers captured significantly higher rates of TPA and MVPA at both 15s and 60s epochs. Conversely, Actical accelerometers reported significantly higher rates of sedentary time at both time sampling intervals. Together, the findings of this final study underscore the current issues with

interpreting accelerometry data collected using different devices (and their respective protocols), and will encourage researchers imploring accelerometers with preschoolers to consider their findings within the context of others' work.

### **Discussion of Implications**

Despite the inherent limitations noted for each study (refer to Chapters 2-4), the overall findings of this body of work provide new insight into the activity levels of young Canadians and the methodological considerations for future research. Firstly, given the high levels of sedentary time noted among the toddler sample, increased efforts are needed to not only confirm these findings (as this was the first published study looking at Canadian toddlers' activity levels over the course of their waking hours), but to examine ways in which extended periods of this detrimental health behaviour can be broken up or limited. These findings also may serve as a prime opportunity for health education with parents/guardians and childcare providers; it is important to ensure that toddlers develop strong physical activity habits now to ensure these behaviours persist throughout the lifespan (Malina, 2001), and thus set the foundation for an active adult life.

Secondly, moving beyond the simple fact that much of the participating toddlers' time was spent engaged in sedentary time (Vanderloo & Tucker, 2015), it is also important to note exactly *which* activities are making up for the bulk of this group's sedentary pursuits. The fact that 81.2% and 75.0% of children under 2 years and 29.2% and 37.5% of 2-3 years olds failed to adhere to the screen-use portion of Canada's sedentary behaviour guidelines (on weekdays and weekend days respectively) is alarming. Similar trends of high screen-viewing are being noted among the preschool-aged cohort in Canada (Active Healthy Kids Canada, 2013; Colley et al., 2013), Australia

(Cox et al., 2012; Hinkley, Salmon, Okely, Crawford, & Hesketh, 2012), and the United States (Heelan & Eisenmann, 2006; Rideout, Foehr, & Roberts, 2010) – approximately 1.5 to 7 hours are being spent in screen-viewing activities daily. To this point, a recent Delphi study which gathered consensus on research priorities concerning physical activity and sedentary behaviours among children and youth (Gillis et al., 2013), ranked screen-time reduction as number 9 of 29 items. Given the many noted negative health implications associated with excessive screen-viewing (Gortmaker et al., 1996; Paik & Comstock, 1994; Thompson & Christakis, 2005), health promotion programs are necessary to develop creative approaches to replacing screen time with non-screen-based activities that include movement.

Thirdly, while the 2016 Physical Activity Report Card released by ParticipACTION (2016) shows promise, in that 70% of preschoolers were reported as meeting national physical activity guidelines, what remains a concern is that once enrolled in some form of early learning environment, sedentary behaviours and inactivity become a reality for many children. The findings from Study 2 reinforce this concern; regardless of type of early learning environment, there is an ongoing need to improve physical activity levels and decrease sedentary time of young children in this setting to ensure they are achieving the daily recommended physical activity (with poorer rates noted among those in centre-based childcare). Additionally, the creation of programs that are tailored to each unique early learning environment is important. Doing so will likely yield better outcomes as these programs can take into consideration the different attributes of these diverse settings and their staff, as each will have their own set of barriers and facilitators therein (i.e., what may be feasible in centre-based childcare may

not be feasible in a FDK classroom). Furthermore, identifying mechanisms by which teachers and ECEs can incorporate physical activity (e.g., standing classrooms, children moving with orbit during lessons on solar system, etc.) into their curriculum may prove useful in the battle to increase this behaviour.

Fourthly, the accurate assessment and interpretation of young children's levels of physical activity and sedentary time is challenging. Such methodological issues were noted in Studies 1 and 3. Taken together, the results from these two studies underscore the need for consensus regarding the choice of device, the application of device-specific cut-points, as well as the choice of epoch length – all of which have been noted to influence accelerometry data outcomes. Such 'agreements' are needed within the field of paediatric exercise science to ensure researchers are capturing the most accurate picture of young children's activity levels, which then directs not only the need for, but the type of, intervention program created to address such issues. While researchers rely on accelerometers to provide the gold standard of measurement and to remove reporting bias and problems with recall, the identification of conflicting rates of activity levels when using these devices are a cause of when interpreting the data.

### **Embedding these Findings within a Health Promotion Model**

The individual articles from this work comprised the majority of the first portion (i.e., "precede") of the PRECEDE-PROCEED model. In an attempt to prevent the further prognosis of health consequences associated with physical inactivity and sedentary behaviours in early childhood, health promotion approaches represent an effective and efficacious method of bettering the health and well-being of young children. The work in this dissertation served as an ideal opportunity to identify and underscore key educational

and environmental approaches to support population health improvements for young children. Furthermore, the findings from this compendium of work may help pave the way for future researchers by carrying-out situational, social, and epidemiological assessments in relation to young children's physical activity and sedentary time while attending early learning environments.

Pursuant to the identification of such key factors, and in line with the PRECEDE-PROCEED model, this dissertation proposes the need for an intervention to enhance and support physical activity in the early years. As a result, and guided in-part by this collection of work, a cluster randomized control trial was designed (i.e., *Phase 4* of model) which aimed at improving the physical activity levels of young children enrolled in centre-based childcare (given that this environment was identified as being the least active setting out of the three early learning environments that were examined). The *Supporting Physical Activity in the Childcare Environment: The SPACE Intervention* comprises of three components (Tucker et al., 2016), all of which were developed based on the findings from this dissertation: 1. increased physical activity training and education for staff (e.g., training workshops and resource materials); 2. increased periods of outdoor playtime (e.g., four 30-minute periods rather than two 60-minute periods); and, 3. introduction of new portable play equipment (e.g., various balls, hop-scotch mats, hula hoops, etc.). As confirmed from the findings from the methodological paper comparing two monitoring devices (i.e., Study 3; Vanderloo et al., 2015), Actical accelerometers using a 15s epoch length are being used to measure young children's physical activity levels at four distinct time points (i.e., pre-intervention, post-intervention, 6-months post-intervention, 12-months post-intervention). The intervention



will be deemed effective if a statistically significant increase in rates of TPA (i.e., LPA and MVPA combined) is reported. While the SPACE study is outside the scope of this dissertation, it is presented to show that the work presented herein has led to future research which completes the PRECEDE-PROCEED model; and that these studies have encouraged action within childcare centres, to try and increase physical activity levels and decrease sedentary time. The final stages of the PRECEDE-PROCEED model will be completed in the coming months by way of conducting process, impact, and outcome evaluations (i.e., Phases 6, 7, 8).

The need for efficacious intervention programs to improve physical activity levels and decrease sedentary time among young children is evident, based not only on the findings from the studies presented herein, but also on past work which postulate a current inactivity crisis among this population. To date, the SPACE study represents one of the first Canadian physical activity interventions for young children attending centre-based childcare. It is anticipated that the results of this intervention (which was developed in-part based on the findings from this dissertation) will have many important implications for young Canadian toddlers and preschoolers.

### **Future Directions and Next Steps**

This compendium of studies highlights the complexity of accurately capturing the levels of physical activity and sedentary time among young children. Several factors or “learnings” can be drawn from this work. First, the young age of the participants, as was the case in all three studies, poses unique challenges for measuring activity behaviours – some children were not interested in wearing the belts, and at times there were challenges with securely fixing the belts to the children without the devices moving around due to

their small waists. Second, the type of environment in which the participants were being assessed is important to consider given the potential variations inherent to each location (e.g., policies, legislation, space allotment, available equipment, etc.) that influence the activity levels and intensities being recorded (see Study 2). Given the many hours that young children spend in care (Bushnik, 2006), the early learning environment plays an important role in promoting active behaviours and deterring sedentary ones among enrolled children; consequently, increased efforts are needed to support these unique settings in their efforts to encourage strong physical activity habits. Third, the method of assessment is a crucial point to consider when examining physical activity and sedentary behaviours. As discussed, accelerometers represent the current gold standard for measuring young children's physical activity levels; however, the choice of monitoring device, cut-points, and epoch length (as evidenced from the findings in Studies 1 and 3) can drastically impact the resulting minutes of physical activity and sedentary time, and dramatically influence whether a child is achieving the national guidelines.

Another important take-away from this work is the importance of collaboration. By nature, health promotion research is inherently collaborative, where the very success of the project can be highly contingent on partnerships and participant buy-in. Specific to Study 1, cooperation from parents/guardians was needed to assist with the daily placement and removal of the accelerometers as well as the completion of the wear-time log. In Study 2, buy-in from multiple stakeholders was required (e.g., school boards, childcare organizations, childcare directors, classroom staff, parents/guardians, preschoolers, etc.) to ensure the success of this study. Lastly, in Study 3, cooperation across two research institutions and their respective staff/researchers and study

participants were needed to help carry out this project as the data was being collected in another city. Overall, strong partnerships and collaborations with all involved parties is an important step in strengthening the quality of health promotion and/or community-based research and to ensure positive related outcomes.

Moving forward, the findings from this work may serve as support for ECEs, parents/guardians, and other early year's stakeholders to ensure early learning environments are supportive of young children's physical activity. More specifically, this work may pose as a starting point for asking questions regarding the physical activity environment of early learning settings as well as advocating for the development of physical activity policies. Likewise, efforts with parents/guardians to better support and improve young children's physical activity levels also represent an avenue of research warranting additional attention given the noted relationship between these dyads (Carson, Rosu, & Janssen, 2014). While the previously mentioned SPACE study represents just one attempt at trying to incorporate and apply the findings from this dissertation (within a health promotion framework), much work is still needed to promote active behaviours among young children (and minimize sedentary ones).

Physical activity offers numerous health benefits for children and adults alike. Ensuring the development of appropriate physical activity and screen viewing patterns early in life is an appropriate health promotion approach for encouraging long-term health and well-being. This dissertation as a whole not only purports that physical activity levels are low and screen-viewing high among toddlers and preschoolers, but that early learning environments specifically, represent a sedentary domain in which many young Canadians are currently enrolled. Although identified as an obesogenic environment,

early learning centres (and their respective characteristics; e.g., staff behaviours, sedentary opportunities, portable play equipment) were also identified as being influential with regard to this cohort's physical activity levels. Regular provision of physical activity opportunities for young Canadians in early learning programs is one of the strongest preventative and proactive actions that can be taken to ensure the acquisition of healthy behaviours early and the reduction of subsequent diseases and associated healthcare costs. This work also confirms the challenges with accurately assessing young children's physical activity levels – be this due to the challenges related to epoch, device, and/or cut-point selection. In summary, the three articles discussed herein serve as foundational studies for future work in paediatric exercise science and health promotion as well as in the betterment of physical activity levels and overall health among the early years population.

## References

- Active Healthy Kids Canada. (2013). *Active Healthy Kids Canada Report Card*.
- Adolph, A. L., Puyau, M. R., Vohra, F. A., Nicklas, T. A., Zakeri, I. F., & Butte, N. F. (2012). Validation of uniaxial and triaxial accelerometers for the assessment of physical activity in preschool children. *Journal of Physical Activity and Health, 9*, 944-953.
- Bushnik, T. (2006). *Child Care in Canada* Statistics Canada.
- Carson, V., Rosu, A., & Janssen, I. (2014). A cross-sectional study of the environment, physical activity, and screen time among young children and their parents, *BMC Public Health, 14*:61. doi: 10.1186/1471-2458-14-61
- Colley, R., Garriguet, D., Adamo, K., Carson, V., Janssen, I., Timmons, B. et al. (2013). Physical activity and sedentary behavior during the early years in Canada: a cross-sectional study. *International Journal of Behavioral Nutrition and Physical Activity, 10*, 54.
- Cox, R., Skouteris, H., Rutherford, L., Fuller-Tyszkiewicz, M., Dell Aulia, D., & Hardy, L. (2012). Television viewing, television content, food intake, physical activity and body mass index: a cross-sectional study of preschool children aged 2–6 years. *Health Promotion Journal of Australia, 23*, 58-62.
- Gillis, L., Tomkinson, G., Olds, T., Moreira, C., Christie, C., Nigg, C. et al. (2013). Research priorities for child and adolescent physical activity and sedentary behaviours: An international perspective using a twin-panel Delphi procedure. *International Journal of Behavioral Nutrition and Physical Activity, 10*, 1-8.

- Gortmaker, S., Must, A., Sobol, A. M., Peterson, K. E., Colditz, G. A., & Dietz, W. H. (1996). Television viewing as a cause of increased obesity among children in the United States: 1986–1990. *Archives of Pediatric and Adolescent Medicine*, *150*(362).
- Heelan, K. A. & Eisenmann, J. C. (2006). Physical activity, media time, and body composition in young children. *Journal of Physical Activity and Health*, *1*, 1-14.
- Hinkley, T., Salmon, J., Okely, A. D., Crawford, D., & Hesketh, K. (2012). Preschoolers' physical activity, screen time, and compliance with recommendations. *Medicine and Science in Sports and Exercise*, *44*, 458-465.
- Malina, R. M. (2001). Physical activity and fitness: Pathways from childhood to adulthood. *American Journal of Human Biology*, *13*(2), 162-172.
- Paik, H. & Comstock, G. (1994). The effects of television violence on antisocial behaviour: A meta-analysis. *Community Research*, *21*, 516-546.
- ParticipACTION (2016). *The ParticipACTION Report Card on Physical Activity for Children and Youth*. Retrieved from <https://www.participaction.com/sites/default/files/downloads/2016%20ParticipACTION%20Report%20Card%20-%20Presentation.pdf>
- Rideout, V. J., Foehr, U. G., & Roberts, D. F. (2010). *Generation M2: media in the lives of 8- to 18-year olds. 7500. Menlo Park, CA: The Kaiser Family Foundation*.
- Thompson, D. A. & Christakis, D. A. (2005). The association between television viewing and irregular sleep schedules among children less than 3 years of age. *Pediatrics*, *116*, 851-856.

- Trost, S. G., Loprinzi, P. D., & Fees, B. S. (2010). *Objective measurement of physical activity and sedentary behaviours in young children*. In Minneapolis, MN: Proceedings of the International Society of Behavioral Nutrition and Physical Activity (ISBNPA) annual meeting.
- Tucker, P., Burke, S. M., Gaston, A., Irwin, J. D., Johnson, A. M., Timmons, B. W. et al. (2016). Supporting Physical Activity in the Childcare Environment (SPACE): Rationale and study protocol for a cluster randomized controlled trial. *BMC Public Health*, *16*, 112. doi: 10.1186/s12889-016-2775-9.
- Vanderloo, L. M., Di Cristofaro, N. A., Proudfoot, N. A., Tucker, P., & Timmons, B. W. (2016). Comparing the Actical and ActiGraph approach to measuring young children's physical activity levels and sedentary time. *Pediatric Exercise Science*, *28*(1), 133-142. doi: 10.1123/pes.2014-0218
- Vanderloo, L. M., Tucker, P., Johnson, A. M., Burke, S. M., & Irwin, J. D. (2015). Environmental influences on preschoolers' physical activity levels in various early learning facilities. *Research Quarterly for Exercise and Sport*, *19*, 1-11.
- Vanderloo, L. M. & Tucker, P. (2015). An objective assessment of toddlers' physical activity and sedentary levels: A cross-sectional study. *BMC Public Health*, *15*(969). doi: 10.1186/s12889-015-2335-8.
- Wong, S. L., Colley, R. C., Connor Gorber, S., & Tremblay, M. S. (2011). Actical accelerometer sedentary activity thresholds for adults. *Journal of Physical Activity and Health*, *8*, 587-591.

Appendix A

Participant Recruitment Poster for Study 1



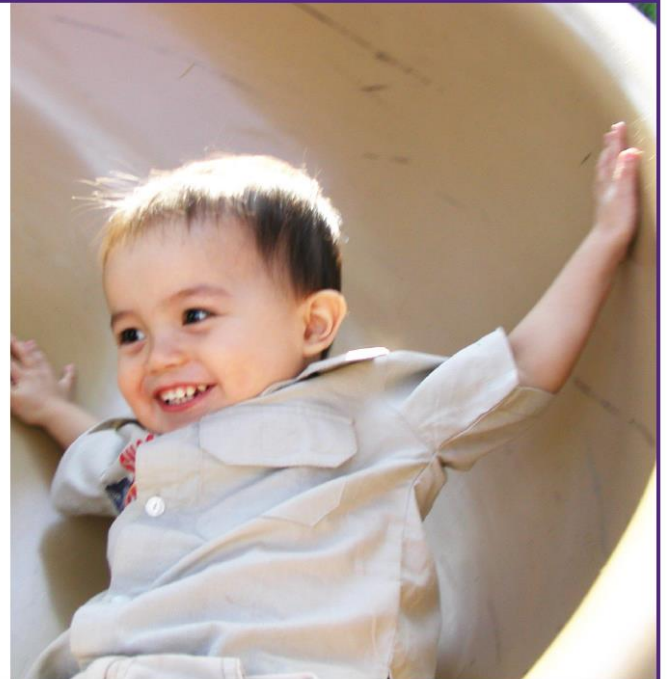
# TOTS IN MOTION: Toddler Physical Activity Study

Our team at Western University is conducting a study on physical activity levels of toddlers.

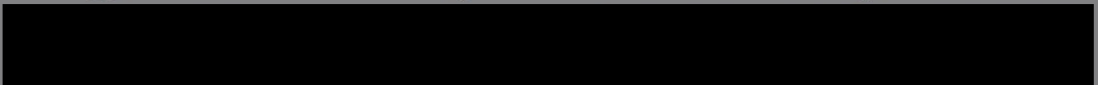
**We are looking for:**

- **Children ranging from 18–35 months of age to participate in the study**

Tokens of appreciation provided at the end of the study.



If interested, please contact:  
**Leigh Vanderloo (PhD Candidate)**



This study will occur in London and data collection will last seven (7) days.

Appendix B

Ethics Approval Notice for Study 1



Use of Human Participants - Ethics Approval Notice

Principal Investigator: Dr. Patricia Tucker  
 File Number:103902  
 Review Level:Delegated  
 Approved Local Adult Participants:65  
 Approved Local Minor Participants:0  
 Protocol Title:Tots in Motion: An Objective Assessment of Toddlers' Physical Activity Levels  
 Department & Institution:Health Sciences|Occupational Therapy,Western University  
 Sponsor:  
 Ethics Approval Date:June 25, 2013 Expiry Date:June 30, 2014  
 Documents Reviewed & Approved & Documents Received for Information:

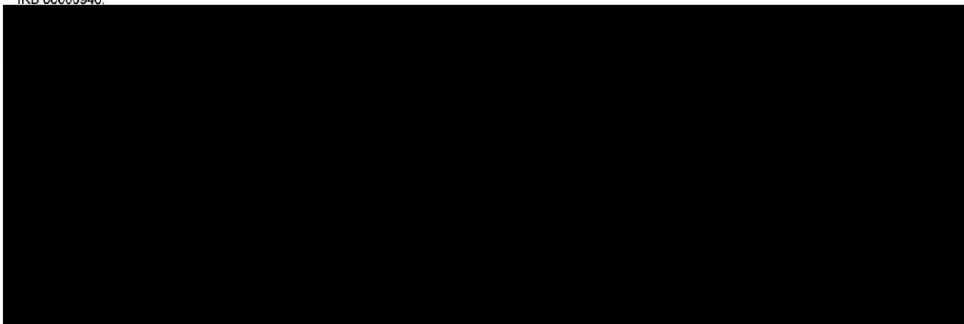
Document Name	Comments	Version Date
Other	Appendix I - Master participant tracking sheet	2013/05/20
Other	Appendix H - Thank you letter	2013/05/20
Other	Appendix E - Accelerometer log	2013/05/20
Western University Protocol		2013/05/22
Letter of Information	Appendix C - LOI	2013/06/23
Other	Appendix B - advertisement for recruitment in magazine	2013/06/13
Other	Appendix A - advertisement for recruitment in physicians' offices and other venues	2013/06/13
Other	Appendix J - email invitation	2013/06/13
Other	Letter outlining revisions to Board's recommendations - REB# 103902	2013/06/13
Other	Appendix G - toddler screen-viewing questionnaire	2013/06/13
Other	Appendix F - parent/guardian demographic questionnaire	2013/06/13
Other	Appendix D - consent form	2013/06/13
Recommendations Form	Recommendations	2013/06/10

This is to notify you that The University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the Health Canada/ICH Good Clinical Practice Practices; Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above. The membership of this REB also complies with the membership requirements for REB's as defined in Division 5 of the Food and Drug Regulations.

The ethics approval for this study shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the University of Western Ontario Updated Approval Request Form.

Members of the HSREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

The Chair of the HSREB is Dr. Joseph Gilbert. The HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 0000940.



Appendix C

Parent/Guardian Consent and Letter of Information for Study 1



## **Tots in Motion: An Objective Assessment of Toddlers’ Physical Activity Levels**

### **Letter of Information for Parents/Guardians**

#### **Investigators:**

Dr. Trish Tucker, PhD, Faculty of Health Sciences, Western University

Leigh Vanderloo, PhD student, Faculty of Health Sciences, Western University

#### **Invitation to participate:**

This study aims to objectively measure the physical activity levels of toddlers. Your child is being invited to participate because he or she falls between the ages of 18 to 35 months.

#### **Purpose of this letter:**

The purpose of this letter is to provide you with the information needed to make an informed decision regarding your child’s participating in the present study.

#### **Background:**

Currently, no investigations in Canada have been conducted to examine the physical activity levels of toddlers in Canada. In addition, there is little information available to assess whether this age group is successfully meeting the newly released physical activity guidelines, which recommend children between the ages of 1-4 years accumulate 180 minutes of activity per day (Canadian Society of Exercise Physiology, 2012).

Consequently, researchers at Western University are undertaking the first study to objectively measure the physical activity behaviours of Canadian toddlers. The information collected in this study will assist in identifying the activity levels of this particular cohort as well as identify potential avenues for promoting and supporting healthy active behaviours among young Canadians.

#### **What will happen in this study:**

If you agree to participate, your child will wear an accelerometer (a small, motion sensor device) during all waking hours for seven consecutive days. A pager-like device in size (please see picture on the next page), the accelerometer would be worn on an adjustable elastic belt around the child’s waist (over top of clothing) to collect information about the amount and intensity of his/her movements. While wearing the accelerometer, your child would still be able to participate in all normal activities. If your child is enrolled in some form of early learning program (e.g., childcare, nursery school, etc.), we ask that you

inform the childcare staff about the procedures of the study (i.e., your child is participating in a physical activity study where he/she is required to wear an accelerometer around his/her waist during all waking hours [including his/her time in childcare], etc.).

In addition to this letter of information and consent form, you will find a brief demographic questionnaire and screen viewing questionnaire included. Please complete both of these forms and return to the research team.



**Inclusion and exclusion criteria:**

In order for your child to participate in this study, he or she: a) must be between the ages of 18 to 35 months years at the time of data collection, b) must speak English, and c) must live in London, Ontario (and/or surrounding areas). Your child will not be able to participate if he or she: a) is not between the ages of 18 to 35 months years at the time of data collection, b) does not speak English, and c) does not live in London, Ontario (or surrounding areas).

**Alternatives and your right to withdraw from the study:**

Your participation (and your child's) in this study is voluntary. You may refuse to participate, refuse to answer any questions, or withdraw from the study at any time. You will also have the right to withdraw your (and your child's) data prior to the point of data entry, at which time, the data will be removed. Your child also has the right to refuse participation on the day of data collection.

**Possible benefits and risks to you for participating in the study:**

There are no known risks for being in this study. You do not waive any of the legal rights you would otherwise have as a participant in a research study. The benefit to participating in this study might include the identification of the physical activity levels of Canadian toddlers, thus potentially supporting improved physical activity behaviours among this particular age group. There are no personal benefits to your child participating in this study. Tokens of appreciation will be distributed to the parents/guardians of the participants to acknowledge their contributions to the study.

**Confidentiality:**

We will keep your child's identity and physical activity level, as well as written records, confidential and secure. No names will appear on any publications generated during the course of this study. If we find information we are required by law to disclose, we cannot guarantee confidentiality.

All data obtained will be stored in secured computer files (password encrypted) and stored in locked filing cabinets at Western University. Only the research team will have access to these data. The data will be retained for five years after the results of the study have been published. After this period, all data will be destroyed (i.e., the computer data will be erased and all written/paper data will be shredded).

**Costs and compensation:**

There is no cost to you for participating in the study. To acknowledge your contribution to the study, you will receive a \$10 gift card to a local grocery store at the end of data collection.

**Publication of the results:**

When the results of the study are published, you/your child's name will not be used. If you would like to receive a copy of the overall results of the study, please tick the appropriate box on your child's consent form.

For further information on this study, you can contact the Principal Investigator, Dr. Trish Tucker at [REDACTED].

\* If you have any further questions regarding your rights as a study participant, please contact Western University's Office of Research Ethics at [REDACTED].

**This letter is for you to keep.**



## Tots in Motion: An Objective Assessment of Toddlers' Physical Activity Levels

I have read the Letter of Information, have had the nature of the study explained to me, and I agree to participate. All questions have been answered to my satisfaction.

_____	_____	_____	_____
Date	Participant's Name (please print)	Parent/Guardian Name (please print)	Parent/Guardian Signature

_____	_____	_____
Date	Name of Researcher Obtaining Informed Consent (please print)	Signature



Do you wish to obtain a copy of the study results?

- Yes
- No

If YES, how would you prefer to receive the results? (please provide necessary contact information)

- Email: \_\_\_\_\_
- Mail (post): \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Would you like to be contacted to participate in future studies conducted by this research team?

- Yes (please provide contact information above)
- No



Appendix D

Wear-Time Log for Study 1



**Accelerometer Log**

Participant ID #	Actical® Serial Number	Wear Time				What was your toddler's experience with the Actical®?	Notes
		Date	Worn?	Time ON	Time OFF		
			<input type="checkbox"/>				
			<input type="checkbox"/>				
			<input type="checkbox"/>				
			<input type="checkbox"/>				
			<input type="checkbox"/>				

Appendix E

Toddler Screen-Viewing Questionnaire for Study 1



**Western**  
UNIVERSITY · CANADA

**Tots in Motion: An Objective  
Physical Activity Levels**

**Assessment of Toddlers'**

**Toddler Screen-Viewing Questionnaire**

Please complete the following questionnaire regarding your toddlers' screen-viewing behaviours. Thank you.

1. Does your toddler watch TV (including VHS, DVD, or online programming)?

- Yes
- No

2. If yes, approximately how many minutes does your child spend watching TV?

Per weekday?	Per weekend day?
<input type="checkbox"/> Less than 30 minutes per day	<input type="checkbox"/> Less than 30 minutes per day
<input type="checkbox"/> 30-59 minutes per day	<input type="checkbox"/> 30-59 minutes per day
<input type="checkbox"/> 60-89 minutes per day	<input type="checkbox"/> 60-89 minutes per day
<input type="checkbox"/> 90-120 minutes per day	<input type="checkbox"/> 90-120 minutes per day
<input type="checkbox"/> More than 120 minutes per day	<input type="checkbox"/> More than 120 minutes per day

3. Does your toddler spend time on a computer and/or on other electronic devices with screens (inclusive of tablets and smart phones)?

- Yes
- No

4. If yes, approximately how many minutes does your child spend on these devices?

Per weekday?	Per weekend day?
<input type="checkbox"/> Less than 30 minutes per day	<input type="checkbox"/> Less than 30 minutes per day
<input type="checkbox"/> 30-59 minutes per day	<input type="checkbox"/> 30-59 minutes per day
<input type="checkbox"/> 60-89 minutes per day	<input type="checkbox"/> 60-89 minutes per day
<input type="checkbox"/> 90-120 minutes per day	<input type="checkbox"/> 90-120 minutes per day
<input type="checkbox"/> More than 120 minutes per day	<input type="checkbox"/> More than 120 minutes per day

5. What are the primary reasons your child watches TV and/or plays on a computer (please check all that apply)?

- |  |   |
|--|---|
| <input type="checkbox"/> Educational   | <input type="checkbox"/> During babysitting/childcare minding hours |
| <input type="checkbox"/> Entertainment   | <input type="checkbox"/> Other: _____                               |
| <input type="checkbox"/> To occupy/mind child while completing household errands |   |

6. What programs does he/she typically enjoy watching on TV (please list the names of the programs)?

7. During the day/evening, is the TV ever left on in the background while your child plays?

- All the time
- Sometimes
- Never

8. Do you typically sit with your child while he/she watches TV?

- All the time
- Sometimes
- Never

9. When thinking about your own screen-viewing behaviours, on average, how many minutes per day do you spend viewing screens outside of work (this refers specifically to watching TV shows and movies as well as internet surfing)?

- |   |  |
|---|--|
| <input type="checkbox"/> Less than 30 minutes | <input type="checkbox"/> 90-119 minutes        |
| <input type="checkbox"/> 30-59 minutes        | <input type="checkbox"/> 120-149 minutes       |
| <input type="checkbox"/> 60-89 minutes        | <input type="checkbox"/> More than 150 minutes |

10. How many TVs do you have in the house?

- 0
- 1
- 2
- 3 or more

**Thank you for completing this questionnaire.**

Appendix F

Parent/Guardian Demographic Questionnaire for Study 1



**Tots in Motion: An Objective Assessment of Toddlers' Physical Activity Levels**

**Parent/Guardian Demographic Questionnaire**

**A. ABOUT YOUR TODDLER**

**What is the sex of your toddler?**

- Male  
 Female

**What is the age of your toddler? (please be exact)**

\_\_\_\_\_ years    \_\_\_\_\_ months

**What is your toddler's height?**

\_\_\_\_\_ cm

**What is your toddler's weight?**

\_\_\_\_\_ kg    OR    \_\_\_\_\_ lbs

**What is your toddler's racial background/ethnicity?**

- |  |  |
|--|--|
| <input type="checkbox"/> Caucasian         | <input type="checkbox"/> Asian                   |
| <input type="checkbox"/> African Canadian  | <input type="checkbox"/> Other (please specify): |
| <input type="checkbox"/> Native/Aboriginal | _____  |
| <input type="checkbox"/> Arab              | <input type="checkbox"/> Prefer not to answer    |
| <input type="checkbox"/> Latin-American    |  |

**Does your toddler attend childcare (home- or centre-based)?**

- Yes  
 No  
 Other (e.g., nanny, etc.)

**If YES, which type of setting?**

- Centre-based childcare  
 Home-based childcare

**If YES, approximately how many hours per week does your toddler spend in this setting?**

- Less than 10 hours
- 10-19 hours
- 20-29 hours
- 30 hours or more

**In your opinion, how active is your toddler?**

- Not at all active
- Somewhat active
- Very active
- Do not know

**Is your toddler enrolled in extra-curricular sports/activities?**

- Yes
- No

**If YES, what kinds of sports/activities is your toddler enrolled in? (please check all that apply)**

- |  |  |
|--|--|
| <input type="checkbox"/> Soccer            | <input type="checkbox"/> Volleyball              |
| <input type="checkbox"/> Hockey            | <input type="checkbox"/> Dance                   |
| <input type="checkbox"/> Skating           | <input type="checkbox"/> Swimming                |
| <input type="checkbox"/> Baseball/Softball | <input type="checkbox"/> Karate                  |
| <input type="checkbox"/> Tennis/Badminton  | <input type="checkbox"/> Other (please specify): |
| <input type="checkbox"/> Basketball        | _____  |

**If YES, how many hours per week does your toddler spend in these extra-curricular sports/activities?**

- Less than 2 hours
- Between 2-5 hours
- More than 5 hours

**B. ABOUT YOUR HOUSEHOLD**

**What is your family situation?**

- |  |   |
|--|---|
| <input type="checkbox"/> Single-parent | <input type="checkbox"/> Other: _____         |
| <input type="checkbox"/> Double-parent | <input type="checkbox"/> Prefer not to answer |
| <input type="checkbox"/> Guardian-led  |   |

**How many people live in your household (including yourself)?**

- 2       3       4       5       6       7+



**What is the approximate yearly income of your household?**

- |  |   |
|--|---|
| <input type="checkbox"/> Less than \$20,000  | <input type="checkbox"/> \$100,000-\$119,999  |
| <input type="checkbox"/> \$20,000 - \$39,999 | <input type="checkbox"/> \$120,000-\$149,999  |
| <input type="checkbox"/> \$40,000 - \$59,999 | <input type="checkbox"/> More than \$150,000  |
| <input type="checkbox"/> \$60,000 - \$79,999 | <input type="checkbox"/> Prefer not to answer |
| <input type="checkbox"/> \$80,000 - \$99,999 |   |

**C. ABOUT YOU**

**Please circle/check your highest level of education completed.**

- Elementary school (Grade school)
- Secondary school (High school)
- College
- University
- Graduate School
- Prefer not to answer

**On average, how many minutes per week do you spend engaged in moderate-vigorous physical activity (e.g., brisk walking, jogging, bike riding, cross-country skiing, etc.)?**

- Less than 30 minutes
- 30-59 minutes
- 60-89 minutes
- 90-119 minutes
- 120-149 minutes
- 150 minutes or more

**With regards to physical activity, do you feel that you are a strong role model for your toddler?**

- Yes, very much
- Somewhat, I could probably be a better role model
- Not at all
- Do not know

**Thank you for completing this questionnaire.**

Appendix G

Ethics Approval Notice for Study 2



**Use of Human Participants - Ethics Approval Notice**

**Principal Investigator:** Dr. Trish Tucker  
**Review Number:** 18280E  
**Review Level:** Delegated  
**Approved Local Adult Participants:** 0  
**Approved Local Minor Participants:** 189  
**Protocol Title:** Are Canadian Preschoolers Sufficiently Active? An Objective Assessment of Physical Activity Levels in Childcare and Full Day Early Learning Centres  
**Department & Institution:** Occupational Therapy, University of Western Ontario  
**Sponsor:** Canadian Institutes of Health Research

**Ethics Approval Date:** September 02, 2011 **Expiry Date:** March 31, 2013  
**Documents Reviewed & Approved & Documents Received for Information:**

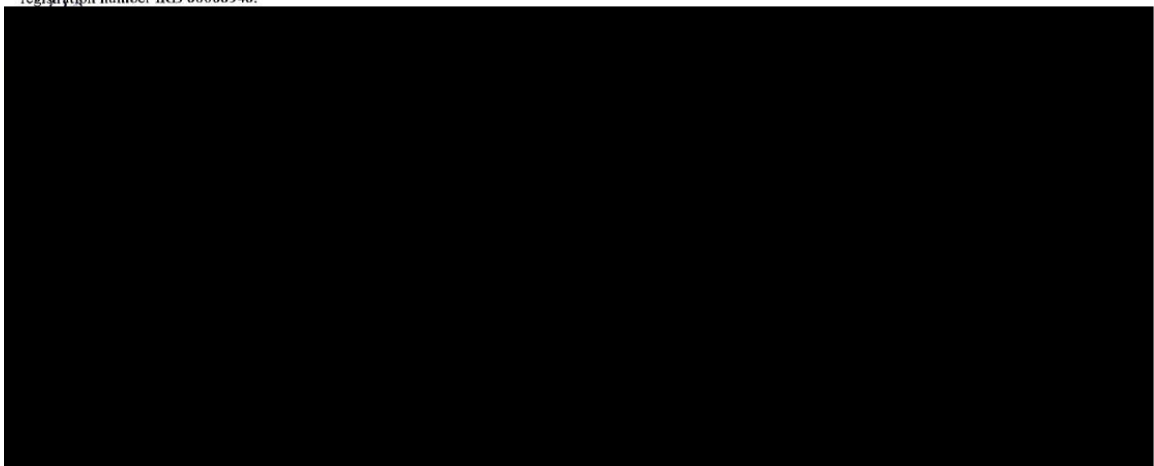
Document Name	Comments	Version Date
UWO Protocol		
Advertisement	Email to Directors and Principals	
Letter of Information & Consent	Parents/Guardians	2011/08/04
Other	Letter of Thanks Parents/Guardians	
Other	Letter of Thanks Directors/Principals	
Letter of Information	Childcare Providers	2011/08/04

This is to notify you that The University of Western Ontario Research Ethics Board for Health Sciences Research Involving Human Subjects (HSREB) which is organized and operates according to the Tri-Council Policy Statement: Ethical Conduct of Research Involving Humans and the Health Canada/ICH Good Clinical Practice Practices: Consolidated Guidelines; and the applicable laws and regulations of Ontario has reviewed and granted approval to the above referenced revision(s) or amendment(s) on the approval date noted above. The membership of this REB also complies with the membership requirements for REB's as defined in Division 5 of the Food and Drug Regulations.

The ethics approval for this study shall remain valid until the expiry date noted above assuming timely and acceptable responses to the HSREB's periodic requests for surveillance and monitoring information. If you require an updated approval notice prior to that time you must request it using the UWO Updated Approval Request Form.

Members of the HSREB who are named as investigators in research studies, or declare a conflict of interest, do not participate in discussion related to, nor vote on, such studies when they are presented to the HSREB.

The Chair of the HSREB is Dr. Joseph Gilbert. The UWO HSREB is registered with the U.S. Department of Health & Human Services under the IRB registration number IRB 00000940.



Appendix H

Parent/Guardian Consent Form and Letter of Information for Study 2



## **Are Canadian Preschoolers Sufficiently Active? An Objective Assessment of Physical Activity Levels in Childcare and Full Day Early Learning Centres**

### **Letter of Information for Parents/Guardians**

#### **Investigators:**

Dr. Trish Tucker, PhD, Faculty of Health Sciences, Western University  
 Dr. Shauna Burke, PhD, Faculty of Health Sciences, Western University  
 Dr. Andrew Johnson, PhD, Faculty of Health Sciences, Western University  
 Dr. Jennifer Irwin, PhD, Faculty of Health Sciences, Western University  
 Dr. Courtney Newnham, PhD, Faculty of Health Sciences, Western University  
 Ms. Leigh Vanderloo, MSc, Faculty of Health Sciences, Western University

#### **Background:**

Based on a pilot study that was conducted in Fall 2010, researchers at the University of Western Ontario are expanding their study to understand the impact of the early learning environment on physical activity levels among preschool-aged children (i.e. those aged 2.5-5 years). The information collected will identify essential elements that support the early learning program's ability to provide opportunities for physical activity education and play. The data from this study may also contribute to the development of future classroom policies and regulations, and provide guidance for future health promotion programs in the early learning environment.

#### **What will happen in this study:**

If you agree to participate, your child will wear an accelerometer (a small, motion sensor device) during childcare hours for five consecutive days. A pager-like device in size (please see picture below), the accelerometer would be worn on a belt around the child's waist (over top of clothing) to collect information about the amount and intensity of his/her movements. While wearing the accelerometer, your child would still be able to participate in all normal activities. One weekday prior to data collection, a researcher will come to your child's childcare centre to take his/her height, weight, and waist circumference measurements (which are necessary to input into the Actical® accelerometer to calculate energy output). Children will be individually measured by the project coordinator, along with a research assistant, and these measurements will be completed in a corner of the centre, to ensure your child's privacy. Two researchers will also be present on the first day of accelerometer data collection to acquire information on the policies and environment of the centre, and consequently, your child will be *indirectly*

observed during this time (i.e., for the purpose of this study, it is the environment being directly observed, not the child).



In addition to this letter of information and consent form, you will find a brief demographic questionnaire and child temperament questionnaire included. Parents are being asked to complete these surveys to seek demographic information about your child, inclusive of your child's age (this is required to program the accelerometer – your child will be unable to participate if the child's date of birth is not provided). Please complete both surveys and send back in the enclosed envelope to your preschooler's childcare provider.

**Alternatives and your right to withdraw from the study:**

Your participation (and your child's) in this study is voluntary. You may refuse to participate, refuse to answer any questions, or withdraw from the study at any time. You will also have the right to withdraw your (and your child's) data prior to the point of data entry, at which time, the data will be removed. Your child also has the right to refuse participation on the day of data collection.

**Possible benefits and risks to you for participating in the study:**

There are no known risks for being in this study. You do not waive any of the legal rights you would otherwise have as a participant in a research study. The benefit to participating in this study might include changes to the early learning environment following this study which may support improved physical activity behaviours of preschool-aged children.

**Confidentiality:**

We will keep your child's identity and physical activity level, as well as written records, confidential and secure. No names will appear on any publications generated during the course of this study.

**Costs and compensation:**

There is no cost to you for participating in the study. To acknowledge your contribution to the study, you will receive a \$20 gift card to the Real Canadian Superstore at the end of data collection.

**Publication of the results:**

When the results of the study are published, your name/your child's name will not be used. If you would like to receive a copy of the overall results of the study, please put your name and address on a blank piece of paper and return it to the researchers along with your child's consent form.

For further information on this study, you can contact the Program Coordinator, Dr. Courtney Newnham at [REDACTED].

\* If you have any further questions regarding your rights as a study participant, please contact the University of Western Ontario Office of Research Ethics at [REDACTED].

**This letter is for you to keep.**



**Are Canadian Preschoolers Sufficiently Active? An Objective Assessment of Physical Activity Levels in Childcare and Full Day Early Learning Centres**

I have read the Letter of Information, have had the nature of the study explained to me, and I agree to participate. All questions have been answered to my satisfaction.

_____	_____	_____	_____
Date	Participant's name (please print)	Parent/Guardian Name (please print)	Parent/Guardian Signature

_____	_____	_____
Date	Name of researcher obtaining informed consent (please print)	Signature

**\*\*Please return to your preschooler's childcare provider along with the parent/guardian demographic questionnaire and child temperament questionnaire in the enclosed envelope.\*\***



Appendix I

Environmental and Policy Assessment and Observation (EPAO) Instrument for Study 2

8818607480

**EPAO Observation**

Center Name \_\_\_\_\_

Date of Observation:  /  /  Observer ID#:  Start time:  :

month                      day                      year

Number of children in classroom:       Ages of children:  1    4      Eating Occasions Observed:  Breakfast

[Mark all that apply]       2    5      [Mark all that apply]       AM Snack

3    6       Lunch

Initials of Teacher Observed: \_\_\_\_\_       PM Snack

Total Physical Activity occasions observed:       End time:  :

Weather:

**Eating Occasions - Foods**

1. How was **breakfast** served? *[Choose one.]*

- family style
- delivered and served in prepared portions
- delivered in bulk and portioned by staff
- N/A

2. How was **a.m. snack** served? *[Choose one.]*

- family style
- delivered and served in prepared portions
- delivered in bulk and portioned by staff
- N/A

3. How was **lunch** served? *[Choose one.]*

- family style
- delivered and served in prepared portions
- delivered in bulk and portioned by staff
- N/A

**EPAO Observation**

4. How was **p.m. snack** served? [Choose one.]

- family style
- delivered and served in prepared portions
- delivered in bulk and portioned by staff
- N/A

5. How many times was **fruit** served the day of observation?

- 0    1    2    3    4    5    other →

6. How many times was **fruit** served fresh, frozed or canned in own juice the day of observation?

- 0    1    2    3    4    5    other →

7. How many times was **100% fruit juice** served the day of observation?

- 0    1    2    3    4    5    other →

8. How many times were **vegetables** (not including French fries or fried vegetables) served the day of observation?

- 0    1    2    3    4    5    other →

9. How many times were **dark green, red, orange or yellow vegetables** served the day of observation?

- 0    1    2    3    4    5    other →

10. Was **margarine, butter, or meat fat** visible on vegetables?

- yes
- no → 10a. According to staff, during the day of observation were vegetables prepared with added fat?  yes    no    unsure
- no vegetables served

**EPAO Observation**

11. Are vegetables **typically** served with added fat? (ask classroom staff or cook)  yes  no  unsure
12. How many times were **fried or pre-fried vegetables** (e.g., tator tots, french fries, fried okra, fried zucchini and hashbrowns) served the day of observation?  0  1  2  3  other →
13. How many times were **fried or pre-fried meats** (e.g., chicken nuggets, fish sticks) served the day of observation?  0  1  2  3  other →
14. How many times were **high fat meats** (e.g., ground beef, bologna, hotdogs, ham) served the day of observation?  0  1  2  3  other →
15. How many times were **lean meats/fish** (e.g., baked chicken or turkey breasts, baked fish, deli turkey, tuna and salmon) served the day of observation?  0  1  2  3  other →
16. How many times were **beans/lentils** served the day of observation?  0  1  2  3  other →
17. How many times were **high sugar and/or high fat foods(not condiments)** served the day of observation?  0  1  2  3  4  5  other →
18. How many times were **high sugar and/or high fat condiments** served the day of observation?  0  1  2  3  4  5  other →
19. How many times were **high fiber grains** served the day of observation?  0  1  2  3  4  5  other →

**EPAO Observation**

**Eating Occasions - Beverages**

20. Was drinking water for children visible in the classroom?

- yes → 20a. How accessible was drinking water to children in the classroom?
- no
  - available for self-serve (child-level fountain or pitcher/cups on table)
  - available by request only

20b. If no, is there a water fountain in a nearby hallway?

- yes → 20b\_1. How accessible is this fountain to children?
- no
  - available by request only (must ask permission to leave classroom)
  - during teacher-designated water breaks

21. Did you witness teachers prompting children throughout the day to drink water?

- yes, regularly (multiple times throughout the day, not just specific occasions such as coming in from outdoor play)
- yes, at specific times only (such as coming in from outdoor play)
- no

22. How many times were **sugar drinks** (Kool-aid, sports drinks, sweet tea, punch, sodas) served the day of observation?

- 0
- 1
- 2
- 3
- 4
- 5
- other →

23. How many times was **milk** served the day of observation?

- 0
- 1
- 2
- 3
- other →

24. What type of **milk** was served **to the majority** of children at a majority of meals?  
*[Mark only one.]*

- Whole
- Skim
- Rice milk
- 2%
- Whole, flavored
- Soy milk
- 1%
- Lower fat, flavored (2%, 1%, skim)
- Lactaid

**EPAO Observation**

25. Note other types of **milk** served to **selected** children: *[Mark all that apply.]*

- Whole       Skim       Rice milk
- 2%       Whole, flavored       Soy milk
- 1%       Lower fat, flavored (2%, 1%, skim)       Lactaid

**Eating Occasions - Staff Behavior**

26. Did staff push children to eat more than they want to (e.g., clean your plate, you won't get dessert until you finish lunch)?

yes → 26a. How many eating occasions was the behavior observed?  
 no       1     2     3     4     5     other →

27. Did staff serve children second helpings without being asked for more by the child (see an empty plate and add food without request by child)?

yes → 27a. How many eating occasions was the behavior observed?  
 no       1     2     3     4     5     other →

28. Did staff positively and gently encourage children to try new or less favorite foods?

yes → 28a. How many eating occasions was the behavior observed?  
 1     2     3     4     5     other →    
 no (children resisted eating but were not encouraged)  
 no children resisting eating observed

29. Was food used to control behavior?

yes → 29a. How many eating occasions was the behavior observed?  
 no       1     2     3     4     5     other →

**EPAO Observation**

30. Did staff sit with children during lunch?

yes → 30a. Did staff consume the same food as children? →  yes  no  
 no

31. Did staff eat and/or drink less healthy foods in front of children?

yes → 31a. How many meals?  1  2  3  4  5  other →    
 no  
 did not observe staff eating

32. Did staff talk with children about healthy foods?

yes → 32a. How many separate times did you observe staff talking to children about healthy foods?  1  2  3  4  5  other →    
 no

33. Was any **formal** nutrition education for children observed?

yes  no

**Physical Activity - CHILD BEHAVIORS**

34. How many minutes of total active play time was observed (includes indoor, outdoor, structured and unstructured)?

minutes

35. Was structured physical activity observed?

no  
 yes ↓  
 35a. How many occasions?  1  2  3  4  5  other ↓  
 35b. Total minutes of structured PA observed:        
minutes  
 35c. Was the structured PA optional for children?  yes  no

**EPAO Observation**

36. Did you observe any outdoor active play?

yes → 36a. How many times/day?  1  2  3  4  5  other →

no → 36b. Was it due to weather (too hot, too cold, rain/snow)?

yes  no  unsure

37. How many total minutes of outdoor active play (structured and unstructured) was observed?

minutes

38. Was drinking water for children available outdoors?

yes  no  no outdoor time observed → 38a. Did you see a drinking fountain  yes  no located in the outdoor play area?

39. While outdoors, did you witness teachers prompting children to drink water?

yes  no  no outdoor time observed

**Sedentary Activities - Child**

40. Did you observe children seated for more than 30 minutes at a time (excluding nap and meal times)?

yes → 40a. How many times/day?  1  2  3  4  5  other →

no

40b. How many total minutes of seated activity (majority of the class seated) was observed?

minutes



**EPAO Observation**

41. Was a TV present in the room?  yes  no

42. Was TV viewing observed?

yes → 42a. Total minutes TV was on:    minutes

no

yes → 42b. Was it on during meals?  yes → 42b\_1. If yes, how many meals?  1  2  3 or more

no

42c. Was the TV used only for viewing educational programs?  yes  no

43. Was a VCR/DVD present in the room?  yes  no

44. Was there a video game system present in the room?  yes  no

45. Was a computer present in the room for use by children?  yes  no

46. Was video game or computer game playing observed?

yes → 46a. Total number of minutes computer/video game playing was observed:    minutes

no

46b. Was it being used for educational purposes only?  yes  no

46c. How many total children participated in computer/video game playing during the entire day?   # of children

**EPAO Observation**

**Physical Activity - Staff Behaviors**

47. Did you observe restricting active play as punishment?

yes → 47a. How many times/day? 
  1 
  2 
  3 
  4 
  5 
  other →

no

48. Did staff join in active play?

yes → 48a. How many times/day? 
  1 
  2 
  3 
  4 
  5 
  other →

no

49. How many positive statements were made about physical activity (e.g., Good throw!, Running is fun!, I like the way you threw that ball!)?

1 
  2 
  3 
  4 
  5 
  other →

50. Did staff provide prompts to **increase** physical activity (e.g., Can you jump higher?, Can you hop on one foot?)?

yes → 50a. How many times/day? 
  1 
  2 
  3 
  4 
  5 
  other →

no

51. Did staff provide prompts to **decrease** physical activity (e.g., Slow down!, Give it a rest! Don't climb on the slide!)?

yes → 51a. How many times/day? 
  1 
  2 
  3 
  4 
  5 
  other →

no

52. Were any **formal** physical education lessons for children observed?  yes  no

53. Were any extra-curricular (special) physical activity programs provided to children on a fee basis (e.g., Tumbling Tots, Tumble Bus)?

yes → 53a. Were any active alternatives provided for those children that did not participate? →  yes  no

no

**EPAO Observation**

**Center Environment**

54. Where were soda and other vending machines located?

- |   |   |   |   |                           |
|---|---|---|---|---------------------------|
| <input type="radio"/> in entrance or front                  | → | 54a. Did they contain only healthy options<br>(e.g., water, milk, 100% fruit juice,<br>granola bars, pretzels, nuts)? | → | <input type="radio"/> yes |
| <input type="radio"/> in public areas, but not the entrance |   |   |   | <input type="radio"/> no  |
| <input type="radio"/> out of sight of parents and kids      |   |   |   |                           |
| <input type="radio"/> no vending machines on site           |   |   |   |                           |

Please indicate where these pieces of physical activity equipment (both fixed and portable) were located:

<b>55. Fixed Play Equipment</b>	<i>indoors only</i>	<i>outdoors only</i>	<i>both indoors &amp; outdoors</i>	<i>not present</i>
a. balancing surfaces (balance beams, boards, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. basketball hoop	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. climbing structures (jungle gyms, ladders, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. merry-go-round	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. pool	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f. sandbox	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g. see-saw	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h. slides	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i. swinging equipment (swings, rope, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
j. tricycle track	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
k. tunnels	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**EPAO Observation**

<b>56. Portable Play Equipment</b>	<i>indoors only</i>	<i>outdoors only</i>	<i>both indoors &amp; outdoors</i>	<i>not present</i>
a. ball play equipment	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
b. climbing structures (ladders, jumble gyms, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
c. floor play equipment (tumbling mats, carpet squares, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
d. jumping play equipment (jump ropes, hula hoops)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
e. parachute	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
f. push/pull toys (wagon, scooters, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
g. riding toys (tricycles, cars, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
h. rocking & twisting toys (rocking horse, sit-n-spin, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
i. sand/water play toys (buckets, scoops, shovels, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
j. slides	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
k. twirling play equipment (ribbons, scarves, batons, etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

57. Was outdoor running space . . .

- unobstructed with plenty of space for groups games (tag, red rover, etc.)
- some obstruction, but space was adequate for individual play (running, skipping, etc.)
- plenty of space for play, but obstructed with play equipment
- little running space or completely obstructed

58. Did staff limit or restrict outdoor play area in a way that substantially affect active play (more than 1/3 of total play space or equipment)?

yes → 57a. How many outdoor play occasions?
  1
  2
  3
  4
  5
  other →

no

EPAO Observation

59. Was indoor play space suitable for . . .

- quiet play (classroom is small and not a lot of room for movement)
- limited movement/some active play (able to translocate by walking, skipping, hopping, jumping, etc.)
- all activities (easily able to perform all gross motor activities)

60. Were any posters, pictures or displayed books about **physical activity** present in the observation room?

- yes → 60a. How many were present?  1  2  3  4  5  other
- no

61. Were any posters, pictures or displayed books about **nutrition** present in the observation room?

- yes → 61a. How many were present?  1  2  3  4  5  other
- no

EPAO Document Review

2689175402

Section 1: Menu Review - Observed Foods & Beverages

Fruits and Vegetables

Date of Assessment:

/  /   
month day year

ID#:

1. Fruit (not juice):

a. Is the menu consistent with observation for frequency served?

yes  no → a1. How many times does fruit appear on the menu **for the day of observation** only?  0  1  2  3  other

↓

b. Is menu consistent with observation for type served?

yes  no  type not specified on menu

c. How many total times does fruit appear on the menu **for that full week**?

2. Vegetables (not including fried or prefried vegetables):

a. Is the menu consistent with observation for frequency served?

yes  no → a1. How many times do vegetables appear on the menu **for the day of observation** only?  0  1  2  3  other

↓

b. Is menu consistent with observation for type served?

yes  no  type of vegetable not specified on menu

c. How many total times do vegetables appear on the menu **for that full week**?

3. Dark green, red, orange, or yellow vegetables:

a. Is the menu consistent with observation for frequency served?

yes  no → a1. How many times do vegetables (dark green, red, orange or yellow) appear on the menu **for the day of observation** only?  0  1  2  3  other

↓

b. Is menu consistent with observation for type served?

yes  no  type of vegetable not specified on menu

c. How many total times do dark green, red, yellow or orange vegetables appear on the menu **for that full week**?

**4. Added fat for cooked vegetables:**

a. Is added meat fat, margarine, or butter specified on the menu for cooked vegetables?

- yes     no → a1. How many total times does it appear on the menu **for the day of observation** only?     0     1     2     3     other

↓

--	--

b. How many total times do vegetables **with added fat** appear on the menu **for that full week?**

--	--

**Fried Foods and High Fat Meats**

**5. Fried or pre-fried meats (chicken nuggets) or fish (fish sticks):**

a. Is the menu consistent with observation for frequency served?

- yes     no → a1. How many times do fried or pre-fried meats appear on the menu **for the day of observation** only?     0     1     2     3     other

↓

--	--

b. Is menu consistent with observation for type served?

- yes     no

c. How many total times do fried or pre-fried meats appear on the menu **for that full week?**

--	--

**6. Fried or pre-fried vegetables (French fries, tater tots, hash browns, fried okra):**

a. Is the menu consistent with observation for frequency served?

- yes     no → a1. How many times do fried or pre-fried vegetables appear on the menu **for the day of observation** only?     0     1     2     3     other

↓

--	--

b. Is menu consistent with observation for type served?

- yes     no

c. How many total times do fried or pre-fried vegetables appear on the menu **for that full week?**

--	--

**7. High fat meats (sausage, bacon, hot dogs, bologna, ground beef):**

a. Is menu consistent with observation for frequency served?

yes  no → a1. How many total times do high fat meats appear on the menu **for the day of observation** only?  0  1  2  3  other

↓

--	--

b. Is menu consistent with observation for type served?

yes  no

c. How many total times do high fat meats appear on the menu for **that full week**? 

--	--

**8. Lean meats (baked or broiled chicken, turkey or fish):**

a. Is the menu consistent with observation for frequency served?

yes  no → a1. How many times do lean meats appear on the menu **for the day of observation** only?  0  1  2  3  other

↓

--	--

b. Is menu consistent with observation for type served?

yes  no

c. How many total times do lean meats appear on the menu **for that full week**? 

--	--

**9. Beans/Lentils:**

a. Is the menu consistent with observation for frequency served?

yes  no → a1. How many times do beans/lentils appear on the menu **for the day of observation** only?  0  1  2  3  other

↓

--	--

b. Is menu consistent with observation for type served?

yes  no

c. How many total times do beans/lentils appear on the menu **for that full week**? 

--	--



Beverages

10. 100% fruit juice:

a. Is the menu consistent with observation for frequency served?

yes  no → a1. How many times does 100% fruit juice appear on the menu  0  1  2  3  other  
for the day of observation only?

↓  
□ □

b. Is menu consistent with observation for type served?

yes  no

□ □

c. How many total times does 100% fruit juice appear on the menu for that full week?

11. Sugar drinks (Kool-aid, sports drinks, sweet tea, punches, soda) other than 100% fruit juice:

a. Is the menu consistent with observation for frequency served?

yes  no → a1. How many times do sugar drinks appear on the menu  0  1  2  3  other  
for the day of observation only?

↓  
□ □

b. Is menu consistent with observation for type served?

yes  no

□ □

c. How many total times do sugar drinks appear on the menu for that full week?

12. Milk:

a. Is the menu consistent with observation for frequency served?

yes  no → a1. How many times does milk appear on the menu  0  1  2  3  other  
for the day of observation only?

↓  
□ □

b. Is menu consistent with observation for type served?

yes  no  type not specified on menu

□ □

c. How many total times does milk appear on the menu for that full week?

d. What type is indicated on the menu as "usually" served?

- Whole
- Skim
- Rice milk
- 2%
- Whole, flavored
- Soy milk
- 1%
- Lower fat, flavored (2%, 1%, skim)
- Type not specified on menu

**MENUS and Variety**

**13. Menus include high fiber grain foods (whole wheat bread, oatmeal, brown rice, Cheerios):**

a. Is the menu consistent with observation for frequency served?

yes  no → a1. How many times do high fiber grain foods appear on the menu **for the day of observation** only?  0  1  2  3  other

↓  

--	--

b. Is menu consistent with observation for type served?

yes  no

c. How many total times do high fiber grain foods appear on the menu **for that full week**?

--	--

**MEALS and SNACKS**

**14. High sugar and/or high fat foods (not including condiments):**

a. Is the menu consistent with observation for frequency served?

yes  no → a1. How many times do high sugar and/or high fat foods appear on the menu **for the day of observation** only?  0  1  2  3  other

↓  

--	--

b. Is menu consistent with observation for type served?

yes  no

c. How many total times do high sugar and/or high fat foods appear on the menu **for that full week**?

--	--

**15. High sugar and/or high fat condiments:**

a. Is the menu consistent with observation for frequency served?

yes  no → a1. How many times do high sugar and/or high fat condiments appear on the menu **for the day of observation** only?  0  1  2  3  other

↓  

--	--

b. Is menu consistent with observation for type served?

yes  no

c. How many total times do high sugar and/or high fat condiments appear on the menu **for that full week**?

--	--

**Section 2: MENU REVIEW - Weekly MENUS**

**MENUS and Variety**

**16. Weekly menus include foods from a variety of cultures:**

a. How many times are foods from a different culture present on the menu *for the observation week* only?

- 0  
  1  
  2  
  3  
  4  
  other →

**Section 3: GUIDELINE REVIEWS**

**FOODS OFFERED OUTSIDE OF REGULAR MEALS AND SNACKS**

**17. Does the center have written guidelines addressing holiday/celebration foods?**

- yes → a. If yes, are healthier items encouraged?  
  yes    no  
 no  
 no documents received from center

**18. Did you review past/future fundraising projects or guidelines?**

- yes → a. If yes, how many were non-food only?  
  all  
 Center guidelines do not address the type of fundraising, or fundraising at all  
  more than half  
 Center doesn't do fundraising  
  half  
 less than half  
 none

**NUTRITION POLICY**

**19. Does the center have a written policy on nutrition and food service?**

- yes → a. If yes, what areas of NAP SACC are covered? *[Mark all that apply.]*  
 no  
 no documents received from center
- |   |   |
|---|---|
| <input type="radio"/> F&V               | <input type="radio"/> Meals and snacks                            |
| <input type="radio"/> Fried food        | <input type="radio"/> Foods offered outside of reg meals & snacks |
| <input type="radio"/> High fat meats    | <input type="radio"/> Support for healthy eating                  |
| <input type="radio"/> Beverages         | <input type="radio"/> Nutrition education                         |
| <input type="radio"/> Menus and variety |   |

**EPAO Document Review**

6506175404

**Play ENVIRONMENT**

**20. Did you review any documentation of safety checks?**

<input type="radio"/> yes →	a. If yes, frequency of checks:	
<input type="radio"/> no	<input type="radio"/> only when installed <input type="radio"/> once a week	
	<input type="radio"/> once a year <input type="radio"/> other →	
	<input type="radio"/> once a month	

**Center Physical Activity Policy**

**21. Does the center have written policy on physical activity?**

<input type="radio"/> yes →	a. If yes, what areas of NAP SACC are covered? <i>[Mark all that apply.]</i>
<input type="radio"/> no	<input type="radio"/> Active play and inactive time <input type="radio"/> Supporting PA
<input type="radio"/> no documents received from center	<input type="radio"/> TV use and TV viewing <input type="radio"/> PA education
	<input type="radio"/> Play environment

**Section 4: TRAINING & CURRICULUM REVIEW**

**Nutrition Education For Children, Parents and Staff**

**22. Does the center provide nutrition training for staff?**

<input type="radio"/> yes →	a. If yes, how often?
<input type="radio"/> no	<input type="radio"/> 2 times/year or more <input type="radio"/> 1 time/year <input type="radio"/> less than 1 time/year
<input type="radio"/> no documents received from center	b. If yes, what was the content of the trainings?

23. Does the center have a documented nutrition curriculum for kids?

yes → a. If yes, what was the content of the curriculum?

no

24. Does the center have documentation of parent nutrition education/workshop materials?

yes → a. If yes, what was the content of the education workshops?

no

**Physical Activity Education For Children, Parents and Staff**

25. Does the center provide physical activity training for staff?

yes → a. If yes, how often?

no

2 times/year or more    1 time/year    less than 1 time/year

no documents  
received from  
center

b. If yes, what was the content of the trainings?

26. Does the center have a documented physical activity curriculum for kids?

yes → a. If yes, what was the content of the curriculum?

no

27. Does the center have documentation of physical activity education/workshop materials?

yes → a. If yes, what was the content of the workshops?

no

***Please use the following citation when referencing this instrument:***

Ball SC, Benjamin SE, Hales DP, Marks J, McWilliams CP, Ward DS. 2005. The Environment and Policy Assessment and Observation (EPAO) child care nutrition and physical activity instrument. Center for Health Promotion and Disease Prevention, University of North Carolina at Chapel Hill.

***Please use the following citation when referencing instrument protocol and interobserver agreement:***

Ward DS, Hales D, Haverly K, Marks J, Benjamin SE, Ball SC, Trost S. An instrument to assess the obesogenic environment of child care centers. Am J Health Behavior. 2008 Jul-Aug;32(4):380-6.

Appendix J

Parent/Guardian Demographic Questionnaire for Study 2

Participant ID #: \_\_\_\_\_



**Western**  
UNIVERSITY · CANADA

**Are Canadian Preschoolers Sufficiently Active? An Objective Assessment of Physical Activity Levels in Childcare and Full Day Early Learning Centres**

**Parent/Guardian Demographic Questionnaire**

*Answers to the first two questions are required to program the accelerometer to collect accurate information about your preschooler's physical activity behaviours. As such, if the first two questions are not answered, your child will NOT be able to participate in this study.*

**What is the sex of your preschooler?**

- Male
- Female

**What is the age of your preschooler?**

\_\_\_\_\_ years

**What is your relationship to the preschooler?**

- Parent
- Grandparent
- Guardian
- Other: \_\_\_\_\_

**What is your preschooler's racial background/ethnicity?**

- White
- African Canadian
- Native/Aboriginal
- Arab
- Latin-American
- Asian
- Other (please specify): \_\_\_\_\_
- I prefer not to answer

**What is your preschooler's height?**

\_\_\_\_\_ feet \_\_\_\_\_ inches



**What is your preschooler's weight?**

\_\_\_\_\_ pounds

How many people live in your household?

- 2     
  3     
  4     
  5     
  6     
  7 or more

**How many siblings does your preschooler have?**

- 0  
 1  
 2  
 3  
 4  
 5 or greater

**What is the approximate yearly income of your household?**

- < \$20,000  
 \$20,000 - \$39,999  
 \$40,000 - \$59,999  
 \$60,000 - \$79,999  
 \$80,000 - \$99,999  
 \$100,000-\$119,999  
 \$120,000-\$149,999  
 >\$150,000  
 I prefer not to answer

**What is your preschooler's family situation with you?**

- Single-parent  
 Double-parent  
 Guardian-led  
 Other: \_\_\_\_\_

**Please circle/check your highest level of education completed.**

- Grade:    1      2      3      4      5      6      7  
                   8      9      10     11     12     13
- College  
 University  
 Graduate School  
 Prefer not to answer

**What is your preschooler's childcare status?**

- Part-time  
 Full-time

**Approximately how many hours per week does your preschooler spend in this setting (home-based childcare facility, centre-based childcare facility, Full-Day Kindergarten, etc.)?**

- Less than 10 hours
- 10-19 hours
- 20-29 hours
- 30-39 hours
- 40-49 hours
- 50 hours or more

**Does your preschooler attend another childcare centre or kindergarten classroom when not at the centre for which you are completing this survey?**

- Yes
- No

**If yes, what type of facility?**

- Full-Day Kindergarten classroom
- Home-based childcare facility
- Centre-based childcare facility

**In your opinion, does the childcare centre your preschooler attends incorporate physical activity into the curriculum?**

- Yes
- No

**In your opinion, how active is your preschooler during childcare hours?**

- Not at all active
- Somewhat active
- Very active
- Do not know

**Is your preschooler enrolled in extra-curricular sports/activities?**

- Yes
- No

**If yes, what kinds of sports/activities is your preschooler enrolled in? (please check all that apply)**

- |  |  |
|--|--|
| <input type="checkbox"/> Soccer            | <input type="checkbox"/> Volleyball              |
| <input type="checkbox"/> Hockey            | <input type="checkbox"/> Dance                   |
| <input type="checkbox"/> Skating           | <input type="checkbox"/> Swimming                |
| <input type="checkbox"/> Baseball/Softball | <input type="checkbox"/> Karate                  |
| <input type="checkbox"/> Tennis/Badminton  | <input type="checkbox"/> Other (please specify): |
| <input type="checkbox"/> Basketball        | _____  |

**If yes, how many hours per week does your preschooler spend in extra-curricular sports/activities (if your child participates in more than one activity, please combine total time engaged in extra-curricular activities)?**

- Less than 2 hours
- Between 2-5 hours
- More than 5 hours

**On average, how many hours per day does your preschooler spend:**

	Less than 1 hour	1-2 hours	3-4 hours	5-6 hours	7 or more hours
<b>Watching TV?</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Playing video games?</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>On the computer?</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Now thinking about your own behaviours, on average, how many minutes per week do you spend engaged in moderate-vigorous activity (e.g., brisk walking, jogging, bike riding, cross-country skiing, etc.)?**

- Less than 30 minutes
- 30-59 minutes
- 60-89 minutes
- 90-119 minutes
- 120-149 minutes
- 150 minutes or more

**With regards to physical activity, do you feel that you are a strong role model for your preschooler?**

- Yes, very much
- Somewhat, I could probably be a better role model
- Not at all
- Do not know

**Thank you for completing this questionnaire. Please return to your preschooler's teacher along with the consent form and child temperament questionnaire in the enclosed envelope.**

Appendix K

Wear-Time Log for Study 2



**Western**  
UNIVERSITY · CANADA

## Daily Accelerometer Log

School name: \_\_\_\_\_

Completed by: \_\_\_\_\_

Participant ID	Actical® Serial #	Wear Time				Notes
		Date	Present?	Time ON	Time OFF	
			<input type="checkbox"/>			
			<input type="checkbox"/>			
			<input type="checkbox"/>			
			<input type="checkbox"/>			
			<input type="checkbox"/>			
			<input type="checkbox"/>			
			<input type="checkbox"/>			
			<input type="checkbox"/>			
			<input type="checkbox"/>			
			<input type="checkbox"/>			
			<input type="checkbox"/>			
			<input type="checkbox"/>			
			<input type="checkbox"/>			
			<input type="checkbox"/>			
			<input type="checkbox"/>			

Appendix L

Description of EPAO Subscales for Study 2

*Description of Physical Activity Subscales from Environment and Policy Assessment and Observation (EPAO) Instrument*

Subscale	Description
Staff Behaviours	Interactions between staff and children that may promote or discourage physical activity behavior; includes restricting active play, joining in activity, positive statements about physical activity (all Y/N)
Sedentary Environment	Items in the physical environment that may promote or discourage physical activity behavior; includes TV in room, computer in room, physical activity displays, posters, and books (all Y/N)
Sedentary Opportunities	Daily opportunities that may result in little or no MVPA; includes seated for 30 or more minutes (Y/N), TV viewing (minutes TV on), video game playing (Y/N)
Portable Play Environment	Presence of several types of play equipment that can be transported and used in various locations; includes jumping or twirling equipment, balls, hula hoops, and riding toys (all Y/N)
Fixed Play Environment	Equipment and space that is anchored or fixed within the center environment; includes climbing structures (Y/N), balancing surfaces (Y/N), running space (Y/N), and indoor play space (4-point rating)
Physical Activity Policies	Child care center written policies (all Y/N) related to: active and inactive time, TV use/viewing, play environment, supporting physical activity, and physical activity education.
Active Opportunities	Daily opportunities that may result in more MVPA; includes structured physical activity (# of occasions), outdoor play (# of occasions), and total minutes of active opportunity (any time play that <i>could</i> be rated as MVPA was an option or part of a structured lesson).
Physical Activity Training and Education	Training and education for children, staff, and/or parents that may increase participation or knowledge related to physical activity behavior; includes physical education curriculum, physical education observed, physical activity training for staff, physical activity education for parents (all Y/N)

*Note.* MVPA = moderate-vigorous physical activity; Y/N = yes/no. Reprinted with permission of the authors (D. Hales as corresponding author – personal communication, August 3, 2016)

Appendix M

EPAO Scoring Guidelines for Study 2



**EPAO Scoring Guidelines**

**Areas**

1. Total Nutrition = (FV+ Grains+HSHF+ Bev+ NutrEnv+SBnutr+ NutrTE+NutrPol)/8
2. Total Physical Activity = (Act+ Sed+ SedEnv+ PortEnv + Fix Env + PaTE +SBpa+ PaPol)/8

**Sub-Areas**

1. Fruits and Vegetables = FV
2. Whole grains and low fat meats = Grains
3. High sugar/high fat foods = HSHF
4. Beverages = Bev
5. Nutrition Environment = NutrEnv
6. Staff Behaviors-Nutrition = SBnutr
7. Nutrition Training and Education = NutrTE
8. Nutrition Policy = NutrPol
9. Active Opportunities = Act
10. Sedentary Opportunities = Sed
11. Sedentary Environment = SedEnv
12. Portable Play Environment = PortEnv
13. Fixed Play Environment = FixEnv
14. Staff Behaviors-Physical Activity = SBpa
15. Physical Activity Training and Education = PaTE
16. Physical Activity Policy = PaPol

**Nutrition**

1. FV = (sum of question scores/9) x 10

Range = 0-20

	Question	Answer	Score (0, 1, or 2)
Observation #5	How many times was fruit served the day of observation?	0	0
		1	1
		2 and greater	2
Doc Review #1c	How many total times does fruit appear on the menu for that full week	0-3	0
		4-6	1
		7 and greater	2
Observation #6	How many times was fruit served fresh, frozen or canned in own juice the day of observation	0	0
		1	1
		2 and greater	2
Observation #8	How many times were vegetables (not including French fries or fried vegetables) served the day of observation	0	0
		1	1
		2 and greater	2

Reprinted with permission of the authors (D. S. Ward as corresponding author – personal communication, August 15, 2016).

Doc Review #2c	How many total times do vegetables appear on the menu for that full week	0-3	0
		4-6	1
		7 and greater	2
Observation #9	How many times were dark green, red, orange or yellow vegetables served the day of observation	0	0
		1 or greater	2
Doc Review #3c	How many total times do dark vegetables appear on the menu for that full week	0-3	0
		4 or greater	2
Observation #10	Was margarine, butter, or meat fat visible on vegetables	No	1
		Yes	0
		No vegetables served	missing
Observation #11	Are vegetables typically served with added fat?	No	1
		Yes	0
		Unsure	missing
Doc Review #4a	Is added meat fat, margarine, or butter specified on the menu for cooked vegetables	No	2
		Yes	0

2. Grains = (sum of question scores/6) x 10

Range = 0-20

	Question	Answer	Score (0, 1, or 2)
Observation #15	How many times were lean meats/fish served the day of observation	0	0
		1 or greater	2
Doc Review #8c	How many total times do lean meats/fish appear on the menu for that full week	0	0
		1 or greater	2
Observation #16	How many times were beans/lentils served the day of observation	0	0
		1 or greater	2
Doc Review #9c	How many total times do beans/lentils appear on the menu for that full week	0	0
		1 or greater	2
Observation #19	How many times were high fiber grains served the day of observation	0	0
		1 or greater	2
Doc Review #13c	How many total times do whole grains appear on the menu for that full week	0	0
		1-3	1
		4 or greater	2

3. HFHS = (sum of question scores/9) x 10 Range = 0-20

	Question	Answer	Score (0, 1, or 2)
Observation #12	How many times were fried or pre-fried vegetables served the day of observation	0	2
		1	1
		2 or greater	0
Doc Review #6c	How many total times do fried or pre-fried vegetables appear on the menu for that full week	0	2
		1-3	1
		4 or greater	0
Observation #13	How many times were fried or pre-fried meats served the day of observation	0	2
		1	1
		2 or greater	0
Doc Review #5c	How many total times do fried or pre-fried meats appear on the menu for that full week	0	2
		1	1
		2 or greater	0
Observation #14	How many times were high fat meats served the day of observation	0	2
		1	1
		2 or greater	0
Doc Review #7c	How many total times do high fat meats appear on the menu for that full week	0	2
		1	1
		2 or greater	0
Observation #17	How many times were high sugar and/or high fat foods (not condiments) served the day of observation	0	2
		1	1
		2 or greater	0
Doc Review #14c	How many total times do high sugar and/or high fat foods (not condiments) appear on the menu for that full week	0	2
		1-3	1
		4 or greater	0
Observation #18	How many times were high sugar and/or high fat condiments served the day of observation	0 or 1	2
		2	1
		3 or greater	0

4. Bev = (sum of question scores/11) x 10

Range = 0-20

	Question	Answer	Score (0, 1, or 2)
Observation #7	How many times was 100% fruit juice served the day of observation	0	2
		1	1
		2 or greater	0
Doc Review #10c	How many total times does 100% fruit juice appear on the menu for that full week	0-1	2
		2	1
		3 or greater	0
Observation #20	Was drinking water for children visible in the classroom?	No	0
		Yes	2
Observation #20b	If no, is there a water fountain in a nearby hallway?	Yes	1
		No	0
** Observation #20 and 20b are combined questions and should be included as one question.			
Observation #21	Did you witness teachers prompting children throughout the day to drink water?	Yes, regularly	2
		Yes, at specific times only	1
		No	0
Observation #38	Was drinking water for children available outdoors?	Yes	2
		No	0
		No outdoor time observed	Missing
Observation #39	While outdoors, did you witness teachers prompting children to drink water?	Yes	2
		No	0
		No outdoor time observed	Missing
Observation #22	How many times were sugar drinks served the day of observation	0	2
		1 or greater	0
Doc Review #11c	How many total times do sugar drinks appear on the menu for that full week	0	2
		1 or greater	0
Observation #23	How many times was milk served the day of observation	0	0
		1	1
		2 or greater	2

Observation #24	What type of milk was served to the majority of children at a majority of meals	Whole	0
		2%	1
		1%	2
		Skim	2
		Whole, flavored	0
		Lower fat, flavored	1
		Rice milk	2
		Soy milk	2
		Lactaid	2
Doc Review #12c	How many total times does milk appear on the menu for that full week	0-3	0
		4-6	1
		7 or greater	2

5. SBnutr = (sum of question scores/6) x 10

Range = 0-20

	Question	Answer	Score (0, 1, or 2)
Observation #26	Did staff push children to eat more than they wanted to?	Yes	0
		No	2
Observation #27	Did staff serve children second helpings without being asked for more by the child?	Yes	0
		No	2
Observation #28	Did staff positively and gently encourage children to try new or less favorite foods	Yes	2
		No	0
		No children resisted eating	Missing
Observation #29	Was food used to control behavior	Yes	0
		No	2
Observation #30	Did staff sit with children during lunch	Yes	1
		No	0
Observation #30a	Did staff consume the same food as children	Yes	1
		No	0
**Observation #30 and 30a are combined questions and should be scored as one question			
Observation #31	Did staff eat and/or drink less healthy foods in front of children	Yes	0
		No	2
		Did not observe staff eating	1

6. NutrEnv (sum of question scores/3) x 10

Range = 0-20

	Question	Answer	Score (0, 1, or 2)
Observation #3	How was lunch served?	Family style	2
		Delivered and served in prepared portions	0
		Delivered in bulk and portioned by staff	0
		N/A	0
Observation #54	Where were soda and other vending machines located	In entrance or front	0
		In public areas, but not front	0
		Out of sight of parents and kids	0
		No vending machines on sight	2
Observation #54a	Did they contain only healthy options?	Yes	1
		No	0
** Observation #54 and 54a are combined questions and should be scored as one question			
Observation #61	Are any posters, pictures or books about nutrition displayed in observation room	No	0
		Yes	2

7. NutrTE = (sum of question scores/5) x 10

Range = 0-20

Variable Name	Variable Label	Answer	Score (0, 1, or 2)
Observation #32	Did staff talk with children about healthy foods	No	0
		yes	2
Observation #33	Was any formal nutrition education for kids observed	No	0
		Yes	2
Doc Review #23	Does the center have a documented nutrition curriculum for kids?	No	0
		Yes	2
Doc Review #24	Does the center have documentation of parent nutrition education/workshop materials?	No	0
		Yes	2

Doc Review #22	Does the center provide nutrition training for staff?	No	0
		Yes	0
		No documents received	0
Doc Review #22a	If yes, how often	2 times/year or more	2
		1x/year	2
		Less than 1x/yr	0
**Doc Review #22 and 22a are combined questions and should be counted as one question.			

8. NutrPol = (sum of question scores/3) x 10

Range = 0-20

	Question	Answer	Score (0, 1, or 2)
Doc Review #17	Does the center have written guidelines addressing holiday/celebration foods?	No	0
		Yes	0
		No documents received	Missing
Doc Review #17a	Healthier items encouraged	No	0
		Yes	2
**Doc Review #17a and 17a1 are combined questions and should be scored as one question.			
Doc Review #18	Did you review past/future fundraising projects or guidelines?	No	0
		Yes	0
		Center doesn't do fundraising	2
Doc Review #18a	If yes, how many were non-food only	All	2
		More than half	2
		Half	1
		Less than half	0
		none	0
**Doc Review #18a and 18a1 are combined questions and should be scored as one question.			
Doc Review #19	Does the center have a written policy on nutrition and food service?	No	0
		Yes	0
		No documents received	Missing
19a1	*These are filled/not filled questions. If one of 19a1-19a9 is filled (1) then score as 1, if more than one are filled (1) then score as 2. If DRV19a=1, but none of the 19a1-19a9 is filled then score as a 0.		
19a2			
19a3			
19a4			
19a5			
19a6			
19a7			
19a8			
19a9			

**Physical Activity**

9. Act = (sum of question scores/3) x 10

Range = 0-20

	Question	Answer	Score (0, 1, or 2)
Observation #34	How many minutes of total active play time was observed?	0-59 min	0
		60-119 min	1
		120 or greater	2
Observation #35	Was structured physical activity observed	No	0
		Yes	0
Observation #35a	If yes, how many occasions	1-2	1
		3 or greater	2
**Observation 35 and 35a are combined questions and should be counted as one question.			
Observation #36	Did you observe any outdoor active play	No	0
		Yes	0
Observation #36a	If yes, how many times/day	1	1
		2 or greater	2
**Observation 36 and 36a are combined questions and should be counted as one question. If ORF36 =1 and 36a is blank score as a 1.			

10. Sed =(sum of question scores/3) x 10

Range = 0-20

	Question	Answer	Score (0, 1, or 2)
Observation #40b	How many total minutes of seated activity was observed	0-59 min	2
		60 or greater min	0
Observation #42	Is TV Viewing observed	No	2
		Yes	0
Observation #42a	Total minutes TV was on	0-29 min	1
		30 or greater min	0
**Observation #42 and 42a are combined questions and should be counted as one question.			
Observation #46	Is video game or computer game playing observed	No	2
		Yes	0



11. SedEnv =(sum of question scores/3) x 10

Range = 0-20

	Question	Answer	Score (0, 1, or 2)
Observation #41	Is a TV present in the room	No	2
		Yes	0
Observation #45	Is a computer present in the room for use by children	No	2
		Yes	0
Observation #60	Are any posters, pictures or books about physical activity displayed in observation room	No	0
		Yes	2

12. PortEnv =(sum of question scores/7) x 10

Range = 0-20

	Question	Answer	Score (0, 1, or 2)
Observation #56a	Is ball play equipment present at site	Indoors only	2
		Outdoors only	2
		Both indoors and outdoors	2
		Not present	0
Observation #56d	Is jumping play equipment present at site	Indoors only	2
		Outdoors only	2
		Both indoors and outdoors	2
		Not present	0
Observation #56e	Is a parachute present at site	Indoors only	2
		Outdoors only	2
		Both indoors and outdoors	2
		Not present	0
Observation #56f	Are push/pull toys present at site	Indoors only	2
		Outdoors only	2
		Both indoors and outdoors	2
		Not present	0

Observation #56g	Are riding toys present at site	Indoors only	2
		Outdoors only	2
		Both indoors and outdoors	2
		Not present	0
Observation #56h	Are rocking/twisting toys present?	Indoors only	2
		Outdoors only	2
		Both indoors and outdoors	2
		Not present	0
Observation #56k	Is twirling play equipment present at site	Indoors only	2
		Outdoors only	2
		Both indoors and outdoors	2
		Not present	0

13. FixEnv =(sum of question scores/8) x 10

Range = 0-20

	Question	Answer	Score (0, 1, or 2)
Observation #55b	Is a basketball hoop present at site	Indoors only	2
		Outdoors only	2
		Both indoors and outdoors	2
		Not present	0
Observation #55e	Is a pool present?	Indoors only	2
		Outdoors only	2
		Both indoors and outdoors	2
		Not present	0
Observation #55h	Are slides present?	Indoors only	2
		Outdoors only	2
		Both indoors and outdoors	2
		Not present	0

Observation #55j	Is a tricycle track present?	Indoors only	2
		Outdoors only	2
		Both indoors and outdoors	2
		Not present	0
Observation #55k	Are tunnels present at site	Indoors only	2
		Outdoors only	2
		Both indoors and outdoors	2
		Not present	0
Observation #57	Was outdoor running space...	Unobstructed with plenty of space for group games	2
		Some obstruction, but space was adequate for individual play	1
		Plenty of space for play, but obstructed with play equipment	1
		Little running space or completely obstructed	0
Observation #58	Did staff limit or restrict outdoor play area in any way that affected active play?	Yes	0
		No	2
Observation #59	Was indoor play space suitable for...	Quiet play	0
		Limited movement/some active play	1
		All activities	2

14. SBpa = (sum of question scores/5) x 10

Range = 0-20

	Question	Answer	Score (0, 1, or 2)
Observation #47	Did you observe restricting active play as punishment	No	2
		Yes	0
Observation #48	Did staff join in active play	No	0
		Yes	2
Observation #49	How many positive statements were made about physical activity	0	0
		1 or greater	2

Observation #50	Did staff provide prompts to increase physical activity?	Yes	2
		No	0
Observation #51	Did staff provide prompts to decrease physical activity?	Yes	0
		No	2

15. PaTE = (sum of question scores/4) x 10 Range = 0-20

	Question	Answer	Score (0, 1, or 2)
Observation #52	Were any formal physical education lessons for children observed	No	0
		Yes	2
Doc Review #25	Does the center provide physical activity training for staff?	No	0
		Yes	0
		No documents received	0
Doc Review #25a	If yes, how often	2 times/year or more	2
		1x/year	2
		Less than 1x/yr	0
**Doc Review #25 and 25a are combined questions and should be scored as one question.			
Doc Review #26	Does the center have a documented physical activity curriculum for kids?	No	0
		Yes	2
Doc Review #27	Does the center have documentation of physical activity education/workshop materials?	No	0
		Yes	2

16. PaPol=scorex10 Range = 0-20

	Question	Answer	Score (0, 1, or 2)
Doc Review #21	Does the center have a written policy on physical activity?	No	0
		Yes	0
		No documents received	Set as missing
21a1	*These are filled/not filled questions. If one of 21a1-21a6 is filled (1) then score as 1, if more than one are filled (1) then score as 2. If DRV21a=1, but none of the 21a1-21a6 is filled then score as a 0.		
21a2			
21a3			
21a4			
21a5			

**Please use the following citation when referencing instrument scoring:**  
 Ward DS, Hales D, Haverly K, Marks J, Benjamin SE, Ball SC, Trost S. An instrument to assess the obesogenic environment of child care centers. Am J Health Behavior. 2008 Jul-Aug;32(4):380-6.

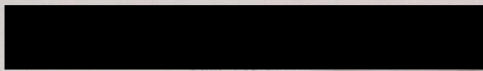
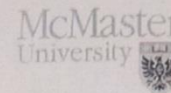
Appendix N

Ethics Approval Notice for Study 3



Hamilton  
Health Sciences

RESEARCH ETHICS BOARD



Research Ethics Board  
Membership

- Jack Holland MD FRCP FRCP(C)  
Chair
- Suzette Salama PhD  
Vice-Chair/Ethics Representative
- Mary Bedek CCHRA (C)  
Privacy Officer
- Morris Blajchman MD FRCP(C)  
Hematology
- Julie Carruthers MLT  
Research, Transfusion Medicine
- Adriana Carvalhal MD, MSc, PhD  
Psychiatry
- David Clark MD PhD FRCP(C)  
Medicine
- Jean Crowe MHSc  
Rehabilitation Science
- Lynn Donohue BA(Hons)  
Community Representative
- Farough Farrokhyar Mphil, PhD, Pdoc  
Surgery
- Sylvia Fung BSP LLB  
Pharmacy/Legal
- Melanie Griffiths FRCR (UK)  
Diagnostic Imaging
- Cindy James BScN  
Gastroenterology
- David Jewell M.S.W, MHSC  
Geriatrics
- Graham Jones BSc, MSc, PhD, MD,  
FRCP, FCCP
- Peter Kavsak PhD  
Laboratory Medicine
- Rosanne Kent RN BA MHSc(M)  
Cardiology
- Carolyn Kezsel RN  
Pediatrics
- Grigorios Leontiadis MD PhD,  
Gastroenterology
- Steve Lloyd MD Family Medicine
- Cheryl Main MD FRCP(C), Medical  
Microbiology and Infectious Diseases
- Shelly McLean MBA  
Community Representative
- Madhu Natarajan MD, FRCP, FACC  
Cardiology
- Ariana Gic Perry BA, LL.B, LL.M  
Candidate Community
- Kesava Reddy MB BS FRCS FACS  
Neurosurgery
- Susan Rivers RN MSC(I)  
Geriatrics
- Gita Sobhi BSc Phm  
Pharmacy
- Brian Timmons PhD  
Pediatrics
- Marie Townsend BA(Hons), MBA  
Administration
- Graham Turpie MD FRCP  
Medicine
- Andrew Worsler MD  
Emergency Medicine
- Jim Wright BSc MD  
Radiation Oncology
- Ed Younglai PhD  
Obstetrics/Gynecology

The HHS/HIS REB operates in compliance with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans; the Health Canada / ICH Good Clinical Practice Consolidated Guidelines (EG); and the applicable laws and regulations of Ontario. The membership of this REB also complies with the membership requirements for REBs as defined in Canada's Food and Drug Regulations (Division 5: Drugs for Clinical Trials Involving Humans Subjects).

July 22, 2009

PROJECT NUMBER: 09-343  
PROJECT TITLE: Health Outcomes and Physical activity in Preschoolers: The 'HOPP' Study  
PRINCIPAL INVESTIGATOR: Dr. Brian Timmons

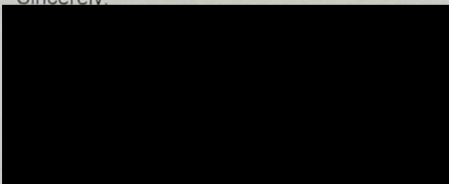
As you are aware your study was presented at the July 21, 2009 Research Ethics Board meeting where it received **final approval** from the full Research Ethics Board. The submission, research protocol 09-01, version 1 dated June 29, 2009, including the Parent Consent Form, the Consent-to-Contact Letter both versions 1 dated June 30, 2009 along with the Preschooler Physical Activity Questionnaire was found to be acceptable on both ethical and scientific grounds. **Please note** attached you will find the Consent Form with the REB approval affixed; all consent forms used in this study must be copies of the attached materials. We ask that future submissions be submitted on the most up to date version of the REB application.

We are pleased to issue final approval for the above-named study for a period of 12 months from the date of the REB meeting on July 21, 2009. Continuation beyond that date will require further review and renewal of REB approval. Any changes or amendments to the protocol or information sheet must be approved by the Research Ethics Board.

The Hamilton Health Sciences/McMaster Health Sciences Research Ethics Board operates in compliance with and is constituted in accordance with the requirements of: The Tri-Council Policy Statement on Ethical Conduct of Research Involving Humans; The International Conference on Harmonization of Good Clinical Practices; Part C Division 5 of the Food and Drug Regulations of Health Canada; and the provisions of the Ontario Personal Health Information Protection Act 2004 and its applicable Regulations.

PLEASE QUOTE THE ABOVE-REFERENCE PROJECT NUMBER ON ALL FUTURE CORRESPONDENCE

Sincerely,



Appendix O

Parent/Guardian Consent Form and Letter of Information for Study 3



**PARENT CONSENT FORM**

**Title of Study:** *Health Outcomes and Physical activity in Preschoolers: The HOPP Study*

**Principal Investigator:** *Brian W. Timmons (PhD), Children's Exercise & Nutrition Centre*

**Co-Investigators:** *Steven Bray (PhD), Department of Kinesiology, McMaster University  
Maureen MacDonald (PhD), Department of Kinesiology, McMaster University  
John Cairney (PhD), Department of Family Medicine, McMaster University*

**Study Sponsor:** *Canadian Institutes of Health Research*

---

**INTRODUCTION**

Your child is being invited to participate in a research study conducted by Dr. Brian Timmons because they are 3 to 5 years of age. In order to decide whether or not you want to be a part of this research study, you should understand what is involved and the potential risks and benefits. This form gives detailed information about the study, which will be discussed with you. Once you understand the study, you will be asked to sign this form if you wish to participate. Feel free to discuss it with your family and take your time to make your decision.

**WHY IS THIS RESEARCH BEING DONE?**

We believe that exercise and physical activity are good for young children and that play is an important part of child development. But we do not know how much physical activity is required for good health. The need to recommend appropriate levels of physical activity has never been greater because more children are becoming overweight and opportunities for preschoolers to be physically active are being replaced by sedentary activities. The best way to understand the relationships between physical activity and health is to follow the same children over time (called longitudinal research) with regular assessments of physical activity and health.

**WHAT IS THE PURPOSE OF THIS STUDY?**

The main purpose of this study is to determine how physical activity is related to health in preschoolers. We also hope to learn about nutrition habits in preschoolers and barriers parents face to getting their preschooler active. We will make these assessments once per year for 3 years to understand how the relationships between these important variables change or stay the same during the early years.





### **WHAT WILL MY CHILD'S RESPONSIBILITIES BE IF THEY TAKE PART IN THE STUDY?**

If you and your child volunteer to participate in this study, we will ask you to do the following things:

- Make 2 visits to our laboratories separated by about 8 days. At the first visit, your child will have some testing done at the Children's Exercise and Nutrition Centre (Chedoke Hospital). At the second visit, testing will be done in the Department of Kinesiology, which is at McMaster University. During each visit we will perform different tests on your child.
- At the Children's Exercise & Nutrition Centre, we will record your child's weight and height, determine their percent body fat, and measure their waist circumference. They will pedal our special bicycle for as fast as they can for about 10 sec. They will then walk on a treadmill for as long as they can to determine fitness while we record their heart rate during and shortly after the exercise test. We will have you fill out some questionnaires at this visit to tell us about your child's health and issues about their physical activity. When it is time to leave, we will put a small pager-like device, called an accelerometer, on the waist of your child. This little box (about the size of a matchbox) will record their physical activity over the next 8 days. We will explain how to care for it during this time. This visit will take about 1.5 hours.
- At the Department of Kinesiology, we will measure the health of the main blood vessel in your child's neck. This test requires your child to lie on a bed for about 15 min for the measurements to be taken. We will then assess your child's motor skills by having them do some running, hopping, and ball-throwing tasks, and this takes about 40 min. We will have you fill out some more questionnaires at this visit to tell us about your child's health and issues about their well-being. This visit will take about 1.5 hours.

### **WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?**

There are no unusual risks or discomforts associated with your child's participation in this study. Your child may feel a little tired after the exercise tests, but this feeling won't last long. If your child already rides a tricycle or a bicycle, the bike test is no different than what they might experience while riding their own machine as fast as they can. Your child may not be used to walking on a treadmill so we will ensure they can safely do this task. To measure body composition we will use a special machine that estimates how much water is in your child's body by sending a small electrical current through your child's body. The current is so small that they will not feel it at all and it will not hurt them whatsoever. To measure blood vessels, we will use the same ultrasound machine that doctors use to take a picture of a baby during a pregnancy. We will ask you about your confidence in providing your child opportunities to be physically active. You can answer these questions to the extent you feel comfortable doing so. Any information collected from you and your child will become anonymous to ensure confidentiality.



**HOW MANY PEOPLE WILL BE IN THIS STUDY?**

We are asking boys and girls aged 3 to 5 years from the Hamilton and surrounding communities to participate. We plan to test 400 children once per year for 3 years in a row. Your participation is voluntary.

**WHAT ARE THE POSSIBLE BENEFITS FOR MY CHILD AND/OR FOR SOCIETY?**

We cannot promise any personal benefits to you or your child from their participation in this study. You will learn how several health characteristics of your child (body fat, blood vessel health, and physical fitness) compares with other children their age. You will also learn how these things change over time and whether these markers of health are associated with how much physical activity or play they do. By participating in this study, you will be contributing to knowledge that will be used to develop physical activity guidelines for Canadian preschoolers.

**WHAT INFORMATION WILL BE KEPT PRIVATE?**

All of your information will be stored in filing cabinets under the supervision of Dr. Brian Timmons for 25 years. We will supervise access to your child's information by other people in our group, only if necessary. Your child will be assigned a subject number, and this number will be used to identify them. Records identifying your child will be kept confidential. If the results of the study are published, their identity will remain confidential.

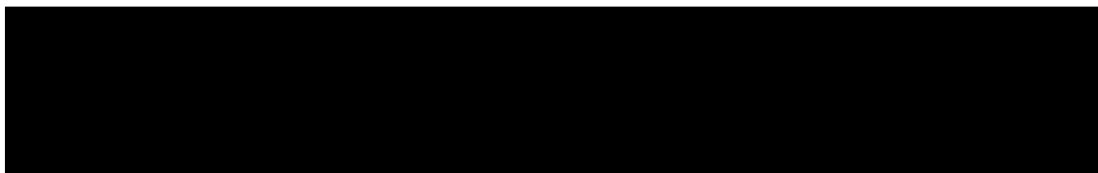
**CAN PARTICIPATION IN THE STUDY END EARLY?**

If your child volunteers to be in this study, you or your child may withdraw at any time with no prejudice. The investigator may withdraw your child from this research if circumstances arise which warrant doing so.

**WILL MY CHILD BE PAID TO PARTICIPATE IN THIS STUDY?**

Your child will not be paid to participate in this study, but we will provide them a gift package including various trinkets and a certificate of participation each year of the study. We will also reimburse you for any parking expenses and provide you an annual "*physical activity report card*". You will be able to make regular visits to our website for updates on the HOPP study.

**IF I HAVE ANY QUESTIONS OR PROBLEMS, WHOM CAN I CALL?**





**CONSENT STATEMENT**

I have read the preceding information thoroughly. I have had the opportunity to ask questions, and all of my questions have been answered to my satisfaction and to the satisfaction of my child. I agree to allow my child to participate in this study entitled: *“Health Outcomes and Physical activity in Preschoolers: The HOPP Study”*. I understand that I will receive a signed copy of this form.

\_\_\_\_\_  
Name of Participant (child’s name)

\_\_\_\_\_  
Printed Name of Legally Authorized Representative

\_\_\_\_\_  
Signature of Legally Authorized Representative

\_\_\_\_\_  
Date

Consent form administered and explained in person by:

\_\_\_\_\_  
Printed Name of Person Obtaining Consent

\_\_\_\_\_  
Signature of Person Obtaining Consent

\_\_\_\_\_  
Date

**SIGNATURE OF INVESTIGATOR:**

In my judgement, the participant is voluntarily and knowingly giving informed consent and possesses the legal capacity to give informed consent for their child to participate in this research study.

\_\_\_\_\_  
Printed Name and title

\_\_\_\_\_  
Signature of Investigator

\_\_\_\_\_  
Date

Appendix P

Wear-Time Log for Study 3

Child Health & Exercise Medicine Program



**ACCELEROMETER DIARY:**

Please have your child wear the accelerometer at all times when they are awake, during all activities (except during prolonged water play), for a full week. We ask that you keep this log to monitor the times the accelerometer was put on and taken off. This will help us to explain times of minimal activity (such as when your child is taking a nap). Please return this form along with your accelerometer at your next visit to McMaster. If for any reason you miss a day, you can record additional days on a separate sheet of paper.

	Example Tues June 19	DAY 1 Day: _____ Date: _____	DAY 2 Day: _____ Date: _____	DAY 3 Day: _____ Date: _____	DAY 4 Day: _____ Date: _____	DAY 5 Day: _____ Date: _____	DAY 6 Day: _____ Date: _____	DAY 7 Day: _____ Date: _____
Time the device was put on	6:46 AM							
Times the device may have been taken off and put back on and reason(s) (e.g. nap, swimming, shower, etc)	1:29 PM off for nap							
	3:01 PM back on							
	5:14 PM off for swimming							
	5:50 PM back on							
Time the device was taken off before bed	8:22 PM							
At Daycare/ School Other Activities?	JK in the morning							

Study ID #: \_\_\_\_\_ Initials: \_\_\_\_\_ Accelerometer #: \_\_\_\_\_

PLEASE SEE THE BACK FOR DETAILED INSTRUCTIONS

Appendix Q

Height and Weight Data Recording Sheet



**HOPP: BODY COMP & FITNESS**    **YEAR:** \_\_\_\_\_

ID: \_\_\_\_\_ Initials: \_\_\_\_\_ DOB (dd-mm-yy): \_\_\_\_\_

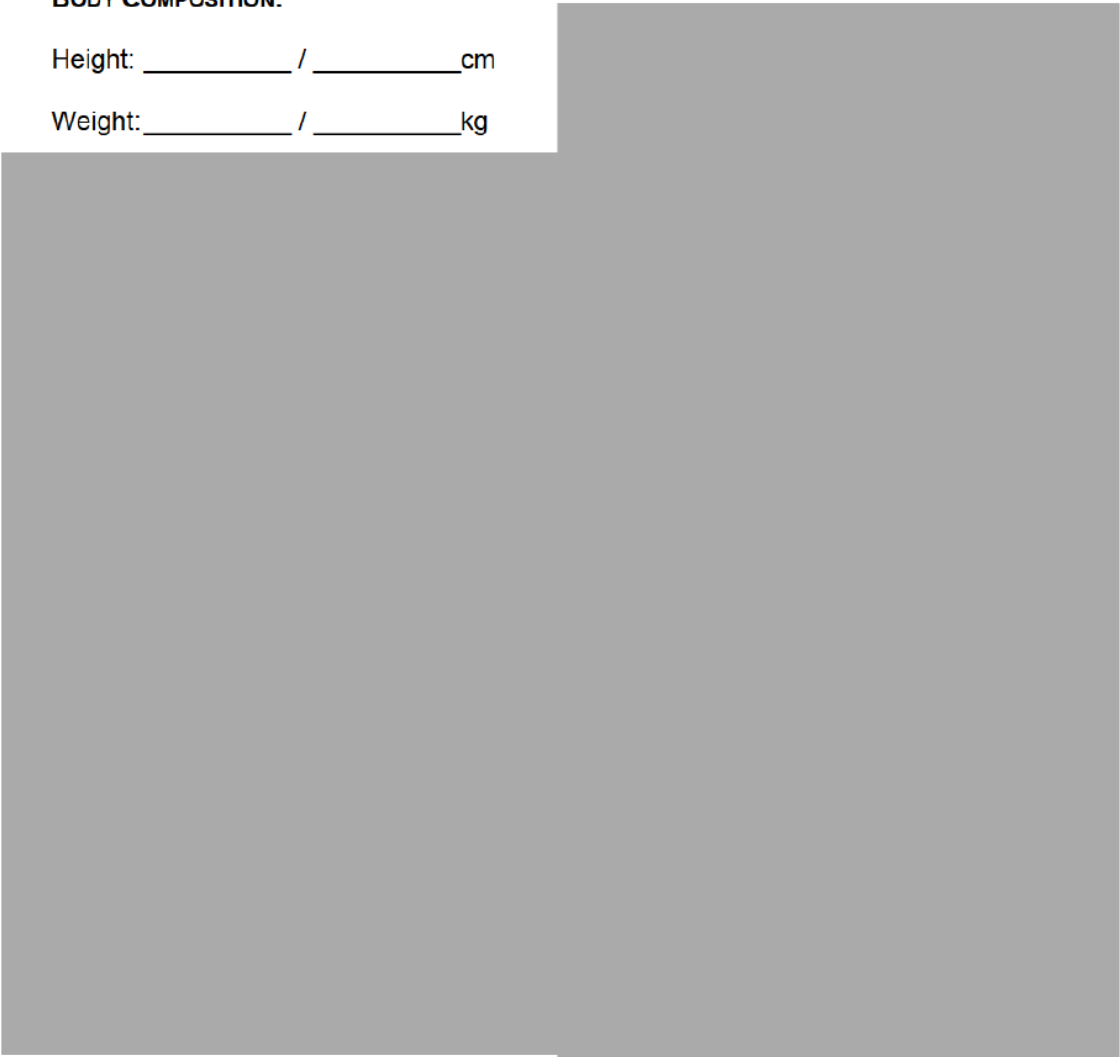
ACC#: \_\_\_\_\_

Date/time of Visit (dd-mm-yy): \_\_\_\_\_ Time: \_\_\_\_\_ Tester: \_\_\_\_\_

**BODY COMPOSITION:**

Height: \_\_\_\_\_ / \_\_\_\_\_ cm

Weight: \_\_\_\_\_ / \_\_\_\_\_ kg



*Testing Session Comments:*

Curriculum Vitea



## CURRICULUM VITAE – LEIGH M. VANDERLOO

### Personal Information

---

Name: Leigh Mary Vanderloo

Citizenship: Canadian

Place of Birth: Calgary, Alberta

### Education, Awards, & Honours

---

#### EDUCATION

#### **Doctor of Philosophy – Health and Rehabilitation Sciences**

2012 – 2016

Field: Health Promotion

University of Western Ontario, London, ON

*Assessing Physical Activity and Sedentary Time in the Early Years* (Dissertation Title)

*Screen-Viewing Among Preschoolers in Childcare: A Systematic Review* (Comprehensive Examination Title)

#### **Master's of Science – Health and Rehabilitation Sciences**

2010 – 2012

Field: Health Promotion

University of Western Ontario, London, ON

*The Influence of the Childcare Environment on the Physical Activity Levels of Preschool-Aged Children: A Feasibility Study* (Thesis Title)

#### **Honours Bachelor of Health Sciences**

2006 – 2010

Specialization in Health Sciences

University of Western Ontario, London, ON

---

#### ADDITIONAL TRAINING AND EDUCATION

#### **Western Certificate in University Teaching and Philosophy**

2014 – 2015

Teaching Support Centre, University of Western Ontario, London, ON

- Through this certificate program, I was able to participate in a series of professional development activities which aimed to develop competencies in: 1) hands-on teaching practice and peer mentoring/feedback; 2) discussing current issues in university teaching and learning (e.g., academic integrity, experiential learning, etc.); and, 3) preparing for an academic profession (e.g., preparing a teaching philosophy and teaching dossier, etc.).

---

**AWARDS & HONOURS****A. GRADUATE-LEVEL**

1. 2016 Best Oral Presentation. University of Western Ontario's Health and Rehabilitation Sciences Graduate Research Forum: *Bright Learners Become Enlightened Learners*.
2. 2015 Marco Cabrera Student Research Award – North American Society of Pediatric Exercise Science (NASPEM). Value: \$1,265 (competitive)
1. 2015 CIHR Institute Community Support Travel Award: Human Development, Child and Youth Health. Value: \$1,000 (competitive)
2. 2014 Canadian Institutes of Health Research Doctoral Research Award: Frederick Banting and Charles Best Canada Graduate Scholarship. Value: \$105,000 (competitive)
3. 2014 Ontario Graduate Scholarship. Value: \$15,000 (competitive – declined in order to accept national scholarship)
4. 2014 Nominated for Vanier Canada Graduate Scholarship. Waitlisted (55 awarded; ranked 65; competitive)
5. 2014 Student Research Award – Oral Presentation (2<sup>nd</sup> place). North American Society of Pediatric Exercise Science (NASPEM; competitive)
6. 2014 Faculty of Health Sciences Graduate Student Conference Travel Award, University of Western Ontario. Value: \$500
7. 2014 Health and Rehabilitation Sciences Graduate Student Conference Travel Award, University of Western Ontario. Value: \$500
8. 2014 Best Oral Presentation. University of Western Ontario's Health and Rehabilitation Sciences Graduate Research Forum: *Bringing Your Creativity to Life*.
9. 2014 Top Article Submission. Health Science Inquiry (student-led journal – category of “*Social, Economic, and Environmental Determinants of Mental Health and Addiction*”)
10. 2014 Health and Rehabilitation Sciences Graduate Student Conference Travel Award, University of Western Ontario. Value: \$300
11. 2013 Ontario Graduate Scholarship. Value: \$15,000 (competitive)
12. 2013 Nominated for the Governor General's Academic Medal. Level: Gold
14. 2013 CIHR Institute Community Support Travel Award: Human Development, Child and Youth Health. Value: \$1,000 (competitive)
15. 2013 Graduate Thesis Research Award, University of Western Ontario. Value: \$810 (competitive)
16. 2013 Faculty of Health Sciences Graduate Student Conference Travel Award, University of Western Ontario. Value: \$600
17. 2012 Health and Rehabilitation Sciences Graduate Student Conference Travel Award, University of Western Ontario. Value: \$500
18. 2012 7<sup>th</sup> Annual Canadian Obesity Summer Research Boot Camp Participant, Canadian Obesity Network. One of 24 handpicked students/new health professionals from across Canada selected to participate in this unique/intensive educational obesity-related event (competitive)

19. 2012 Faculty of Health Sciences Graduate Student Conference Travel Award, University of Western Ontario. Value: \$244
20. 2011 Canadian Institutes of Health Research Master's Award: Frederick Banting and Charles Best Canada Graduate Scholarship. Value: \$17,500 (competitive)
21. 2011 Ontario Graduate Scholarship. Value: \$15,000 (competitive – declined in order to accept national scholarship)
22. 2010 Ontario Graduate Scholarship in Science and Technology. Value: \$10,000 (competitive)
23. 2010 Faculty of Health Sciences Graduate Scholarship, University of Western Ontario. Value: \$1,000
24. 2010 Raymond Héту Prize in Acoustics, Canadian Acoustics Association. Awarded for paper entitled: *Sorry, Can You Repeat That?: A Health Promotion Campaign Addressing Noise-Induced Hearing Problems Among Senior Health Sciences Students* (competitive)

#### B. UNDERGRADUATE-LEVEL

1. 2010 Dean's Honours List
2. 2009 Dean's Honours List
3. 2009 Maude Gordon Educational Award, University of Western Ontario. Value: \$500
4. 2007 Western Scholarship of Distinction. Value: \$1,500
5. 2007 Queen Elizabeth II Aiming for the Top Scholarship. Value: \$3,500

#### **Related Work Experience**

---

#### **RESEARCH EXPERIENCE**

**Research Coordinator** 2010 – 2016  
 Child Health and Physical Activity Lab, University of Western Ontario, London, ON

*Supervisor: Dr. Patricia Tucker*

- Assist with the preparation of ethics submissions; organize participant recruitment; liaise with childcare stakeholders; collect data using Actical accelerometers and an environmental scan at childcare facilities; assist with data entry, cleaning, and analysis; assist with manuscript writing; aid with the dissemination of study results

**Research Assistant** 2015 – 2016  
 Centre for Research on Migration and Ethnic Relations Principal Investigator, Pathways to Prosperity Partnership, Department of Psychology, University of Western Ontario, London, ON

*Supervisors: Drs. Victoria Esses, Suzanne Huot, and Zenaida Ravanera*

- Assist with the searching, screening, and extraction of data from French peer-reviewed articles, reports, and grey literature as it pertains to Official Language

Minority Communities in Canada (OLMC). Final deliverable: comprehensive report on OLMCs for Citizenship and Immigration Canada

**Moderator – Focus Groups**

2014

University of Western Ontario, London, ON

- Served as the focus group moderator and co-moderator for a study which aimed to solicit the barriers, facilitators, and health benefits of middle-aged women with memberships to commercial fitness facilities (“Middle-Aged Women’s Perceived Barriers, Facilitators, and Health Benefits of Sustaining a Membership in a Commercial Fitness Facility”)

**Data Analyst**

2011 – 2012

Children’s Health and Activity Modification Program (C.H.A.M.P.), University of Western Ontario, London, ON

*Supervisor: Dr. Shauna Burke*

- Assist with cleaning and analyzing collected data (including accelerometer data, and various questionnaires [demographic, PAQ-C, self-efficacy, etc.]) as well as drafting manuscripts

**Undergraduate Research Assistant**

2009 – 2010

Faculty of Health Sciences, University of Western Ontario & Middlesex-London Health Unit, Public Health Research, Education, & Development Program, London, ON

*Supervisors: Dr. Patricia Tucker and Melissa van Zandvoort*

- Co-moderated focus group discussions; cleaned, coded, and analyzed data using QSR-NVivo software; formatted and edited manuscripts for publication; conducted literature searches and reviews; created and updated Reference Manager databases; measured participants’ heights and weights (for calculating BMI); assisted with grant writing; assisted with verifying the accuracy of data entries; created participant and stakeholder summaries from research studies; assisted with questionnaire development

---

**TEACHING EXPERIENCE**

**Course Instructor**

a) UDERGRADUATE COURSES

**Management of Health and Illness (Soc 3305G/570)**

Department of Sociology, King’s College University, University of Western Ontario, London, ON

- This course presents a critical examination of the profile of current health problems in Canada and how our health care system is organized to manage them. Special attention is given to chronic diseases such as heart disease, cancer, diabetes and how these vary in terms of age, social class, sex/gender, ethnicity, and geography.

Overall Effectiveness as a University Teacher (taken from instructor/course evaluations)

- **Winter 2016** ( $n = 24$  students) – mean = 6.68/7.0 (68% *outstanding*, 32% *very good*)
- **Fall 2015** (second half;  $n = 18$  students) – mean = 6.18/7.0 (27% *outstanding*, 64% *very good*, 9% *good*)
- **Winter 2014** ( $n = 26$  students) – mean = 5.83/7.0 (39% *outstanding*, 35% *very good*, 13% *good*)

\*Scale upon which evaluation is based: 7 point-scale (where: 7 outstanding, 6 very good, 5 good, 4 satisfactory, 3 borderline, 2 unsatisfactory, 1 very poor)

b) GRADUATE COURSES

**Health Promotion Intensive (OT 9662)**

School of Occupational Therapy, University of Western Ontario, London, ON

- The focus of this intensive course is to explore how health promotion tenets and principles can be incorporated into occupational therapy practice. This course provides students with foundational knowledge on health promotion, what models are used in within this field, and how occupational therapists can use health promotion techniques in their practice.

Overall Effectiveness as a University Teacher (taken from instructor/course evaluations)

- Winter 2014 ( $n = 19$  students) – 25% *outstanding*, 41.7% *very good*, 33.3% *good*

**Teaching Assistant**

Fall 2012

HS 2250a – Health Promotion in Canada

Faculty of Health Sciences, University of Western Ontario, London, ON

**Lab Instructor**

Winter 2011

HS 2330b/Kin 2222b – Systematic Approach to Functional Anatomy

Faculty of Health Sciences, University of Western Ontario, London, ON

**Undergraduate Student Co-Supervision – Scholars Elective**

- Kathleen O'Brian – *Physical Activity and Sedentary Time Among Preschoolers in Centre-Based Childcare: A Systematic Review* (2015-2016)

**Undergraduate Student Co-Supervision – Work Study**

- Kuvanya Pillay (2015-2016)
- Vincent Chung (2014-2015)
- Bianca Masseli (2012-2013)

---

**ADDITIONAL WORK EXPERIENCE****Volunteer Coordinator**

2003 – 2010

The Canadian Medical Hall of Fame, London, ON

- Managed volunteer program (including developing volunteer schedules, recruiting, and training new volunteers, etc.); aided in the facilitation of various educational programs for elementary and secondary school students; assisted with writing grant proposals and with the preparation of various communication material

**Publications & Presentations**

---

**PUBLICATIONS****Summary**

	<b># of Publications</b>
Published Refereed Papers	19 (12 first-author)
Accepted Papers	2 (0 first author)
Submitted Papers	1 (0 first author)
Published Abstracts	4 (4 first author)
Student Journal Publications	3 (2 first author)
Technical Reports	2
Media Communications	1
<b><i>h-index (based on the # of documents and the # of citations) = 4</i></b>	

**A. PUBLISHED REFEREED PAPERS**

1. **Vanderloo, L. M.**, & Tucker, P. (2016, Mar). Physical Activity and Sedentary Time Among Young Children in Full-Day Kindergarten: Comparing the Traditional and Balanced Day Schedules. *Health Education Journal*, 1-9. doi: 10.1177/0017896916643354 [Impact Factor: 0.821]
2. **Vanderloo, L. M.**, Di Cristofaro, N., Proudfoot, N. Tucker, P., & Timmons, B. W. (2016, Feb). *Comparing the Actical and ActiGraph Method to Measuring Young Children's Physical Activity Levels and Sedentary Time. Pediatric Exercise Science*, 28(1),133-142. doi: 10.1123/pes.2014-0218 [Impact Factor: 1.613]
3. Tucker, P., Burke, S. M., Gaston, A., Irwin, J. D., Johnson, A. M., Timmons, B. W., **Vanderloo, L. M.**, Driediger, M. (2016, Jan). Supporting Physical Activity in the Childcare Environment (SPACE): Rationale and Study Protocol for a Cluster

- Randomized Controlled Trial. *BMC Public Health*, 16,112. doi: 10.1186/s12889-016-2775-9 [Impact Factor: 2.321]
4. **Vanderloo, L. M.** (2016, Mar). Preparing students for practical exams: The dreaded bell ringer exam. (2015, Oct). *Teaching Innovation Projects (TIPS)*, 6(1), 1.
  5. Martyniuk, O. J. M., **Vanderloo, L. M.**, Tucker, P., Burke, S. M., & Irwin, J. D. (2015, Nov). Comparing the Nutrition Environment and Practices of Home- and Center-Based Childcare Facilities. *Public Health Nutrition*, 9(4), 575-584. doi:10.1017/S1368980015003535 [Impact Factor: 2.679]
  6. **Vanderloo, L. M.** & Tucker, P. (2015, Sept). An Objective Assessment of Toddlers' Physical Activity and Sedentary Levels. *BMC Public Health*, 15, 969. doi: 10.1186/s12889-015-2335-8 [Impact Factor: 2.321]
  7. Tucker, P., **Vanderloo, L. M.**, Burke, S.M., Irwin, J.D., Johnson, A.M. (2015, Sept). Prevalence and influences of preschoolers' sedentary behaviors in early learning centers: A cross-sectional study. *BMC Pediatrics*, 15,128. doi: 10.1186/s12887-015-0441-5 [Impact Factor = 1.93]
  8. **Vanderloo, L. M.**, Martyniuk, O. J. M., & Tucker, P. (2015, Sept). Physical activity levels among preschoolers in home-based childcare: A systematic review. *Journal of Physical Activity & Health*, 12(6), 879-889. doi: 10.1123/jpah.2013-0483 [Impact Factor: 1.884]
  9. **Vanderloo, L. M.**, Tucker, P., Johnson, A., Burke, S. M., & Irwin, J. D. (2015, Aug). Environmental influences on preschoolers' physical activity levels in early learning facilities. *Research Quarterly for Exercise and Sport*, 86(4), 360-370. doi: 10.1080/02701367.2015.1053105 [Impact Factor: 1.702]
  10. Irwin, J. D., Johnson, A. M., **Vanderloo, L. M.**, Burke, S. M., & Tucker, P. (2015, Jul). Temperament and objectively measured physical activity and sedentary time among Canadian preschoolers *Preventive Medicine Reports*, 2, 598-560; doi: 10.1016/j.pmedr.2015.07.007 [Impact Factor: 0.199]
  11. **Vanderloo, L. M.**, & Tucker, P. (2015, Feb). *Weekly trends in preschoolers' physical activity and sedentary time in childcare. International Journal of Environmental Research and Public Health*, 2(3), 2454-2464; doi: 10.3390/ijerph120302454 [Impact Factor: 2.063]
- †Invited (peer-reviewed) article for a special issue on Physical Activity and Public Health*
12. Burke, S. M., **Vanderloo, L. M.**, Gaston, A., Pearson, E. S., & Tucker, P. (2015). An examination of self-reported physical activity and physical activity self-efficacy among children with obesity: Findings from the Children's Health and Activity

Modification Program (C.H.A.M.P.) pilot study. *Retos: Nuevas tendencias en Educacion Fisica, Deporte y Recreacion (Challenges: New tendencies in Physical Education, Sport, and Recreation)*, 28, 212-218.

<sup>†</sup> *Invited (peer-reviewed) article for a special issue of the academic journal "Retos", edited by the Spanish Federation of Associations of Physical Education Professionals.*

13. **Vanderloo, L. M.** (2014, Jan). Screen-viewing among preschoolers in childcare: A systematic review. *BMC Pediatrics*, 4, 205. doi: 10.1186/1471-2431-14-205 [Impact factor: 1.813]
14. Tucker, P., **Vanderloo, L. M.**, Irwin, J. D., Mandich, A., & Bossers, A. (2014, Jun). Exploring the nexus between health promotion and occupational therapy: Synergies and similarities. *Canadian Journal of Occupational Therapy*, 81(3), 183-193. doi: 10.1177/0008417414533300 [Impact Factor: 0.742]
15. **Vanderloo, L. M.**, Tucker, P., Johnson, A. M., van Zandvoort, M. M., Burke, S. M., & Irwin, J. D. (2014, Jan). The influence of centre-based childcare on preschoolers' physical activity levels: A cross-sectional study. *International Journal of Environmental Research and Public Health*, 11(2), 1794-1802. doi:10.3390/ijerph110201794 [Impact Factor: 2.063]
16. **Vanderloo, L. M.**, Tucker, P., Johnson, A. M., & Holmes, J. D. (2013, Nov). *Physical activity among preschoolers during indoor and outdoor childcare play periods. Applied Physiology, Nutrition, and Metabolism*, 38(11): 1173-1175. doi: 10.1139/apnm-2013-0137 [Impact Factor: 2.789]

<sup>†</sup> *This study was used in the development of the 2015 ParticipACTION Physical Activity Report Card and Outdoor Play Position Statement.*

*This study was used in the development of the 2014 Active Healthy Kids Canada Physical Activity Report Card.*

17. **Vanderloo, L. M.**, & Mandich, G. (2013, Mar). Battling bullying: Do obese children face the same fight? *Canadian Journal of Community Mental Health*, 32(4), 85-88. doi: 10.7870/cjcmh-2013-032 [Impact Factor: 0.57]

<sup>†</sup> *Submitted for re-publication to reach a broader audience (originally published in Health Science Inquiry and was awarded top selection).*

18. Tucker, P., **Vanderloo, L. M.**, Newnham-Kanas, C., Burke, S. M., Irwin, J. D., Johnson, A. M., & van Zandvoort, M. M. (2013, Nov). Learning Environments' Activity Potential for Preschoolers (LEAPP): Study Rationale and Design. *Journal of Public Health Research*, 2, e19. doi:10.4081/jphr.2013.e19



19. **Vanderloo, L. M.**, Tucker, P., Ismail, A., & van Zandvoort, M. (2012, May). Physical activity opportunities in Canadian childcare facilities: A provincial/territorial review of legislation. *Journal of Physical Activity & Health*, 9(4), 461-472. Retrieved from <http://journals.humankinetics.com/jpah> [Impact Factor: 1.884]

#### B. ACCEPTED PAPERS

1. Tucker, P., Maltby, A. M., Burke, S. M., **Vanderloo, L. M.**, & Irwin, J. D (2016, May). Comparing Physical Activity and Sedentary Time among Overweight and Non-Overweight Preschoolers Enrolled in Early Learning Programs: A Cross-Sectional Study. Manuscript accepted for publication to *Applied Physiology, Nutrition, and Metabolism*.

#### C. SUBMITTED PAPERS ('UNDER REVIEW')

1. Truelove, S., **Vanderloo, L. M.**, & Tucker, P. Defining *Active Play* Among Young Children: A Systematic Review. Manuscript submitted to the *Journal of Physical Activity and Health*. (July 2016, 18 pages).
2. Maltby, A. M., **Vanderloo, L. M.**, Tucker, P. Exploring Mothers' Influence on Preschoolers' Physical Activity and Sedentary Time. Manuscript submitted for publication to *Maternal and Child Health Journal*. (July 2016; 17 pages).

#### D. PUBLISHED ABSTRACTS

1. **Vanderloo, L. M.**, Tucker, P., Johnson, A. M., Burke, S. M., & Irwin, J. D. (2015). Environmental Influences on Preschoolers' Physical Activity Levels in Early Learning Facilities: The LEAPP Study. *Pediatric Exercise Science*, 27, s3.
2. **Vanderloo, L. M.** (2014). Screen-Viewing Among Preschoolers in Childcare: A Review. *Journal of Physical Activity and Health*, 11(suppl 1), s194.
3. **Vanderloo, L. M.**, Martyniuk, O. J. M., & Tucker, P. (2014). Physical Activity Among Preschoolers in Home-Based Childcare: A Systematic Review. *Journal of Physical Activity and Health*, 11(suppl 1), s193.
4. **Vanderloo, L. M.**, Gaston, A., Burke, S. M. (2013). Criterion-Related Validity of the Physical Activity Questionnaire for Older Children in Obese Children. *Annals of Behavioral Medicine*, 45, s39.

#### E. STUDENT JOURNAL PUBLICATIONS

1. **Vanderloo, L. M.**, & Mandich, G. Paediatric obesity prevention: The role of primary health care physicians. *Health Science Inquiry*, 5(1), 63-64. Retrieved from [http://healthscienceinquiry.ca/issues/\\_2014](http://healthscienceinquiry.ca/issues/_2014). [Times cited: 0]

2. **Vanderloo, L. M.**, & Mandich, G. (2013). *Battling bullying: Do obese children face the same fight?*. *Health Science Inquiry*, 4(1), 70-71. Retrieved <http://hsinquiry.sa.utoronto.ca/> [Times cited: 0]

*† Selected as ‘Top Submission’ in category of “Social, Economic, and Environmental Determinants of Mental Health and Addiction”. Health Science Inquiry is a student-led journal.*

3. Mandich, G.\* & **Vanderloo, L. M.\*** (2012). Obesity and diabetes among children: Nutrition-related educational and practical barriers and future opportunities. *Health Science Inquiry*, 3(1), 78-79. Retrieved from <http://hsinquiry.sa.utoronto.ca/> [Times cited: 0]

*\*Authors listed in alphabetical order – contributed equally to this work*

#### F. TECHNICAL REPORTS (NON-REFEREED)

1. Esses, V., Huot, S., Ravanera, Z., Thakur, S., & **Vanderloo, L. M.** (2016, Apr). *Synthesis and analysis of research on immigrants to Official Language Communities in Canada*. Report prepared for the Ministry of Immigration, Refugees and Citizenship Canada.
2. Tucker, P., van Zandvoort, M., Irwin, J.D., Burke, S.M., & **Vanderloo, L. M.** (2010, Apr). *Community advocacy plan for improved physical activity opportunities in childcare*. London, ON: Middlesex-London Health Unit & University of Western Ontario.

#### G. MEDIA COMMUNICATIONS

1. Vanderloo, L. M. (2015, November 27). *Preschoolers in daycare need more outdoor time*. <http://www.reuters.com/article/us-health-preschool-recess-idUSKBN0TG29T20151127>. Reuters News Online (L. Rapaport, reporter).

*‡Asked to provide commentary on recent publication of an article surrounding preschooler physical activity in childcare.*

---

### CONFERENCES & PRESENTATIONS

#### Summary

Refereed Academic Conferences & Presentations	15 (10 first presenter)
Student Conferences & Presentations	10 (10 first presenter)
Guest Lectures	4
Invited Talks	7
Radio Interviews	3

## A. REFEREED ACADEMIC CONFERENCES &amp; PRESENTATIONS

1. **Vanderloo, L. M.**, Tucker, T., Gaston, A., Timmons, B. W., Johnson, A. M., Burke, S. M., & Irwin, J. (2016, August 12). Supporting Physical Activity in the Childcare Environment (SPACE): A Cluster Randomized Controlled Trial. North American Society of Pediatric Exercise Medicine (NASPEM). Knoxville, TN. *Abstract and Oral Presentation.*
2. Tucker, P., Maltby, A. M., Burke, S. M., **Vanderloo, L. M.**, Irwin, J. D. (2016, August 13). Comparing Physical Activity and Sedentary Time among Overweight and Non-Overweight Preschoolers Enrolled in Early Learning Programs: A Cross-Sectional Study. North American Society of Pediatric Exercise Medicine (NASPEM). Knoxville, TN. *Abstract and Poster Presentation.*
3. **Vanderloo, L. M.**, Tucker, P., Di Cristofaro, N. A., Proudfoot, N. A., & Timmons, B. W. (2015, June 11). *Comparing the Actical and ActiGraph Approach to Measuring Young Children's Physical Activity Levels and Sedentary Time.* International Conference on Ambulatory Monitoring of Physical Activity and Movement (ICAMPAM). Limerick, Ireland. *Abstract and Poster Presentation.*
4. Tucker, P., **Vanderloo, L. M.**, Burke, S. M., Irwin, J. D., & Johnson, A. M. (2015, June 5). *A Cross-Sectional Exploration of the Prevalence and Influences of Preschoolers' Sedentary Behaviors in Early Learning Environments.* International Society of Behavioral Nutrition and Physical Activity (ISBNPA). Edinburgh, UK. *Abstract and Oral Presentation.*
5. **Vanderloo, L. M.**, & Tucker, P. (2015, June 4). *A Cross-Sectional Examination of Toddlers' Physical Activity and Sedentary Time in London, Canada.* International Society of Behavioral Nutrition and Physical Activity (ISBNPA). Edinburgh, UK. *Abstract and Poster Presentation.*
6. Maltby, A., **Vanderloo, L. M.**, & Tucker, P. (2015, June 3). *Exploring Maternal Influences on Preschoolers' Physical Activity and Sedentary Time.* International Society of Behavioral Nutrition and Physical Activity (ISBNPA). Edinburgh, UK. *Abstract and Poster Presentation.*
7. **Vanderloo, L. M.** (2015, May 22). *A Systematic Review of Preschoolers' Screen-Viewing Levels in Childcare.* Child Health Symposium, Thames Valley Children's Centre & University of Western Ontario. London, ON. *Abstract and Poster Presentation.*
8. Truelove, S., Tucker, P., **Vanderloo, L. M.**, Driediger, M., Johnson, A. M., Timmons, B. W., Gaston, A., Burke, S. M., & Irwin, J. D. (2015, May 22). *Change in Preschoolers' Health-Related Quality of Life Following the Implementation of a Physical Activity Intervention in Centre-Based Childcare.* Child Health Symposium, Thames Valley Children's Centre & University of Western Ontario. London, ON. *Abstract and Poster Presentation.*

9. **Vanderloo, L. M.**, Tucker, P., Johnson, A., Burke, S., & Irwin, J. (2014, August 21). *Environmental Influences on Preschoolers' Physical Activity Levels in Early Learning Facilities: The LEAPP Study*. North American Society of Pediatric Exercise Medicine (NASPEM). Minneapolis, MN. Abstract and Oral Presentation.

<sup>†</sup> Received student research award (second place) for this oral presentation

10. **Vanderloo, L. M.**, Martyniuk, O. J. M., & Tucker, P. (2014, May 22). *The Physical Activity Levels of Preschoolers in Home-Based Childcare: A Systematic Review*. Child Health Symposium, Thames Valley Children's Centre & University of Western Ontario. London, ON. Abstract and Oral Presentation.
11. **Vanderloo, L. M.**, Martyniuk, O. J. M., & Tucker, P. (2014, May 21). *A Review of Physical Activity Among Preschoolers in Home-Based Childcare*. Global Summit on the Physical Activity of Children. Toronto, ON. Abstract and Poster Presentation.
12. **Vanderloo, L. M.** (2014, May 20). *A Review of Preschoolers' Screen-Viewing in Childcare*. Global Summit on the Physical Activity of Children. Toronto, ON. Abstract and Poster Presentation.
13. Tucker, P., **Vanderloo, L. M.**, Holmes, J. D., & Johnson, A. (2013, June 19). *Physical Activity among Preschoolers at Childcare: Differences in Participation Indoors Versus Outdoor?* International Conference on Ambulatory Monitoring of Physical Activity and Movement (ICAMPAM). Amherst, MA. Abstract and Poster Presentation.
14. **Vanderloo, L. M.**, Tucker, P., Johnson, A., Burke, S., & Irwin, J. (2013, May 25). *Influence of the Centre-Based Childcare Environment on the Physical Activity Levels of Preschool-Aged Children: A Feasibility Study*. International Society of Behavioral Nutrition and Physical Activity (ISBPA). Ghent, BE. Abstract and Oral Presentation.
15. **Vanderloo, L. M.**, Gaston, A., Burke, S. M. (2013, March 20). *Criterion-Related Validity of the Physical Activity Questionnaire for Older Children in Obese Children*. Society of Behavioral Medicine (SBM). San Francisco, CA. Abstract and Poster Presentation.

## B. STUDENT CONFERENCES & PRESENTATIONS

1. **Vanderloo, L. M.** (2016, February 3). *Supporting Physical Activity in the Childcare Environment: The SPACE Study*. Health and Rehabilitation Sciences Graduate Research Conference, University of Western Ontario. London, ON. Abstract and Oral Presentation.

<sup>†</sup> Awarded "Best Oral Presentation"

2. **Vanderloo, L. M.** (2014, February 5). *A Review of Preschoolers' Screen-Viewing Behaviours in Childcare*. Health and Rehabilitation Sciences Graduate Research Forum, University of Western Ontario. London, ON. *Abstract and Oral Presentation*.
3. **Vanderloo, L. M.**, Tucker, P., Johnson, A., Burke, S., & Irwin, J. (2013, February 6). *The Influence of Early Learning Environments on Preschoolers' Physical Activity Behaviours*. Health and Rehabilitation Sciences Graduate Research Forum, University of Western Ontario. London, ON. *Abstract and Oral Presentation*.

† Awarded “Best Oral Presentation”

4. **Vanderloo, L. M.**, Tucker, P., Irwin, J. D., Burke, S. M., Johnson, A., & van Zandvoort, M. (2012, March 22-24). *The influence of the childcare environment on the physical activity behaviours of preschool-aged children: A pilot study*. Eastern Canada Sport and Exercise Psychology Symposium (ECSEPS). London, ON. *Abstract and Oral Presentation*.
5. **Vanderloo, L. M.**, Tucker, P., Irwin, J. D., Burke, S. M., Johnson, A., & van Zandvoort, M. (2012, February 8). *The influence of the childcare environment on physical activity among preschoolers: A feasibility study*. Health and Rehabilitation Sciences Graduate Research Forum, University of Western Ontario. London, ON. *Abstract and Oral Presentation*.
6. **Vanderloo, L. M.**, Tucker, P., Irwin, J. D., Burke, S. M., & Johnson, A. (2011, March 26). *Environmental influences of childcare centres on preschoolers' physical activity levels: A pilot study*. Eastern Canada Sport and Exercise Psychology Symposium (ECSEPS). Waterloo, ON. *Abstract and Oral Presentation*.
7. **Vanderloo, L. M.**, Tucker, P., Irwin, J. D., Burke, S. M., & Johnson, A. *Are Canadian preschoolers sufficiently active? An objective assessment of physical activity levels and environmental influences in childcare centres*. (2011, February 9). Health & Rehabilitation Sciences Graduate Research Forum, University of Western Ontario. London, ON. *Abstract and Oral Presentation*.
8. Tucker, P., **Vanderloo, L. M.**, Ismail, A., & van Zandvoort, M. M. (2011, March 25). *Physical Activity Opportunities in Canadian Childcare Facilities: A Provincial/Territorial Review of Legislation*. Faculty of Health Sciences Research Day, University of Western Ontario. London, ON. *Poster Presentation*.
9. **Vanderloo, L. M.** (2010, November 1). *Bullying: Bystander intervention among elementary students*. An invited lecture for the graduate level course, HS9721a – Current Topics in Health Promotion. University of Western Ontario. London, ON. *Oral Presentation*.

10. **Vanderloo, L. M.**, Tucker, P., van Zandvoort, M. M., Burke, S. M., & Irwin, J. D. (2010, April 7). *Decreasing Barriers: Advocating for Physical Activity in Childcare*. Independent Study Research Forum, Faculty of Health Sciences, University of Western Ontario. London, ON. Abstract and Oral Presentation.

#### C. GUEST LECTURES

1. *Health Promotion in the Childcare Environment: The Usefulness of the Precede-Proceed Model*. (2016, February 8). An invited lecture for the Health Promotion Graduate Seminar. Health and Rehabilitation Sciences Program, University of Western Ontario, London, ON.
2. *Child and Youth Health Promotion: Physical Activity and Sedentary Behaviours*. (2015, October 29). An invited lecture for PHRE 3008 – Health Promotion. Fitness & Health Promotion Program, Fanshawe College, London, ON.
3. *Illicit drug use in Canada*. (2013, March 27). An invited lecture for HS 3290b – Special Topics in Health Promotion. Faculty of Health Sciences, University of Western Ontario. London, ON. Oral Presentation.
4. *Assessing preschoolers' physical activity levels in childcare using Actical accelerometers: Advantages, challenges, and logistics*. (2012, November 9). An invited lecture for the Canadian Obesity Network – Western University Chapter. University of Western Ontario. London, ON. Oral Presentation.
5. *Childhood obesity in Canada: A major public health concern*. (2011, June 9). An invited lecture for the undergraduate level course, HS 3700 – Child & Adolescent Health Issues. Faculty of Health Sciences, University of Western Ontario. London, ON. Oral Presentation.

#### D. INVITED TALKS

1. *Scholarship Application Training Session*. (2015, September 11). An invited panelist to discuss with graduate students how best to prepare competitive applications for external scholarships. Faculty of Health Sciences, University of Western Ontario, London, ON.
2. *Discovery Days in Health Sciences @ University of Western Ontario*. (2015, May 1). An invited panelist for the TD Canada Trust Discovery Days in Health Sciences. The Canadian Medical Hall of Fame, London, ON.
3. *Consult the Expert Scholarship Session*. (2015, September 12). An invited panelist to help graduate students prepare their scholarship application submission. University of Western Ontario, London, ON.

4. *Scholarship Application Training Session*. (2014, September 10). An invited panelist to discuss with graduate students how best to prepare competitive applications for external scholarships. Faculty of Health Sciences, University of Western Ontario, London, ON.
5. *Strategies/challenges to undertaking graduate-level research*. (2013, November 28). An invited panelist for HS 9516a – Introduction to Research Methods in Health Sciences. Health and Rehabilitation Sciences, University of Western Ontario, London, ON.
6. *Discovery Days in Health Sciences @ University of Western Ontario*. (2013, May 3). An invited panelist for the TD Canada Trust Discovery Days in Health Sciences. The Canadian Medical Hall of Fame, London, ON.

E. RADIO BROADCAST INTERVIEWS

1. CHRW 94.9FM. “Health Science Radio”. *Radio interview regarding the Canadian Obesity Network-Student & New Professional group at Western*. Segment aired February 16, 2016.
2. CHRW 94.9FM. “Fat and Queer”. *Radio interview regarding obesity among the LGBTQ community*. Segment aired July 20, 2015.
3. CHRW 94.9FM. “Gradcast”. *Radio interview regarding preschoolers’ physical activity levels in childcare*. Segment aired February 13, 2014.

---

**RESEARCH FUNDING**

Summary (count) according to the following categories:

- Grant applications currently under review: 1 (total = \$)
- Non-competitive funding received: 1 (total = \$20,800)

A. SUBMITTED GRANTS (N = 1)

<b>Date of Submission</b>	<b>Principal Investigator(s)</b>	<b>Co-Investigator(s)</b>	<b>Granting Agency</b>	<b>Grant Title</b>	<b>Total Amount Requested</b>
2016 (October)	Patricia Tucker	<b>Leigh Vanderloo</b> , Valerie Carson, Patti-Jean Naylor, Kristi	Canadian Institutes of Health Research	Physical Activity Training for Early Childhood	\$530,000

		Adamo, Brian Timmons, Shauna Burke, Jennifer Irwin		Education Students: A Proactive Approach to Developing Healthy Children	
--	--	---	--	---	--

B. AWARDED NON-COMPETITIVE FUNDING ( $N = 1$ )

Start Date	End Date	Principal Investigator	Co-Investigator(s)	Granting Agency	Grant Title	Total Amount Requested
2016 (March)	2016 (June)	Patricia Tucker	<b>Leigh Vanderloo,</b> Molly Driediger	Ministry of Health and Long Term Care (Ontario)	Run. Jump. Play: Promoting young children's daily physical activity through childcare provider education	\$20,800

---

**KNOWLEDGE TRANSLATION ACTIVITIES**
**Research Summaries**

- *Physical Activity and Sedentary Time among Toddlers: Results from the Tots in Motion Study* (September 2015)
  - Distributed to participants' parents/guardians
- *Physical Activity and Nutrition in Early Learning Environments: Results from the LEAPP Study* (July 2015)
  - Distributed to participants' parents/guardians, childcare organizations and local school boards, and the Ministry of Education (for which a response was received from the Hon. Liz Sandals)

**Community Engagement Sessions – Facilitator**

- *Run, Jump, Play: Promoting Physical Activity and Physical Literacy Among Young Children* (June 2016)
  - Representatives from school boards and numerous childcare centres in London attended this one-day workshop, where they were provided with the



most current research on young children's physical activity levels and sedentary behaviours. Tips and hands-on activity ideas on how best to support physical activity during care/school hours were provided. This initiative was funded by the Healthy Kids Community Challenge.

- *Learning Environment Activity Potential for Preschoolers* (LEAPP; November 2014)
  - Presented and discussed the findings from the LEAPP study with a group of childcare Directors, childcare staff, home-based childcare providers and other early-years stakeholders. Attendees were given the opportunity to ask questions of researchers and to brainstorm next steps

### **Research Uptake Strategies – Assistant Moderator**

April 2010

- Following a study which examined childcare providers' perspectives to engaging preschoolers in physical activity, a knowledge exchange lunch was organized to actively disseminate/share the findings with service providers and early years stakeholders. This meeting resulted in the creation of a community advocacy plan.

### **Services & Administration**

## **EVALUATION OF ARTICLES FOR SCIENTIFIC JOURNALS**

### **Editorial Positions**

1. Executive Editor: Content Development for Health Science Inquiry (student-led journal; 2015-2016)
2. Senior Editor for Health Science Inquiry (student-led journal; 2014-2015)

### **Manuscript Revision**

1. Reviewer for Health & Social Care in the Community (2016) – 1 paper
2. Reviewer for BMC Public Health (2015, 2016) – 2 papers
3. Reviewer for Medicine and Science in Sports and Exercise (2015) – 2 papers
4. Reviewer for Pediatric Obesity (2015) – 1 paper
5. Reviewer for Pediatrics (2014) – 1 paper
6. Reviewer for BMC Pediatrics (2014) – 1 paper
7. Reviewer for Journal of Behavioral Education (2014) – 1 paper
8. Reviewer for Journal of Physical Activity and Health (2013-2015) – 3 papers
9. Reviewer for American Journal of Preventive Medicine (2012-2015) – 4 papers

### **Proofreading**

1. Insel's Core Concepts in Health (2<sup>nd</sup> edition textbook). Health & Human Performance, McGraw-Hill Education. (2015)
2. Health Science Inquiry (student-led journal; 2014)

---

**OTHER SCHOLARLY AND ADMINISTRATIVE ACTIVITIES**

**University Senate – Senate Committee on Academic Policy and Awards (SCAPA)** 2015 – 2016  
 University Secretariat, University of Western Ontario, London, ON

**2015 Health and Rehabilitation Sciences Graduate Research Conference (HRS HRC) Planning Committee** 2014 – 2015  
 Faculty of Health Sciences, University of Western Ontario, London, ON

*\*Served as Lead Peer Judge for this event as well*

**2012 Eastern Canada Sport and Exercise Psychology Symposium (ECSEPS) Organizing & Planning Committee** 2011 – 2012  
 Faculty of Health Sciences, University of Western Ontario, London, ON

**VP Communications, Health Studies Students’ Council** 2009 – 2010  
 School of Health Studies, University of Western Ontario, London, ON

---

**COMMUNITY SERVICE**

**Board Member and Secretary to the Board** 2009 – 2015  
 Vanier Children’s Services, Board of Directors, London, ON

- Member of Governance and Executive Committees (2013-2015)
- Chair of Fund Development & Public Relations (2011-2012)

**Health Promotion Field Mentor** 2013 – 2014  
 Health and Rehabilitation Sciences Program, University of Western Ontario, London, ON

**Occupational Science Field Mentor** 2012 – 2013  
 Health and Rehabilitation Sciences Program, University of Western Ontario, London, ON

**Health Promotion Field Mentor** 2011 – 2012  
 Health and Rehabilitation Sciences Program, University of Western Ontario, London, ON

**Ambassador for Heart Healthy Children and Youth Initiative** 2010 – 2014  
 Heart & Stroke Foundation of Ontario, London, ON

---

### PROFESSIONAL MEMBERSHIPS & AFFILIATIONS

- Past President (2016–2017), Chapter President (2015-2016), Chapter Vice-President (2011– 2014) – Canadian Obesity Network-Student and New Professional (CON-SNP), University of Western Ontario, London, ON
- Student Member (2014–Present) – Internal Society of behavioral nutrition and Physical Activity
- Member (2015 –Present) – Canadian Knowledge Transfer and Exchange Community of Practice
- Student Member (2015 – Present) – Exercise is Medicine – Campus Chapter, University of Western Ontario, London, ON
- Member (2014 – Present) – Sedentary Behaviour Research Network (SBRN)
- Student Member (2011-Present) – North American Society for Pediatric Exercise Medicine
- Student Member (2012-2014) – Society of Behavioral Medicine
- Student Member (2011-2014) – Health Promotion Ontario
- Member (2011-2013) – Child & Youth Network of London

---

### Professional Development and Additional Training

---

- |   |      |
|---|------|
| Introduction to evaluation (EVA1)<br>Skills Online Program, Public Health Agency of Canada (PHAC)   | 2015 |
| Behind the Scenes: Addressing weight bias and stigma in obesity<br>School of Health and Human Performance, Dalhousie University (facilitator: Dr. Sara Kirk)  | 2015 |
| <ul style="list-style-type: none"> <li>• Module 1: Course introduction and exploring our own biases</li> <li>• Module 2: Understanding obesity as a complex health and societal issue</li> <li>• Module 3: Weight bias and stigma, what it is and where it comes from?</li> <li>• Module 4: How do we address weight bias and stigma?</li> <li>• Module 5: Bringing it all together in best practices</li> </ul>                                |      |
| National Collaborating Centre for Measurement and Tools, Hamilton, ON   | 2014 |
| <ul style="list-style-type: none"> <li>• Critical Appraisals of Intervention Studies</li> <li>• Critical Appraisals of Qualitative Studies</li> <li>• Assessing the Applicability and Transferability of Evidence</li> <li>• Critical Appraisal of Systematic Reviews</li> <li>• Quantitative Research Designs 101 – Addressing Practice-Based Issues in Public Health</li> <li>• Evidence-Informed Decision Making in Public Health</li> </ul> |      |
| Tri-Council Policy Statement: Ethics Conduct for Research Involving Humans<br>(TCPS 2: CORE)  | 2013 |

Knowledge mobilization workshop – “Designing Knowledge Mobilization Plans: A Guide for Research and Grant Applications”, University of Western Ontario, London, ON	2012
World Health Organization Growth Chart training program (Modules 1-5)	2012
Workplace Hazardous Material Information System (WHMIS) training	2011
National Institute of Health’s (NIH) Office of Extramural Research course on Protecting Human Research Participants	2010
Interagency Advisory Panel on Research Ethics’ Introductory Tutorial for the Tri Council Policy Statement: Ethics Conduct for Research Involving Humans (TCPS)	2010
Teaching Assistant Training Program (TATP) University of Western Ontario, London, ON	2010
Leadership Education Program – Individual Leadership University of Western Ontario, London, ON	2009

---

### **Languages**

---

1. English (native)
2. French (highly proficient, verbal and written)