# Factors Related to Energetic Play During Outdoor Time in Childcare Centres

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## Abstract

Outdoor time is a positive correlate of physical activity in preschoolers; however, children remain highly sedentary even outdoors. This cross-sectional study thus aimed (1) to measure the physical activity levels of 30 preschool-aged children attending a centre-based childcare centre in a remote region located in Northwestern Québec (Canada) and (2) to identify the factors associated with moderate-to-vigorous physical activity (MVPA) during outdoor time. Two observers monitored the children individually over a period totalling approximately 40 h using a translated version of the *Observational System for Recording Physical Activity in Children-Preschool version* (OSRAC-P). In addition, parents and early childhood educators each completed a short questionnaire to, respectively, collect child demographics and educators' personal characteristics and physical activity habits. When children were outdoors, sedentary activities predominated (60.2%), compared with light activities (18.1%) and MVPA (21.7%). A binary logistic regression analysis also showed that MVPA was associated with different social and non-social factors: the group composition, the early childhood educator, the prompting behaviors, the outdoor educational context, the time of day, and the children's age and sex. Although no clear profile of early childhood educators seemed to be linked to children's MVPA, some factors under their control appear to contribute to increasing preschoolers' PA. Prompting children to be active and integrating more high energy expenditure activities in their daily routine stood out as good ways to optimize time spent outdoors.

**Keywords** Physical activity · Preschool children · Childcare centres · Outdoor play · Direct observation · Correlates

Often perceived as highly active, many young children are actually not (Driediger et al. 2018). In Canada, only 61.8%

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of preschoolers (3–4 years) and 47.6% of school-aged children (5–11 years) meet the 24-h Movement Guidelines (Chaput et al. 2017; Roberts et al. 2017), which recommend doing at least 60 min of daily moderate-to-vigorous physical activity (MVPA or energetic play) and limiting sedentary time (Tremblay et al. 2017, 2016). Non-adherence to movement guidelines may prevent children from gaining several physical, cognitive and psychosocial health benefits and may expose them to unnecessary risks (Carson et al. 2017; Poitras et al. 2016). Physical activity (PA) is a key determinant of health; PA is also a changeable behavior (World Health Organization 2010).

Childcare centres can be change agents regarding PA promotion; they have high attendance rates, children spend extended hours there, and early childhood educators (ECEs) can provide them with positive motor experiences (Goldfield et al. 2012; Larson et al. 2011). However, children's PA remains low even during outdoor time (Truelove et al. 2018). In this specific context—identified as a positive correlate of PA—they spend a mean of 13.5% (range: 10.5–16.7%)

of their time in MVPA and 56.9% (range: 50.2–63.5%) in sedentary activities (Truelove et al. 2018; Truelove 2019). In addition to a recent call to action to increase daily opportunities for energetic play in these settings (Driediger et al. 2018), some researchers emphasized the need to explore environmental influences on children's active behaviors and to focus on what they actually do when they are outside (Soini et al. 2014; Hinkley et al. 2016).

Direct observation can contribute to filling this gap by revealing the exact circumstances in which children are active and by assessing some educator variables (i.e., presence, prompts)—which are understudied and present inconclusive results (Tonge et al. 2016). Research using direct observation is scarce and most has been undertaken in the U.S and in Europe in large urban communities (Truelove et al. 2018). The health behaviors of children living in small communities or rural settings, though, also need to be researched to better intervene (Froehlich Chow and Humbert 2014). Moreover, reasearchers who investigated the factors related to PA in outdoor play focused on a limited number of educational contexts; but, we believe that some infrequent contexts are worth examination.

Gaining better knowledge of the contextual factors associated with PA in childcare centres is a major prerequisite for implementing effective, health-promoting actions in these educational settings. In this respect, the present article aimed (1) to measure the PA levels of children attending a childcare centre in Abitibi-Témiscamingue (Québec, Canada) and (2) to identify the factors related to MVPA in the outdoor context. To our best knowledge, this is the first Canadian study using the *Observational System for Recording Physical Activity in Children-Preschool version* (OSRAC-P).

## Study Context

This study was conducted in Abitibi-Témiscamingue, a remote resource area located in Northwestern Québec (Canada). Its population of approximately 148,000 inhabitants is spread over a 57,738 km$^2$ territory, which makes it a low population density region (2.6 inhabitants per km$^2$) (Institut de la statistique du Québec 2016). Our study took place in two cities of this region.

## Method

### Recruitment

Recruitment for this cross-sectional study was four-fold: we sent invitation letters to all childcare directors in two cities of Abitibi-Témiscamingue (Québec, Canada) (N = 10); we carried out follow-up calls, after which three childcare

centres agreed to participate; we invited all ECEs of these facilities working with children aged 3–5 years; and we solicited these children's parents. In the end, recruitment totalled 30 children distributed in nine classes (a maximum of six children per class was set to diversify the sample).

### Data Collection

Parents completed a short questionnaire on child demographics. It included questions on age, sex, ethnicity, family type (two-parent or one-parent), parents' education levels and annual household income. ECEs also completed a questionnaire including questions on age, sex, education, professional experience, perception of their ability to support children in PA (Likert scale 1–4) and perception of their own PA-related abilities (Likert scale 1–4). The *Godin-Shephard Leisure-Time Physical Activity Questionnaire* (Godin 2011) was also added to measure ECEs' personal PA habits. This four-item, self-administered questionnaire seeks information on the number of times spent in three PA levels during a typical week (which are multiplied by 3, 5 or 9 metabolic equivalents, then summed). The scores derived from this tool result in a *Leisure Score Index* (LSI), allowing classification as active, moderately active or insufficiently active.

As for children's PA measurement, we selected the OSRAC-P to collect contextually rich data (Brown et al. 2006). This instrument measures PA levels on a five-point scale (e.g., from stationary to vigorous movements) and assesses the social (e.g., initiator of activity, group composition and prompt for PA) and non-social (e.g., PA type, location and educational context) related factors. PA levels 4 and 5 refer to MVPA. For the purpose of this study, two professional translators performed a reverse translation process on the OSRAC-P; first from English to French and then from French to English. The last version was compared to the original to ensure consistency.

We trained two observers according to Hartmann and Wood's method (1990), which suggests progressing from code memorizing and informal observation periods to intensive in situ observation and codification periods. Data collection began when the interobserver agreement (IOA) reached a minimal 0.80 Kappa coefficient and maintained it over three consecutive training days.

Children were observed individually during two blocks of two hours (e.g., between 9 a.m. and 11 a.m. on one day and between 2 p.m. and 4 p.m. on another day), at times when they were most likely to be active (i.e., excluding most naps and lunchtime). Throughout the observation sessions, the observers stood in the background to avoid interfering with the daily activities and recorded data on a Windows® tablet (Acer W510 and Samsung Notebook XE500T1C) running the Multi-Option Observation System for Experimental Studies software (MOOSES™) (Tapp et al. 1995). To ensure IOA,

11.7% of observations were done simultaneously and independently by the two observers. We used a momentary time sampling procedure in which 5 s of observation were followed by 25 s of recorded observation. For each interval, the highest PA level was recorded and served as a reference to make the other coding decisions. Observations took place between June and August 2013.

## Analysis

Analyses were conducted using IBM SPSS Statistics® 22.0. Throughout data collection, we measured the IOA 14 times (1-h sessions) using the total percentage of agreement (%) and, to control for chance agreement, with Cohen's Kappa (k). For the OSRAC-P's eight observational categories, the average IOA ranged from 90.8 ($SD = 4.8$) to 98.8% ($SD = 2.7$). Based on Viera and Garrett (2005) Kappa's benchmark scale, the two observers obtained a near perfect agreement (k range from $0.85 \pm 0.09$ to $0.98 \pm 0.17$), except for the *adult and peer prompts* category that was moderate ($k = 0.45 \pm 0.12$) despite a good IOA (95.0%, $SD = 6.5$). Rare events, such as positive prompts, might affect Cohen's coefficient (Viera and Garrett 2005).

We used descriptive statistics to depict participants' characteristics and observed intervals. All intervals for which a PA level could not be identified were excluded, after which the number and percentage of intervals in MVPA during outdoor time were calculated by (a) sex, (b) early childhood educator, (c) outdoor activity, (d) group composition, (e) prompt, and (f) time of day.

Pearson's chi-square test was used to compare PA levels (MVPA versus non-MVPA) by sex, time of day and primary location categories. Bivariate logistic regression analyses were caried out to identify the factors related to MVPA. The model included the children's characteristics (age and sex), the time of day (morning or afternoon), the ECEs (to differenciate groups), all 10 outdoor educational contexts, the four group composition types and finally, the presence versus absence of prompts. The *initiator of the activity* variable was not included in the model given its redundancy with the *group composition* variable. Ethnicity was also excluded, as nearly all children were caucasian. To reduce bias, the potentially confounding effect of age, sex and group were controlled for in the presented model. The odd ratios (OR) presented in the logistic regression model are actually *adjusted OR*, because their value has been adjusted based on the other variables included in the model.

## Results

### Participants and Context

Children (14 girls and 16 boys) had an average age of 4.5 years ($\pm 0.5$) and lived in advantaged households (i.e., two-parent families, parents with post-secondary education and a high family income), as shown in Table 1. These children attended one of the three participating facilities—a type of centre-based childcare centre called *Centre de la petite enfance* (CPE) in French—all sharing the same educational curriculum (Ministère de la famille 2007). The facilities hosted between 80 and 160 children.

The nine ECEs had an average age of 46.1 years ($\pm 9.2$) and a mean of 16.6 ($\pm 6.3$) years of professional experience. All of them completed a recognized college degree in the field of early childhood education (3-year college program), which qualified them as professional early childhood educators. In-service educators also benefit from annual continuous training days, which sometimes address PA.

This study took place within a context of change regarding children's healthy life habits. One childcare centre was then elaborating an internal policy on PA, another was implementing a new practice encouraging ECEs to plan three structured PAs a week (for about 20–30 min), while the

**Table 1** Children's demographic characteristics (N = 30)

| Characteristic | M (SD) or % |
|---|---|
| **Sex** | |
| Boy | 46.7 |
| Girl | 53.3 |
| **Age** | |
| Range | 3.5–5.7 |
| Mean (SD) | 4.5 (0.5) |
| **Ethnicity** | |
| White | 96.7 |
| Black | 3.3 |
| **Family type** | |
| Two-parent family | 90 |
| One-parent family | 10 |
| **Highest educational attainment in household** | |
| High school degree | 10 |
| College degree | 26.7 |
| University degree | 63.3 |
| **Household annual income ($)** | |
| 20,000–39,999 | 6.7 |
| 40,000–59,999 | 10 |
| 60,000–79,999 | 13.3 |
| ≥ 80,000 | 70 |

*M* mean, *SD* standard deviation

last one only relied on the provincial curriculum (Ministère de la famille 2007). This curriculum suggests that children should engage every day in high-intensity energy expenditure activities, inside and outside. All three centres allowed children to play outdoors twice a day during the summer months, weather permitting.

## Physical Activity Levels and Contextual Factors

### Primary Location, Time of Day and Sex

Even though this article presents the results of outdoor observations, data has also been collected in other contexts. Among the 13,934 intervals observed (approximately 120 h), 60.1% were recorded indoors, 35.0% outdoors and 4.9% in transition between the two. MVPA was significantly more frequent outdoors than indoors (21.7% vs. 3.5%, $X^2$ (1) = 1115.77, $p < 0.001$), and boys spent totally more intervals in MVPA than girls (12.4% vs. 8.5%, $X^2$ (1) = 56.21, $p < 0.001$).

During outdoor time specifically (4887 intervals), 60.2% of the intervals were sedentary, 18.1% were in light PA and 21.7% were in MVPA (Table 2). Again, boys spent more intervals in MVPA than girls (25.1% vs. 17.1%, $X^2(1) = 44.46$, $p < 0.001$). Regarding the time of day, MVPA was more frequent in the afternoon than in the morning when children were outside (27.0% vs. 18.8%, $X^2$ (1) = 44.15, $p < 0.001$). As no significant differences were noted for girls, boys spent more time in MVPA in the afternoon than in the morning (31.9% vs. 19.8%, $X^2$ (1) = 54.51, $p < 0.001$).

### Outdoor Educational Contexts

During outdoor time, children were mainly observed in the following educational contexts: 19.9% of intervals in socioprops (15.2% MVPA), 19.8% in the sandbox (2.3% MVPA), 19.3% in an open space (26.8% MVPA) and 17.7% on fixed equipment (35.3% MVPA). Inversely, they rarely engaged in the following contexts: wheel toys (6.9% of intervals and 34.0% MVPA), teacher-arranged activities (6.0% of intervals and 24.7% MVPA), balls and objects (3.0% of intervals and 29.9% MVPA), expeditions ("other" category, 2.7% of intervals and 51.2% MVPA) and games (i.e., activity involving rules, 0.5% of intervals and 52.2% MVPA).

### Social Contexts During Outdoor Time

Children spent most of their time in group contexts, with 56.9% of the intervals referring to a peer-only group (23.7% MVPA) and 24.0% of them referring to a group including an adult (21.4% MVPA). A comparaison of MVPA levels across the different classes revealed a percentage varying

between 10.8 and 37.0%. Children initiated activities in 89.5% of the intervals, and adults did so in 10.5% of them.

Positive prompts were recorded in only 3.6% of outdoor intervals (of which 2.3% are prompts by adults and 1.3% are prompts by children), so we examined when this behavior occured. We noticed that teachers mainly prompted children during teacher-arranged activities (48/62) and that children prompted their peers in three main contexts: while playing in an open space (57/113), during sociodramatic play (29/113) and during activities involving portable equipment (11/113).

## Contextual Factors Associated with Outdoor PA

Given that children are more active during outdoor play, we performed a binary logistic regression analysis to identify the factors related to MVPA in this specific context (see Table 2). Significant odd ratios for MVPA were observed for children's age and sex, outdoor context, group composition, prompts, educators and time of day. Considering the large sample size and previous simulation research that showed that with over 4000 observations the Hosmer–Lemeshow test is invariably significant, we consulted the Omnibus test (Yu et al. 2017). The significant Omnibus test suggests that the final model $X^2$ (24) = 1066.62, $p < 0.001$ predicts our dependent variable significantly better than the null model as well as the model including the control variables. This model correctly classified 82.0% of cases.

Regarding children's characteristics, boys were 1.36 times more likely than girls to engage in MVPA, and increased age was associated with a decreased likelihood of MVPA (OR = 0.59).

Among the outdoor contexts, seven showed a positive statistical association with MVPA: six of them raising the chances of being highly active and one reducing it. Compared to socioprops (chosen as the reference category due to its high frequency), MVPA was 12.73 times more likely during expeditions, 9.53 times more likely during games, 2.94 times more likely when children played with fixed equipment, 2.45 times more likely when they played with wheel toys, 2.71 times more likely when they played with balls and objects, and 2.31 more times more likely when they played in open space. Inversely, the probability of being in MVPA was reduced by 85% when children were playing in the sandbox (OR = 0.15).

As for the social contexts, MVPA was 1.59 times more likely when the focal child was in a peer-only group, compared to activities carried out with adults. MVPA was also 30.76 times more probable when children were prompted to increase PA, whether by an ECE or a peer. Finally, children were 3.03, 2.71, 1.82 and 1.65 times more likely to engage in MVPA if they were with Educator A, E, F and C, respectively.

**Table 2** Total observed intervals and logistic regression for (a) children's characteristics, (b) educators, (c) outdoor contexts, (d) group compositions, (e) prompts and (f) time of day

| Variable | Total observed intervals | | Intervals in MVPA | | | |
|---|---|---|---|---|---|---|
| | N | % | N | % | OR | 95% CI |
| Children's characteristics | | | | | | |
| Age | | | | | 0.59 | [0.46–0.76] |
| Sex | | | | | | |
| Boy | 2818 | 57.7 | 707 | 25.1 | 1.36 | [1.10–1.68] |
| Girl[a] | 2069 | 42.3 | 352 | 17.1 | 1.00 | |
| Educator | | | | | | |
| Educator A | 594 | 12.2 | 220 | 37.0 | 3.03 | [1.90–4.82] |
| Educator B | 218 | 4.5 | 61 | 28.0 | 1.44 | [0.84–2.47] |
| Educator C | 1003 | 20.5 | 267 | 26.7 | 1.65 | [1.12–2.43] |
| Educator D | 129 | 2.6 | 34 | 26.4 | 1.24 | [0.67–2.27] |
| Educator E | 580 | 11.9 | 144 | 25.1 | 2.71 | [1.69–4.36] |
| Educator F | 245 | 5.0 | 52 | 21.2 | 1.82 | [1.07–3.11] |
| Educator G | 710 | 14.5 | 120 | 17.0 | 1.04 | [0.68–1.60] |
| Educator H | 1000 | 20.5 | 117 | 11.7 | 1.13 | [0.71–1.82] |
| Educator I[a] | 408 | 8.3 | 44 | 10.8 | 1.00 | |
| Outdoor contexts | | | | | | |
| Games | 23 | 0.5 | 12 | 52.2 | 9.53 | [3.84–23.65] |
| Expeditions (other) | 129 | 2.7 | 66 | 51.2 | 12.73 | [7.91–20.49] |
| Fixed equipment | 849 | 17.7 | 300 | 35.3 | 2.94 | [2.24–3.85] |
| Wheel toys | 332 | 6.9 | 113 | 34.0 | 2.42 | [1.69–3.45] |
| Balls and objects | 147 | 3.0 | 44 | 29.9 | 2.71 | [1.75–4.21] |
| Open space | 933 | 19.3 | 250 | 26.8 | 2.31 | [1.77–3.02] |
| Socioprops[a] | 959 | 19.9 | 146 | 15.2 | 1.00 | |
| Teacher-arranged | 288 | 6.0 | 71 | 24.7 | 0.85 | [0.53–1.35] |
| Portable equipment | 200 | 4.1 | 35 | 17.5 | 0.68 | [0.42–1.10] |
| Sandbox | 956 | 19.8 | 22 | 2.3 | 0.15 | [0.09–0.25] |
| Group compositions | | | | | | |
| Group with peers only | 2782 | 56.9 | 659 | 23.7 | 1.59 | [1.26–1.99] |
| Solitary | 336 | 6.9 | 59 | 17.6 | 1.40 | [0.97–2.02] |
| One-to-one with peer | 589 | 12.1 | 90 | 15.3 | 0.99 | [0.71–1.39] |
| Adult present (group and one-to-one)[a] | 1171 | 24.0 | 251 | 21.4 | 1.00 | |
| Prompts | | | | | | |
| Positive prompts | 175 | 3.6 | 150 | 85.7 | 30.76 | [19.08–49.57] |
| No prompt[a] | 4704 | 96.4 | 905 | 19.3 | 1.00 | |
| Time of day | | | | | | |
| Morning | 3119 | 64.0 | 586 | 18.8 | 0.69 | [0.58–0.82] |
| Afternoon[a] | 1754 | 36.0 | 473 | 27.0 | 1.00 | |

[a]reference category

Model Hosmer & Lemeshow's test: $X^2(8) = 28.22$, $p < .001$, Omnibus test: $X^2(24) = 1066.62$, $p < .001$

*MVPA* moderate-to-vigorous physical activity; *OR* odds ratio; *CI* confidence interval

## Characteristics of Early Childhood Educators

To better understand the ECEs' influence on children's MVPA, we examined some of their personal characteristics in search of distinctive features (Table 3). A closer look at the four ECEs with whom children were more likely to be active revealed no clear pattern. Educator A, who was the most experienced, had the highest LSI score and perceived herself as highly competent and reported doing PA in her personal life and job. Educator E, who was the least experienced, reached the minimal LSI score to be considered active and shared the same perception of competence

**Table 3** Early childhood educators' characteristics

| Educator | MVPA (%) | Intervals in positive prompts | | Age | Years of experience | ECEs' perception | | LSI |
|---|---|---|---|---|---|---|---|---|
| | | N | % | | | PA-related abilities | Ability to support children in PA | |
| A | 37.0 | 4 | 0.7 | 48 | 25 | 4 | 4 | 61 |
| B | 28.0 | 0 | 0.0 | 58 | 21 | 3 | 3 | 20 |
| C | 26.7 | 10 | 1.0 | 45 | 13 | 4 | 1 | 0 |
| D | 26.4 | 3 | 2.3 | 55 | 27 | 2 | 3 | 49 |
| E | 25.1 | 44 | 7.6 | 30 | 9 | 4 | 4 | 24 |
| F | 21.2 | 0 | 0.0 | 53 | 11 | 2 | 4 | 5 |
| G | 17.0 | 1 | 0.1 | 39 | 16 | 3 | 3 | 43 |
| H | 11.7 | 0 | 0.0 | 38 | 14 | 3 | 3 | 37 |
| I | 10.8 | 0 | 0.0 | 50 | 14 | 3 | 3 | 24 |

*LSI* Leisure Score Index

as Educator A. However, Educator E had the highest number of intervals in positive prompts. Educator F, who had cumulates 11 years of experience, was insufficiently active and perceived herself as highly competent to support children in PA, although she believed she had little PA-related abilities. Finally, Educator C had 13 years of experience and, according to her LSI score, she was insufficiently active. She considered having high PA-related abilities, but perceived herself as less skilled to support children in PA.

## Discussion

Outdoor play is part of preschoolers' daily life in childcare centres and it is a privileged way to engage in active behaviors (Gray et al. 2015). Given the substantial amount of sedentary time observed in childcare settings (O'Brien et al. 2018), this study aimed (1) to measure, through direct observation, the PA levels of children attending a centre-based childcare in the region of Abitibi-Témiscamingue (Québec, Canada) and (2) to identify the factors related to MVPA in outdoor contexts.

The PA behaviors observed during outdoor time were distributed as follows: 60.2% of intervals in sedentary pursuits, 18.1% in light PA and 21.7% in MVPA. These results corroborate previous findings from large urban communities revealing proportions of outdoor sedentary time that exceed 60% and that call for interventions to increase PA levels in this population (Truelove et al. 2018).

Although some authors have suggested considering temporality in PA interventions (Hesketh et al. 2014), results from previous research tend to differ. Children in our sample were more active in the afternoon than in the morning, a difference that was significant for boys only. These findings contrast from those of Hesketh et al. (2014) in which girls

were significantly less active in the morning, and from those of Soini et al. (2016) in which Finnish children were more active in the morning and Dutch children were unaffected by the time of the day. The children's energy level might explain our results, since the afternoon observations took place right after resting time. The outdoor contexts proposed to children in the afternoon could be another reason, but only three educational contexts were more frequent in the afternoon than in the morning (i.e., games, teacher-arranged activities and portable equipment). Among those, *games* was the only high energy expenditure activity.

Regarding the outdoor educational contexts, the activities generating the highest PA levels were also infrequent. In fact, games (52.2% MVPA) and expeditions (51.2% MVPA) respectively account for 0.5% and 2.7% of all the outdoor activities, although children were 9.53 and 12.73 times more likely to engage in MVPA than during socioprops. Previous research also found that some rare activities, such as games and teacher-arranged PA, induced more MVPA (Brown et al. 2009a; Soini et al. 2014).

Other more frequent contexts raised the probability of children being in MVPA. Compared to socioprops, children playing with fixed equipment, wheel toys, balls/objects or in an open space resulted, respectively, in 2.94, 2.42, 2.71 and 2.31 more chances of them engaging in energetic play. Similar results have been reported before (Brown et al. 2009a; Nicaise et al. 2011).

Teacher-arranged activities, in which ECEs lead a formal gross motor activity, would be expected to generate high levels of PA; yet, we noted that this educational context was not statistically associated with MVPA. As reported in previous studies, formalized motor instructions—though infrequent in many childcare centers—are associated with energetic play (Brown et al. 2009a; Soini et al. 2014; Van Cauwenberghe et al. 2012) and might facilitate children's PA engagement

(Palmer et al. 2017). Investigating the circumstances under which teacher-arranged activities are effective would thus be an interesting avenue to explore.

Regardless of the context, adult involvement did not necessarily translate into higher PA levels. ECEs rarely prompted children to increase PA (3.6% of intervals), but doing so resulted in more energetic play. Except for one previous study in which staff encouragement was not related to outdoor MVPA (Henderson et al. 2015), positive prompts are generally associated with PA (Brown et al. 2009b; Gubbels et al. 2011; Soini et al. 2014). In that respect, Driediger et al. (2018) recommended that ECEs get PA-specific training, including prompts and role modeling, to better support children's energetic play.

Concerning group composition, children were 1.59 times more likely to engage in MVPA when in a peer-only group compared to a context with adults present. Such results were reported in a few studies, and the presence of adults was generally associated with reduced PA levels (Nicaise et al. 2011; Brown et al. 2009a; Gubbels et al. 2011). This finding raised the delicate issue of adults' involvement in children's play—previously qualified by Brown et al. (2009a) as complex, multifaceted and controversial—that should be further investigated for the benefit of children's health.

So far, different hypotheses have been raised to explain ECEs' lack of involvement in children's PA: outdoor time is mainly devoted to free play or filled with supervision duties (Sisson et al. 2017), ECEs are not motivated to engage children in PA (Gagné and Harnois 2013), and ECEs are insufficiently trained regarding PA (Bruijns et al. 2019) or are unsure of their role in children's energetic play (Connelly et al. 2018). These barriers to PA remind us the need for interventions to promote healthy life habits in childcare centres; improving the providers' practices should thus be a priority (Hnatiuk et al. 2019).

## Strengths and Limitations

To our knowledge, this is the first Canadian study using the OSRAC-P. This observational tool provided rich contextual information regarding active behaviors in centre-based childcare centres, thereby contributing to the scarce literature on the social and non-social factors influencing PA. The large number of educational contexts included also contributed to create a more comprehensive regression model, thus reducing the risk of confounding bias. Finally, the study was conducted in a remote area, a setting that is little studied.

As for limitations, the small sample size limits generalization, and the cross-sectional design makes any causal inference impossible. Body mass index was not measured since it was not authorized by the ethical committee, although none of the children were visibly overweight. The results might also suffer

from a seasonal bias, as data collection occurred during summer. Not only would children be more active in warm weather (Soini et al. 2014), but also according to all the childcare centres' schedules, outdoor time was twice as frequent at this time of the year. Despite all its advantages, direct observation—compared to accelerometry—tends to overestimate PA levels and does not provide a precise measure of children's actual active time (Oliver et al. 2007).

## Conclusion

Increasing children's PA levels and reducing sedentary time are a public health necessity (Tremblay et al. 2017). In this vein, childcare centres offer an ideal setting to build children's healthy life habits. And through their daily decisions (e.g., regarding planning, activities and material offered, etc.), ECEs are in a key position to positively impact active play. Our results highlight the crucial role played by ECEs in children's PA; in fact, some factors under their control could serve to raise PA levels during outdoor time, such as offering a wider range of educational contexts and prompting children to be active. As preschoolers spend many hours under ECEs' care, future research should also elucidate their influence on outdoor energetic play—for example, in terms of personal characteristics and of knowledge or educational approaches that result in higher PA levels. Particular attention should also be given to childcare centres located in rural settings and remote areas. A better understanding of the social and non-social contexts surrounding active play is still needed and might help ECEs to fully play their role in children's health.

## Compliance with Ethical Standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical Approval** The ethical approval for this study was granted by the ethical committee for research involving human participants of the *Université du Québec en Abitibi-Témiscamingue*.

**Informed Consent** All participants (directors, ECEs and parents) provided their written and informed consent.

## References

Brown, W. H., Pfeiffer, K. A., McIver, K. L., Dowda, M., Addy, C. L., & Pate, R. R. (2009a). Social and environmental

factors associated with Preschoolers' nonsedentary physical activity. *Child Development, 80*(1), 45–58. https://doi.org/10.1111/j.1467-8624.2008.01245.x.

Brown, W. H., Pfeiffer, K. A., McIver, K. L., Dowda, M., Almeida, M. J. C. A., & Pate, R. R. (2006). Assessing preschool children's physical activity: The observational system for recording physical activity in children—Preschool version. *Research Quarterly for Exercice and Sport, 77*(2), 167–176. https://doi.org/10.1080/02701367.2006.10599351.

Brown, W. H., Smith Googe, H., McIver, K. L., & Rathel, J. M. (2009b). Effects of teacher-encouraged physical activity on preschool playgrounds. *Journal of Early Intervention, 31*(2), 126–145. https://doi.org/10.1177/1053815109331858.

Bruijns, B. A., Adamo, K. B., Burke, S. M., Carson, V., Irwin, J. D., Naylor, P.-J., et al. (2019). Exploring the physical activity and screen-viewing-related knowledge, training, and self-efficacy of early childhood education candidates. *BMC Pediatrics, 19*(5). https://doi.org/10.1186/s12887-018-1358-6.

Carson, V., Lee, E.-Y., Hewitt, L., Jennings, C., Hunter, S., Kuzik, N., et al. (2017). Systematic review of the relationships between physical activity and health indicators in the early years (0–4 years). *BMC Public Health, 17*(5), 854. https://doi.org/10.1186/s12889-017-4860-0.

Chaput, J.-P., Colley, R. C., Aubert, S., Carson, V., Janssen, I., Roberts, K. C., et al. (2017). Proportion of preschool-aged children meeting the Canadian 24-Hour Movement Guidelines and associations with adiposity: Results from the Canadian Health Measures Survey. *BMC Public Health, 17*(5), 829. https://doi.org/10.1186/s12889-017-4854-y.

Connelly, J.-A., Champagne, M., & Manningham, S. (2018). Early childhood educators' perception of their role in children's physical activity: Do we need to clarify expectations? *Journal of Research in Childhood Education, 32*(3), 283–294. https://doi.org/10.1080/02568543.2018.1464979.

Driediger, M., Vanderloo, L. M., Truelove, S., Bruijns, B. A., & Tucker, P. (2018). Encouraging kids to hop, skip, and jump: Emphasizing the need for higher-intensity physical activity in childcare. *Journal of Sport and Health Science*, 7(3), 333–336. https://doi.org/10.1016/j.jshs.2018.03.003.

Froehlich Chow, A., & Humbert, M. L. (2014). Perceptions of early childhood educators: Factors influencing the promotion of physical activity opportunities in Canadian rural care centers. *Child Indicators Research, 7*(1), 57–73. https://doi.org/10.1007/s12187-013-9202-x.

Gagné, C., & Harnois, I. (2013). The contribution of psychosocial variables in explaining preschoolers' physical activity. *Health Psychology, 32*(6), 657–665. https://doi.org/10.1037/a0031638.

Godin, G. (2011). The Godin-Shephard leisure-time physical activity questionnaire. *The Health & Fitness Journal of Canada, 4*(1), 18–22.

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*(4), 1326–1342. https://doi.org/10.3390/ijerph9041326.

Gray, C., Gibbons, R., Larouche, R., Sandseter, E. B. H., Bienenstock, A., Brussoni, M., et al. (2015). What is the relationship between outdoor time and physical activity, sedentary behaviour, and physical fitness in children? A systematic review. *International Journal of Environmental Research and Public Health, 12*(6), 6455–6474. https://doi.org/10.3390/ijerph120606455.

Gubbels, J. S., Kremers, S. P. J., van Kann, D. H. H., Stafleu, A., Candel, M. J. J. M., Dagnelie, P. C., et al. (2011). Interaction between physical environment, social environment, and child characteristics in determining physical activity at child care. *Health Psychology, 30*(1), 84–90. https://doi.org/10.1037/a0021586.

Hartmann, D. P., & Wood, D. D. (1990). Observational methods. *International handbook of behavior modification and therapy* (pp. 107–138). New York: Plenum.

Henderson, K. E., Grode, G. M., O'Connell, M. L., & Schwartz, M. B. (2015). Environmental factors associated with physical activity in childcare centers. *The International Journal of Behavioral Nutrition and Physical Activity, 12*, 43. https://doi.org/10.1186/s12966-015-0198-0.

Hesketh, K. R., McMinn, A. M., Ekelund, U., Sharp, S. J., Collings, P. J., Harvey, N. C., et al. (2014). Objectively measured physical activity in four-year-old British children: A cross-sectional analysis of activity patterns segmented across the day. *International Journal of Behavioral Nutrition and Physical Activity, 11*(1). https://doi.org/10.1186/1479-5868-11-1.

Hinkley, T., Salmon, J., Crawford, D., Okely, A. D., & Hesketh, K. D. (2016). Preschool and childcare center characteristics associated with children's physical activity during care hours: An observational study. *International Journal of Behavioral Nutrition and Physical Activity, 13*(1), 117. https://doi.org/10.1186/s12966-016-0444-0.

Hnatiuk, J., Brown, H., Downing, K., Hinkley, T., Salmon, J., & Hesketh, K. (2019). Interventions to increase physical activity in children 0–5 years old: a systematic review, meta-analysis and realist synthesis. *Obesity Reviews, 20*(1), 75–87. https://doi.org/10.1111/obr.12763.

Institut de la statistique du Québec (2016). *Le bilan démographique du Québec-Édition 2016*, [The demographic profile of Québec—Edition 2016]. Québec: Gouvernement du Québec. Retrieved from https://www.stat.gouv.qc.ca/statistiques/population-demographie/bilan2016.pdf.

Larson, N., Ward, D. S., Neelon, S. B., & Story, M. (2011). What role can child-care settings play in obesity prevention? A review of the evidence and call for research efforts. *Journal of the American Dietetic Association, 111*(9), 1343–1362. https://doi.org/10.1016/j.jada.2011.06.007.

Ministère de la famille. (2007). *Meeting early childhood needs: Québec's Educational Program for childcare services update*. Québec: Gouvernement du Québec.

Nicaise, V., Kahan, D., & Sallis, J. F. (2011). Correlates of moderate-to-vigorous physical activity among preschoolers during unstructured outdoor play periods. *Preventive Medicine, 53*(1), 309–315. https://doi.org/10.1016/j.ypmed.2011.08.018.

O'Brien, K. T., Vanderloo, L. M., Bruijns, B. A., Truelove, S., & Tucker, P. (2018). Physical activity and sedentary time among preschoolers in centre-based childcare: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 15*(1), 117. https://doi.org/10.1186/s12966-018-0745-6.

Oliver, M., Schofield, G. M., & Kolt, G. S. (2007). Physical activity in preschoolers: Understanding prevalence and measurement issues. *Sports Medicine (Auckland, N. Z.)*. https://doi.org/10.2165/00007256-200737120-00004.

Palmer, K. K., Matsuyama, A. L., & Robinson, L. E. (2017). Impact of structured movement time on preschoolers' physical activity engagement. *Early Childhood Education Journal, 45*(2), 201–206. https://doi.org/10.1007/s10643-016-0778-x.

Poitras, V. J., Gray, C. E., Borghese, M. M., Carson, V., Chaput, J.-P., Janssen, I., et al. (2016). Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. *Applied Physiology, Nutrition, and Metabolism, 41*(6), S197–S239. https://doi.org/10.1139/apnm-2015-0663.

Roberts, K. C., Yao, X., Carson, V., Chaput, J.-P., Janssen, I., & Tremblay, M. S. (2017). Respect des Directives canadiennes en matière de mouvements sur 24 heures pour les enfants et les jeunes. *Rapports Sur La Santé, 28*(10), 3–7.

Sisson, S. B., Smith, C. L., & Cheney, M. (2017). Big impact on small children: child-care providers' perceptions of their role in early childhood healthy lifestyle behaviours. *Child Care in Practice, 23*(2), 162–180. https://doi.org/10.1080/13575279.2017.1299111.

Soini, A., Gubbels, J., Sääkslahti, A., Villberg, J., Kremers, S., Van Kann, D., et al. (2016). A comparison of physical activity levels in childcare contexts among Finnish and Dutch three-year-olds. *European Early Childhood Education Research Journal, 24*(5), 775–786. https://doi.org/10.1080/1350293X.2016.1213569.

Soini, A., Villberg, J., Sääkslahti, A., Gubbels, J. S., Mehtälä, A., Kettunen, T., et al. (2014). Directly observed physical activity among 3-year-olds in Finnish childcare. *International Journal of Early Childhood, 46*(2), 253–269. https://doi.org/10.1007/s13158-014-0111-z.

Tapp, J., Wehby, J., & Ellis, D. (1995). A multiple option observation system for experimental studies: MOOSES. *Behavior Research Methods, Instruments, & Computers, 27*(1), 25–31. https://doi.org/10.3758/BF03203616.

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, 89*, 129–139. https://doi.org/10.1016/j.ypmed.2016.05.019.

Tremblay, M. S., Carson, V., Chaput, J.-P., Connor Gorber, S., Dinh, T., Duggan, M., et al. (2016). Canadian 24-hour movement guidelines for children and youth: An integration of physical activity, sedentary behaviour, and sleep. *Applied Physiology, Nutrition, and Metabolism, 41*(6), S311–S327. https://doi.org/10.1139/apnm-2016-0151.

Tremblay, M. S., Chaput, J.-P., Adamo, K. B., Aubert, S., Barnes, J. D., Choquette, L., et al. (2017). Canadian 24-Hour Movement Guidelines for the early years (0–4 years): An integration of physical activity, sedentary behaviour, and sleep. *BMC Public Health, 17*(5), 874. https://doi.org/10.1186/s12889-017-4859-6.

Truelove, S., Bruijns, B. A., Vanderloo, L. M., O'Brien, K. T., Johnson, A. M., & Tucker, P. (2018). Physical activity and sedentary time during childcare outdoor play sessions: A systematic review and meta-analysis. *Preventive Medicine, 108*, 74–85. https://doi.org/10.1016/j.ypmed.2017.12.022.

Truelove, S., Bruijns, B. A., Vanderloo, L. M., O'Brien, K. T., Johnson, A. M., & Tucker, P. (2019). Corrigendum to "Physical activity and sedentary time during childcare outdoor play sessions: A systematic review and meta-analysis" [Pre. Med. 108 (2018) 74–85]. *Preventive Medicine,* 127. https://doi.org/10.1016/j.ypmed.2019.105814.

Van Cauwenberghe, E., De Craemer, M., De Decker, E., De Bourdeaudhuij, I., & Cardon, G. (2012). The impact of a teacher-led structured physical activity session on preschoolers' sedentary and physical activity levels. *Journal of Science and Medicine in Sport, 16*(5), 422–426. https://doi.org/10.1016/j.jsams.2012.11.883.

Viera, A. J., & Garrett, J. M. (2005). Understanding interobserver agreement: The kappa statistic. *Family Medicine, 37*(5), 360–363.

World Health Organization. (2010). *Global recommendations on physical activity for health*. Geneva: World Health Organization.

Yu, W., Xu, W., & Zhu, L. (2017). A modified Hosmer-Lemeshow test for large data sets. *Communications in Statistics—Theory and Methods, 46*(23), 11813–11825. https://doi.org/10.1080/03610926.2017.1285922.