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# Environmental Influences on Preschoolers' Physical Activity Levels in Various Early-Learning Facilities

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**Purpose:** This study aimed to: (a) compare the physical activity (PA) levels (i.e., moderate-to-vigorous PA [MVPA] and total PA [TPA]) of preschoolers in 3 different early-learning environments (center-based childcare, home-based childcare, and full-day kindergarten [FDK]); and (b) assess which characteristics (e.g., play equipment, policies, etc.) of these settings influenced preschoolers' PA. **Method:** Twenty-seven facilities (9 centers, 10 homes, and 8 FDK) participated in this study. Participants (aged 2.5–5 years; $n = 297$) were fitted with Actical™ accelerometers for 5 consecutive days during childcare/school hours to assess their PA. The Environment and Policy Assessment and Observation (EPAO) tool was used to objectively examine the PA environment of all participating facilities. Finally, demographic questionnaires were administered to preschoolers' parents/guardians. **Results:** Preschoolers in FDK accumulated significantly more MVPA ($p < .05$; 3.33 min/hr) than those in center- (1.58 min/hr) and home-based (1.75 min/hr) childcare, and they accumulated significantly more TPA ($p < .05$; 20.31 min/hr) than those in center-based childcare (18.36 min/hr). For FDK, the Active Opportunities, Sedentary Opportunities, Sedentary Environment, and Fixed Play Environment subscales of the EPAO significantly impacted both MVPA and TPA. For center-based childcare, only the Sedentary Environment subscale was found to impact MVPA and TPA. No subscales influenced children's MVPA or TPA in home-based childcare. **Conclusions:** This research underscores the need to encourage/support preschoolers' active behaviors in early-learning settings, particularly for those in center- and home-based childcare. Furthermore, this article highlights environmental and staff characteristics on which future PA programming should focus.

**Keywords:** accelerometry, childcare, early years, health promotion

Recently, the landscape of early-learning environments in Ontario, Canada, has transformed dramatically. Specific to this province, the three main types of early-learning arrangements include: (a) center-based childcare, (b) home-based childcare, and (c) full-day kindergarten (FDK). Center-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 five children plus the provider's own children) across various age groups (e.g., aged 1–11 years; Temple, Naylor, Rhodes, & Wharf Higgins, 2009). Home-based childcare facilities are usually privately operated and owned by the childcare provider (Lawlis, Mikhailovich, & Morrison, 2008) and can operate as either licensed or unlicensed establishments. In 2010, the Government of Ontario announced its decision to implement FDK for all children aged 3 to 5 years old (Ontario Ministry of Education, 2010). The reasoning provided for this new early-learning program was to

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optimize emotional, academic, social, and physical development among young children in the school system (Ontario Ministry of Education, 2010). Compared with the previous kindergarten structure in Ontario (i.e., full days on alternating days or half-days every day), children attending FDK programming are required to attend all day every week day (i.e., Monday to Friday from approximately 9 a.m. to 3 p.m.), and they receive instruction from both a teacher (i.e., responsible for student learning, elementary curriculum, and formal evaluation and reporting) and an early childhood educator (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 (Goldfield, Harvey, Grattan, & Adamo, 2012; Tucker et al., 2013).

The early years mark a critical time for growth and development. It is during this time that many children establish health-related behaviors, including physical activity (PA) practices (Malina, 2001). Developing strong PA 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, Cleland, & Venn, 2005; Taylor et al., 2009). Specific to the preschool population (i.e., children aged 2.5–5 years old), regular participation in PA 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 PA participation within this age group is low and sedentary behaviors are common (Alhassan, Sirars, & Robinson, 2007; Cliff et al., 2009; Pate, Pfeiffer, Trost, Ziegler, & Dowda, 2004). Such low (and counterintuitive) PA levels have been documented among Canadian preschoolers (Temple et al., 2009; Vanderloo et al., 2014). 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 PA.

The appropriateness of intervening in early-learning environments to target preschoolers' PA 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, PA-specific training/education), and adequate space (e.g., indoor and outdoor), have been noted as playing an important role in fostering active behaviors 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 aforementioned influential factors within this unique setting, little is known regarding the degree to which they support or hinder preschoolers' 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, which was conducted in center-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 (Brown et al., 2009; Pate et al., 2004; Vanderloo et al., 2014), underscores the strong need to establish evidence-informed "healthful" environments in support of preschoolers' PA behaviors.

No research to date has examined preschoolers' PA levels across different types of early-learning facilities or potential environmental influences on PA 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 PA-related resources, infrastructure, and programming across center-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 center-based childcare are at an increased risk for gains in adiposity in comparison with those who receive parental care (Geoffroy et al., 2012), increased attention is required to understand the context in which PA occurs while in early-learning environments.

## Study Purpose

The purpose of this study was twofold: (a) to compare the PA levels (i.e., moderate-to-vigorous PA [MVPA], total PA [TPA]) of preschoolers in three different early-learning environments (i.e., center-based childcare, home-based childcare, and FDK); and (b) to assess which characteristics (i.e., play equipment, policies, staff behavior and training, outdoor play periods, sedentary behaviors/opportunities) of these early-learning environments are associated with preschoolers' PA.

## 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 from September 2011 to 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 the University of Western Ontario's Research Ethics Board.

### Participants

Researchers invited preschool children (aged 2.5–5 years old) from three different early-learning environments (i.e., center-based, home-based, and FDK) to participate (Tucker et al., 2013). Tailored recruitment strategies were used to enlist participants from each of the three environments and are detailed elsewhere (Tucker et al., 2013). All eligible children who received written informed parent/guardian consent were invited to take part in the study.

### Procedures and Tools of Measurement

This study utilized two direct assessment tools, Actical™ accelerometers (MiniMitter, Bend, OR) and the Environment and Policy Assessment and Observation instrument (EPAO; Ball et al., 2005). A demographic questionnaire for parents/guardians was also administered.

PA duration and intensity were assessed via Actical accelerometers fastened over the right hip of participating children, using a 15-s epoch length. Participants wore the accelerometers for 5 consecutive days during early-learning hours only. Trained staff secured the devices on the children as they arrived in the morning and removed them prior to departure at the end of the day. Staff recorded the on/off times of the devices for each child in a log.

During the week of accelerometry data collection, two researchers administered the EPAO instrument. Divided into two subsections (a day-long observation of the environment followed by a review of all PA-related documents and policies), the PA portion of this tool was used to conduct an objective evaluation of each early-learning venue (Ball et al., 2005; Benjamin et al., 2007; Bower et al., 2008). Specifically, eight PA subscales were examined during each 1-day observation period: (a) Sedentary Opportunities, (b) Sedentary Environment, (c) Active Opportunities, (d) Staff Behaviors, (e) Physical Activity Training and Education, (f) Physical Activity Policies, (g) Portable Play Environment, and (h) Fixed Play Environment (Ball et al., 2005; Ward et al., 2008). Bower et al. (2008) presented a complete description of the PA subscales. Tucker et al. (2013) presented a full description of research protocol and measurement procedures.

### 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, Saskatoon, Saskatchewan, Canada) 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: nonwear time was defined as 60 min of consecutive zeroes (which accounted for nap time, where applicable; Colley, Connor Gorber, & Tremblay, 2010); 5 hr 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, Garriguet, 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, McIver, Dowda, Almeida, and Pate's (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), PA 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 the Statistical Package for the Social Sciences (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) were entered as *clusters*. Unstandardized residual scores were created from running a regression analysis of age onto MVPA and TPA to account for the effect of age on activity levels. These residual scores were used in subsequent linear mixed-model analysis of covariance (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 for the following fixed factors were included in the model: type of early-learning environment (i.e., center-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 model. Post-hoc comparisons using Tukey's honest significant difference 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' PA, instrument-specific guidelines and a scoring tool were used to calculate the results of the EPAO's eight PA subscales (Ward et al., 2008). A Total Physical Activity Environment EPAO score (ranging from 0 to 20, where lower scores indicate a less supportive environment, with regards to PA) was calculated for each site by averaging the scores across all eight PA subscales. All items within the PA portion of the EPAO tool were coded by two reviewers, and intraclass correlation coefficients (ICCs) were calculated to examine interrater 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 Behaviors 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·15 s$^{-1}$·epoch$^{-1}$; dependent variable) and TPA ($\geq$ 50 counts·15 s$^{-1}$·epoch$^{-1}$; dependent variable), and the EPAO PA subscales (independent variable) and the Total Physical Activity 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 center-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 PA data (i.e., 3 days with 5 hr 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 min ($SD = 53.75$). Among the center- and home-based childcare facilities that had nap times scheduled, average daily naptime was measured (via accelerometers) at 73.17 min ($SD = 44.29$). 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, $t(216) = 4.11$, $p < .05$, $\eta^2 = .07$, TPA than their female counterparts; the difference in MVPA levels across the two sexes approached statistical significance, $t(216) = 1.90$, $p = .06$, $\eta^2 = .02$. Results of the omnibus ANCOVA test indicated that type of early-learning environment had a statistically significant effect on preschoolers' levels of MVPA, $F(2, 215) = 62.76$, $p < .05$, $\eta^2_{par} = .06$, and TPA, $F(2, 215) = 6.22$, $p < .05$, $\eta^2_{par} = .37$ (Table 2). Post-hoc analyses revealed that in comparison with children attending FDK, levels of MVPA

TABLE 1
Preschooler and Family Demographic Information ($N = 218$)

| | *N* | % |
|---|---|---|
| Sex of Preschooler | | |
| Male | 102 | 46.8 |
| Female | 116 | 53.2 |
| Type of Early-Learning Environment | | |
| Home-based childcare | 20 | 9.2 |
| Center-based childcare | 71 | 32.6 |
| Full-day kindergarten | 127 | 58.3 |
| School/Childcare Status | | |
| Part-time | 23 | 10.5 |
| Full-time | 193 | 88.1 |
| Preschoolers' 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 hr 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

| | *Center-Based Childcare* | | *Home-Based Childcare* | | *Full-Day Kindergarten* | |
|---|---|---|---|---|---|---|
| *Physical Activity Intensity* | *M (SD)* | *95% CI* | *M (SD)* | *95% CI* | *M (SD)* | *95% CI* |
| MVPA | 1.58 (0.74)$^{\pm}$ | [1.40, 1.75] | 1.75 (0.96) | [1.31, 2.20] | 3.33 (1.30) | [3.10, 3.56] |
| TPA | 18.36 (3.39)$^{\pm}$ | [17.55, 19.16] | 19.28 (6.34)$^{\infty}$ | [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).
$\pm$Statistically significant difference in physical activity levels between center-based childcare and full-day kindergarten ($p < .05$).
$\infty$Statistically significant difference in physical activity levels between home-based childcare and full-day kindergarten ($p < .05$).

were found to be statistically significantly lower among those attending home- ($p < .05$) and center-based ($p < .05$) childcare. TPA levels were found to be statistically significantly higher among children attending FDK versus those in center-based childcare ($p < .05$).

## EPAO Physical Activity Subscales and MVPA

The average EPAO PA subscale scores and Total Physical Activity 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.

Direct entry linear regression analyses revealed that the model for *center-based childcare* was composed of: Active Opportunities, Sedentary Opportunities, Sedentary Environment, Fixed Play Environment, Portable Play Environments, Staff Behaviors, Staff Training and Education, and Physical Activity Policy. The model for *home-based childcare* and *FDK* was composed of: Active Opportunities, Sedentary Opportunities, Sedentary Environment, Fixed Play Environment, Portable Play Environments, Staff Behaviors, 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 the center-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 center-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 PA subscale included in these models.

## EPAO Physical Activity Subscales and TPA

Based on direct entry linear regression analyses, the model for *center-based childcare* was composed of: Active

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

| *EPAO Physical Activity Subscales* | *Centers* | *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 Behaviors | 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 and Education | 3.17 (5.07) | [2.57, 3.77] | 0.50 (1.54) | [−0.17, 1.17] | 7.17 (2.49) | [6.74, 7.6] |
| Physical Activity Policies | 0.14 (1.19) | [−0.14, 0.42] | 0.00 (0.00) | — | 10.00 (0.00) | — |
| 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.

TABLE 4
Summary of Coefficients, Confidence Intervals, *t* Values, *p* Values, and Correlations for the Environment and Policy Assessment and Observation (EPAO) Physical Activity Subscales and Daily Moderate-to-Vigorous Physical Activity (MVPA)

| | | | | | | Correlations | |
|---|---|---|---|---|---|---|---|
| *Environment Type* | *EPAO Physical Activity Subscales* | *B* | *95% CI [Lower Bound, Upper Bound]* | *t* | *p* | *Zero-Order* | *Partial* |
| Home[a] | Active Opportunities | −0.00 | [−0.15, 0.15] | −0.05 | .96 | .19 | .02 |
| | Sedentary Opportunities | 0.06 | [−0.05, 0.17] | 1.12 | .29 | .24 | .31 |
| | Sedentary Environment | −0.07 | [−0.29, 0.15] | −0.60 | .56 | .41 | −.17 |
| | Portable Play Environment | −0.12 | [−0.47, 0.23] | −0.67 | .52 | −.60 | −.19 |
| | Fixed Play Environment | 0.08 | [−0.02, 0.28] | 0.81 | .44 | .09 | .23 |
| | Staff Behaviors | −0.09 | [0.15, −0.33] | −0.72 | .49 | −.58 | −.20 |
| | PA Training and Education | 0.09 | [−0.43, 0.61] | 0.34 | .74 | −.23 | .10 |
| | PA Policy | — | — | — | — | — | — |
| Center[b] | Active Opportunities | −0.01 | [−0.06, 0.04] | −0.39 | .70 | −.18 | −.05 |
| | Sedentary Opportunities | 0.09 | [−0.02, 0.20] | 1.50 | .14 | .04 | .19 |
| | Sedentary Environment | −0.09 | [−0.16, −0.02] | −2.46 | .02* | −.04 | −.30 |
| | Portable Play Environment | 0.00 | [−0.17, 0.17] | 0.05 | .96 | −.16 | .01 |
| | Fixed Play Environment | 0.08 | [−0.06, 0.22] | 1.13 | .26 | .15 | .14 |
| | Staff Behaviors | −0.04 | [−0.10, 0.03] | −1.10 | .27 | .20 | −.14 |
| | PA Training and Education | −0.09 | [−0.018, 0.00] | −1.82 | .07 | −.26 | −.23 |
| | PA Policy | 0.09 | [−0.10, 0.28] | 0.92 | .36 | .02 | .12 |
| FDK[c] | Active Opportunities | 0.12 | [0.03, 0.21] | 2.59 | .01* | .53 | .23 |
| | Sedentary Opportunities | 0.07 | [0.03, 0.11] | 3.35 | .00* | .11 | .29 |
| | Sedentary Environment | −0.19 | [−0.27, −0.11] | −4.35 | .00* | −.48 | −.37 |
| | Portable Play Environment | −0.01 | [−0.11, 0.09] | −0.22 | .82 | .32 | −.02 |
| | Fixed Play Environment | 0.23 | [0.07, 0.39] | 2.74 | .01* | .04 | .24 |
| | Staff Behaviors | −0.01 | [−0.06, 0.04] | −0.32 | .75 | .35 | −.03 |
| | PA Training and Education | −0.03 | [−0.12, 0.06] | −0.60 | .60 | −.16 | −.06 |
| | PA Policy | — | — | — | — | — | — |

*Note*. Physical activity presented as a daily rate (min/day). CI = confidence interval; PA = physical activity; FDK = full-day kindergarten.
*Statistically 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.
[a] Model accounts for 23.8% of the variability in MVPA.
[b] Model accounts for 5.7% of the variability in MVPA.
[c] Model accounts for 38.8% of the variability in MVPA.

Opportunities, Sedentary Opportunities, Sedentary Environment, Fixed Play Environment, Portable Play Environments, Staff Behaviors, Staff Training and Education, and Physical Activity Policy. The model for *home-based childcare* and *FDK* was composed of: Active Opportunities, Sedentary Opportunities, Sedentary Environment, Fixed Play Environment, Portable Play Environments, Staff Behaviors, 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 the center-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 *center-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 PA 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 TPA EPAO score for each environment type, again, direct entry regression analyses were completed. The 2.0% (adj $R^2 = -.020$), 0.4% (adj $R^2 = .004$), and 18.0% (adj $R^2 = .180$) of the variability seen in MVPA was accounted for by the home-based childcare, center-based 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 the home-based childcare, center-based childcare, and FDK models, respectively. No models were statistically significant. See Table 6

TABLE 5
Summary of Coefficients, Confidence Intervals, *t* Values, *p* Values, and Correlations for the Environment and Policy Assessment and Observation (EPAO) Physical Activity Subscales and Daily Total Physical Activity (TPA)

| | | | | | | Correlations | |
|---|---|---|---|---|---|---|---|
| *Environment Type* | *EPAO Physical Activity Subscales* | *B* | *95% CI [Lower Bound, Upper Bound]* | *t* | *p* | *Zero-Order* | *Partial* |
| Home[a] | Active Opportunities | −0.06 | [−0.99, 0.87] | −0.13 | .90 | .15 | −.04 |
| | Sedentary Opportunities | 0.43 | [−0.24, 1.1] | 1.26 | .23 | .16 | .34 |
| | Sedentary Environment | −1.02 | [−2.4, 0.36] | −1.45 | .17 | .28 | −.39 |
| | Portable Play Environment | −0.29 | [−2.53, 1.95] | −0.25 | .81 | −.59 | −.07 |
| | Fixed Play Environment | 0.02 | [−1.25, 1.29] | 0.03 | .98 | −.16 | .01 |
| | Staff Behaviors | −1.37 | [−2.91, 0.17] | −1.75 | .11 | −.62 | −.45 |
| | PA Training and Education | 0.31 | [−3.0, 3.62] | 0.19 | .86 | −.16 | .05 |
| | PA Policy | — | — | — | — | — | — |
| Center[b] | Active Opportunities | −0.14 | [−0.35, 0.07] | −1.26 | .21 | −.22 | −.16 |
| | Sedentary Opportunities | 0.53 | [0.02, 1.04] | 2.05 | .04* | .25 | .25 |
| | Sedentary Environment | −0.25 | [−0.59, 0.09] | −1.48 | .14 | .01 | −.19 |
| | Portable Play Environment | −0.55 | [−0.21, 0.21] | −1.42 | .16 | −.21 | −.18 |
| | Fixed Play Environment | 0.47 | [−0.15, 1.09] | 1.47 | .15 | .05 | .18 |
| | Staff Behaviors | −0.06 | [−0.34, 0.22] | −0.41 | .67 | .22 | −.05 |
| | PA Training and Education | −0.01 | [−0.43, 0.41] | −0.03 | .98 | −.19 | −.00 |
| | PA Policy | 0.14 | [−0.71, 0.99] | 0.32 | .75 | −.04 | .04 |
| FDK[c] | Active Opportunities | −0.31 | [−0.60, −0.02] | −2.11 | .04* | −.09 | −.19 |
| | Sedentary Opportunities | 0.16 | [0.06, 0.32] | 2.75 | .01* | .16 | .24 |
| | Sedentary Environment | −0.57 | [−0.84, −0.30] | −4.19 | .00* | −.17 | −.36 |
| | Portable Play Environment | −0.06 | [−0.37, 0.26] | −0.35 | .73 | .03 | −.03 |
| | Fixed Play Environment | 0.86 | [0.34, 1.38] | 3.26 | .00* | .10 | .29 |
| | Staff Behaviors | −0.05 | [−0.20, 0.10] | −0.69 | .50 | .03 | −.06 |
| | PA Training and Education | −0.05 | [−0.35, 0.25] | −0.32 | .75 | .16 | −.03 |
| | PA Policy | — | — | — | — | — | — |

*Note*. Physical activity presented as a daily rate (min/day). CI = confidence interval; PA = physical activity; FDK = full-day kindergarten.

*Statistically 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.

[a] Model accounts for 31% of the variability in TPA.

[b] Model accounts for 8% of the variability in TPA.

[c] Model accounts for 14.0% of the variability in TPA.

for statistics pertaining to the Total Physical Activity Environment EPAO score.

## DISCUSSION

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

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; center-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 min/hr and 20.51 min/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 did those attending center-based childcare facilities and significantly more TPA than children attending both center- 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 center- and home-based childcare in this study was 73 min as measured via the accelerometers). An additional explanation could be a result of the newly revised FDK curriculum, which specifically targets "health

TABLE 6
Summary of Coefficient, Confidence Interval, *t* Value, *p* Value, and Partial Correlation for Total Physical Activity EPAO Score and Moderate-to-Vigorous Physical Activity (MVPA) and Total Physical Activity (TPA)

| | | | | | | Correlations | |
|---|---|---|---|---|---|---|---|
| | *Environment Type* | *B* | *95% CI [Lower Bound, Upper Bound]* | *t* | *p* | *Zero-Order* | *Partial* |
| MVPA | Center[a] | −0.07 | [−0.24, 0.10] | −0.87 | .39 | −.10 | −.10 |
| | Home[b] | −0.16 | [−0.55, 0.23] | −0.79 | .44 | −.18 | −.18 |
| | FDK[c] | 0.54 | [0.34, 0.74] | 5.35 | .00* | .43 | .43 |

| | | | | | | Correlations | |
|---|---|---|---|---|---|---|---|
| | *Environment Type* | *B* | *95% CI [Lower Bound, Upper Bound]* | *t* | *p* | *Zero-Order* | *Partial* |
| TPA | Center[d] | −0.19 | [−0.96, 0.58] | −0.49 | .62 | −.06 | −.06 |
| | Home[e] | −2.24 | [−4.64, 0.16] | −1.83 | .08 | −.40 | −.40 |
| | FDK[f] | 0.31 | [−0.26, 0.88] | 1.06 | .29 | .10 | .10 |

*Note.* CI = confidence interval; EPAO = Environment and Policy Assessment and Observation; FDK = full-day kindergarten.
*statistically significant ($p < .05$).
[a] Model accounts for 2.0% of the variability in MVPA.
[b] Model accounts for 0.4% of the variability in MVPA.
[c] Model accounts for 18.0% of the variability in MVPA.
[d] Model accounts for 1.1% of the variability in TPA.
[e] Model accounts for 11.0% of the variability in TPA.
[f] Model accounts for 0.1% of the variability in TPA.

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-motor 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 center-based facilities), the EPAO PA subscales did not significantly impact the PA levels of preschoolers in center- or home-based childcare. This finding contradicts previous research, even among preschoolers in center-based childcare in the same city, which has shown 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 PA subscales and center-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 center that promote sedentary behaviors (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 and Education subscale and time spent by preschoolers in PA; 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 to PA, 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 PA in these settings. Further, in comparison with FDK and center-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 regards 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 that impacted PA within this particular environment.

Perhaps the most counterintuitive finding relates to the discovery of a positive relationship between the Sedentary Opportunities subscale and PA levels in FDK; our results would suggest that having more opportunities available for children to engage in activities that discourage active behaviors (e.g., sitting for more than 30 min, watching TV, playing computer/video games) is positively associated with PA among preschool-aged children. Although it is unclear why this relationship was found, one possible explanation could be that because 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, tends 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 PA by preschoolers in FDK; the more items present in the classroom that discourage PA (e.g., television and/or computer present in the classroom), the less active the preschool sample was. Interestingly, similar results have been noted among preschoolers in both center- 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 PA when provided with fixed play equipment (e.g., climbers and slides). Given some high-level similarities between the FDK and center-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 center-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 center-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 Scores for center-based childcare, home-based childcare, and FDK facilities were 10.39, 8.95, and 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 PA 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 center-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 center-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' active behaviors.

The regression analyses conducted between the Total Physical Activity Environment 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 center-based childcare (Vanderloo et al., 2014). With regard to the Total Physical Activity Environment 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 PA 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 the early years should strive for 180 min of daily PA at *any* intensity (Canadian Society of Exercise Physiology, 2012), it may prove worthwhile for early-learning specialists and public health officials to modify these particular environments to better support PA among preschoolers.

The primary limitation of this study was the use of the EPAO tool for the FDK and home-based childcare environments. Traditionally developed and validated for use in center-based childcare settings (Ball et al., 2005; Ward et al., 2008), it is possible that this tool may not have accurately captured the PA 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 different study response rates (notably the low response rate among the FDK group) may also be of concern and may impact interpretation of 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 reporting and/or underreporting may have occurred.

This was the first study to compare the objectively measured PA 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 PA. 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.

## WHAT DOES THIS ARTICLE ADD?

This is the first international study to compare and contrast preschoolers' PA levels across various early-learning environments. This article also highlights a number of environmental and staff characteristics that both positively and negatively impact preschoolers' PA. The findings from this work underscore the importance of early intervention as it relates to increasing preschoolers' PA during care hours and also identify factors within each environment type that can be modified in service of supporting this health-inducing behavior. The findings of this article both complement and add to the growing body of literature that explores the relationship between early-learning environments and young children's activity levels. Specifically, early-learning stakeholders and health promotion specialists can draw on this research to assist in creating more activity-supportive environments for preschool-aged children enrolled in early-years programming. Future work should focus primarily on increasing and facilitating active behaviors among preschoolers enrolled in center-based and home-based childcare.

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