

Accelerometry-measured physical activity and sedentary behaviour of preschoolers in Nova Scotia, Canada

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Abstract: The objective of this study was to describe the levels and bouts of physical activity (PA) and sedentary behaviour (SB) among preschoolers in Nova Scotia, Canada, and the proportion meeting PA and step guidelines. Children (75 boys, 49 girls; mean age = 4.2 (range = 3–5 years)) participating in the Physical Literacy in the Early Years (PLEY) study provided data. Average time (minutes, % of day) spent sedentary, in light PA (LPA), moderate-to-vigorous PA (MVPA), and total PA; average frequency; and duration of bouts of MVPA (≥ 5 min, ≥ 10 min) and sedentary bouts (≥ 10 min) per day were determined using published cut-points, using 15-s epochs. The proportion of children meeting PA and step guidelines was determined, and differences by sex explored. Children spent the majority (70.8%) of their day active; nearly all ($\geq 97\%$) met PA guidelines. Most children met step guidelines on a weekly basis, but not daily. Only LPA differed by sex (greater in girls; $p = 0.001$). Little time was spent in sustained SB (bouts ≥ 10 min). Boys had greater and longer bouts of MVPA and spent more of their day in these ($p < 0.05$). Girls spent less time in sustained SB ($p = 0.009$). This is the first study to describe the PA and SB of Nova Scotia preschoolers using accelerometry. Findings suggest preschoolers spend the majority of their day active, and that there are sex-related differences in PA and SB, warranting further examination.

Key words: accelerometer, activity, bouts, childcare, guidelines, physical activity, preschool, sedentary behaviour.

Résumé : Cette étude a pour objectif de décrire les niveaux et les séances d'activité physique (« PA ») et de comportement sédentaire (« SB ») chez les enfants d'âge préscolaire en Nouvelle-Écosse (Canada) et de déterminer la proportion des enfants qui se conforment aux directives concernant PA et le nombre de pas. Les enfants (75 garçons et 49 filles; âge moyen = 4,2 ans, écart = 3 à 5 ans) participant à l'étude sur le savoir-faire physique au cours de la petite enfance (« PLEY ») procurent les données. En utilisant les points de coupure publiés, on détermine par tranches de 15 s le temps moyen (minutes, % du jour) consacré journalièrement à des activités sédentaires, à PA légère (« LPA »), modérée à vigoureuse (« MVPA ») et totale, la fréquence et la durée moyenne des séances de MVPA (≥ 5 minutes, ≥ 10 minutes) et des séances sédentaires (≥ 10 minutes). On examine la proportion d'enfants se conformant aux directives concernant PA et le nombre de pas; on évalue aussi les différences liées au sexe. Les enfants sont actifs la majorité du temps de jour (70,8%); presque tous ($\geq 97\%$) se conforment aux directives concernant PA. La plupart des enfants se conforment aux directives hebdomadaires, mais pas journalières. Seule LPA diffère selon le sexe (plus élevée chez les filles; $p = 0,001$) et peu de temps est consacré à SB soutenu (séances ≥ 10 minutes). Les garçons ont plus de séances de MVPA plus longues et y consacrent plus de temps ($p < 0,05$). Les filles consacrent moins de temps au SB maintenu ($p = 0,009$). C'est la première étude qui utilise l'accélérométrie pour décrire PA et SB des enfants d'âge préscolaire de la Nouvelle-Écosse. Les résultats suggèrent que les enfants d'âge préscolaire passent la majeure partie de leur journée à l'activité physique et qu'il existe des différences PA et SB liées au sexe, ce qui justifie un examen plus approfondi. [Traduit par la Rédaction]

Mots-clés : accéléromètre, activité, séances, garde d'enfants, directives, activité physique, préscolaire, comportement sédentaire.

Introduction

Physical activity (PA) during the early years (age 0–4 years) and in school-aged children and youth (age 5–17 years) is critical for the development and maintenance of physical, mental, and social wellbeing. Systematic reviews provide evidence that higher levels of PA are associated with more favourable measures of adiposity, bone and skeletal health, cardiometabolic health, motor skill de-

velopment, psychosocial health, and cognitive development in infants, toddlers, and preschoolers (Carson et al. 2017a; Timmons et al. 2012). Moreover, moderate to vigorous physical activity (MVPA) and more PA in general, appears to be better for health in the early years (Carson et al. 2017a). Insufficient levels of PA and excess time sedentary among preschoolers has been linked with increased adiposity (LeBlanc et al. 2012) and blood pressure (Vale et al. 2015), poorer motor skills (Iivonen et al. 2013), cardiorespi-

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ratory fitness (Burgi et al. 2011), and psychosocial and cognitive development (LeBlanc et al. 2012).

PA and sedentary behaviour (SB) have independent and distinctly different physiological and psychological responses (Tremblay et al. 2010), yet interact with each other to impact health outcomes (Chaput et al. 2017; Kuzik and Carson 2016; Kuzik et al. 2017). Consequently, there has been a move away from separate PA and SB guidelines to comprehensive 24-h movement guidelines for the early years (Tremblay et al. 2017b) and for school-aged children and youth (Tremblay et al. 2016). These guidelines take a “whole day” approach to understanding children’s movement and non-movement behaviours across a 24-h period and identify optimal levels of PA, sleep, and time spent sedentary for respective age groups. Daily step guidelines also exist for the early years (Gabel et al. 2013), which correspond to the movement guidelines previously established.

Data from several cycles of the Canadian Health Measures Survey (CHMS; 2009–2011; 2012–2013; 2014–2015) provide an account of time spent in movement and nonmovement behaviours across a 24-h continuum (Chaput et al. 2017). The 24-h movement guidelines classify PA guideline adherence based on an average of all valid days of accelerometer wear. Previous reports (Colley et al. 2013; Garriguet et al. 2016) have operationalized PA guideline adherence differently, requiring that children meet recommended amounts of PA on every valid day of accelerometer wear. These earlier reports also use varying classifications for the amount of PA required to meet guideline adherence, which consequently impacts the percentage of children achieving guidelines. Together, these findings highlight the importance of clearly defining how PA guidelines are operationalized when indicating the proportion of preschoolers achieving guidelines. Furthermore, these findings indicate the utility of investigating guideline adherence in a variety of ways to determine whether preschoolers are sufficiently active on a daily versus on an average basis.

Several other studies have used accelerometers to provide a direct, objective assessment of PA and SB in Canadian preschoolers (Borkhoff et al. 2015; Carson et al. 2017b; Colley et al. 2013; Garriguet et al. 2016; Kuzik and Carson 2016; Kuzik et al. 2015), contributing to the growing international body of evidence (Aguilar-Farias et al. 2015; Andersen et al. 2017; Berglind and Tynelias 2017; Gutiérrez-Hervás et al. 2018; Møller et al. 2017). The results of these studies vary because of inconsistencies in accelerometers used to measure PA and SB, and accelerometer data reduction decisions (e.g., wear and nonwear time, number of valid days necessary for inclusion in data analysis, intensity cut-points, etc.). Furthermore, the PA and SB profiles of Canadian preschoolers are mostly based on national samples; less is known about the behaviours of regional/local Canadian preschoolers. While national PA and SB data provide a larger, more diverse and representative sample of preschoolers, data from large population-level studies (e.g., CHMS) are not typically compared by region in resulting publications (Chaput et al. 2017), leaving a gap in the understanding of whether the PA and SB of Canadian preschoolers differ significantly by region. Studies that provide regional or local-level data, albeit on smaller, possibly more homogenous populations, can be compared with national data to explore whether these preschoolers’ PA and SB patterns appear to be similar or different to national averages. Regional-level PA and SB data on preschoolers can also be linked to other regional-level data (e.g., childcare/school programming and policies for outdoor play provision, quality of childcare/school outdoor play environments) to determine whether any relationships exist. This information can spark a greater conversation, regionally, about potential changes that need to be made, to better support preschoolers’ opportunities to be physically active in major settings and places (e.g., childcare, school, home, greater community).

Few studies have examined less traditional measures of PA (i.e., sustained bouts of MVPA) and SB (sedentary bouts) in preschoolers

(Andersen et al. 2017; Carson et al. 2016). Sustained bouts of MVPA have been associated with more favourable health outcomes (adiposity, cardiometabolic health) in school-aged children and youth (Poitras et al. 2016), with 5- and 10-min bouts of MVPA having similar associations with cardiometabolic health (Holman et al. 2011), but there is little evidence of health benefits of sustained MVPA in the early years (Carson et al. 2017a). Similarly, there is evidence to suggest that the manner in which sedentary time is broken up is significantly and independently associated with markers of cardiometabolic health, independent of sedentary time and PA, in children (Saunders et al. 2013) and adults (Healy et al. 2008, 2011); however, there is less evidence of the health benefits of breaking up sedentary time in the early years (Poitras et al. 2017). A study by Kuzik et al. (2015) provides an estimate of the amount of sedentary bouts Alberta preschoolers typically accumulate while in childcare; findings lead the authors to conclude that promoting SB in short bouts during the preschool years might be important for the primary prevention of overweight and obesity. More evidence around the amount (and duration) of sustained bouts of MVPA, and sedentary bouts, that preschoolers typically accumulate during the day is needed.

Therefore, the purpose of this study was to (i) describe the accelerometry-measured PA and SB of a sample of preschoolers living in Nova Scotia, Canada (including bouts of MVPA and sedentary bouts); and (ii) examine preschoolers’ adherence with age-appropriate PA and step guidelines.

Materials and methods

Participants and study design

Data presented in this paper are baseline (e.g., pre-intervention) results of the Physical Literacy in the Early Years (PLEY) study. The primary aim of this randomized, mixed-methods control study was to evaluate the efficacy of a loose parts intervention versus standard early years settings’ practice to improve children’s physical literacy, increase time in PA and outdoor play, and reduce time spent sedentary. Details of the PLEY protocol are published elsewhere (Houser et al. 2019). A total of 19 childcare centres across Nova Scotia participated in the PLEY study. Only children whose parents provided informed consent were assessed. The study was granted ethics approval by Dalhousie University’s Research Ethics Board.

Measures

Demographics

Children’s age and sex were recorded, and direct measures of height and weight were taken by trained research personnel at childcare centres. Standing height was assessed using a portable stadiometer (SECA, Hamburg, Germany) and taken to the nearest 0.1 cm. Body weight was assessed using a digital scale (A&D Medical, Milpitas, Calif., USA) and taken to the nearest 0.1 kg. Height and weight measures were taken twice, and if the 2 measures were greater than a 0.5 difference, a third measure was taken and an average was calculated. Height and weight were measured while children were wearing light clothing and no footwear.

Objective measures of PA and SB

Participants were asked to wear an accelerometer (ActiGraph wGT3X+; ActiGraph LLC, Pensacola, Fla, USA) during waking hours for 9 consecutive days. To improve compliance and ensure data quality, parents were given an instruction sheet that explained how to attach the accelerometer over their child’s right hip and when the device was to be removed (night-time sleep, bathing/swimming). Parents and educators were also informed of the importance of consistent accelerometer wear to provide typical PA and SB patterns. Accelerometer data were collected from March 2017 to February 2018. Accelerometer data were reduced and analyzed using ActiLife (version 6; ActiGraph LLC). To im-

Table 1. Descriptive characteristics of participants (total; boys, girls).

Characteristics	Total, n = 124	Boys, n = 75	Girls, n = 49	Sex difference value
Age, y	4.2 (3.0–5.9)	4.2 (3.0–5.9)	4.3 (3.0–5.2)	0.60
Height, cm	104.8 (86.5–120.0)	105.2 (92.6–120.0)	104.2 (86.5–117.5)	0.40
Weight, kg	17.6 (11.9–31.3)	17.8 (14.1–31.3)	17.4 (11.9–24.1)	0.40
Valid days of accelerometry	8.3 (4.0–9.0)	8.3 (4.0–9.0)	8.4 (4.0–9.0)	0.63
Daily wear time, h/day	11.0 (7.9–14.3)	11.0 (7.9–13.5)	11.1 (9.2–14.3)	0.50

Note: Values are presented as means (range).

prove comparability of data, accelerometer data reduction decisions were consistent with previously established protocols (Carson et al. 2017b). Data were collected in 15-s epochs. Nonwear time was defined as ≥ 20 min of consecutive zero counts (Carson et al. 2017b). To be included in analyses, participants were required to have ≥ 4 days with ≥ 6 h of wear time each day (Hinkley et al. 2012). A weekend day was not necessary for inclusion. Sedentary time was defined as ≤ 100 counts/min, light physical activity (LPA) as 100–1679 counts/min, and MVPA as ≥ 1680 counts/min (Janssen et al. 2013). Accelerometer data were then classified into minutes per day and the percent of the day spent sedentary, in LPA, in MVPA, and in activity of any intensity (total PA; TPA). Bouts of MVPA were defined as a period during which the children had ≥ 1680 counts/min for 5 consecutive minutes or more, and 10 consecutive minutes or more. The average number, duration, and total duration of bouts of MVPA ≥ 5 min and ≥ 10 min per day were calculated. Definitions of SB constructs were taken from the Sedentary Behaviour Research Network Terminology Consensus Project (Tremblay et al. 2017a). A sedentary bout was defined as a period of uninterrupted sedentary time (Altenburg and Chinapaw 2015; Kim et al. 2015), which comprises a period of ≤ 100 counts/min for 10 consecutive minutes or more. The average number and duration of sedentary bouts were calculated.

The proportion of children meeting age-appropriate PA guidelines was determined, along with average daily steps and the proportion of children meeting daily step guidelines. For children aged 3 to 4 years, PA guideline adherence was defined as accumulating at least 180 min of PA of any intensity, of which at least 60 min is MVPA (Tremblay et al. 2017b), based on an average of all valid days, and also on a daily basis (Chaput et al. 2017). For children aged 5 years, PA guideline adherence was defined as accumulating at least 60 min of MVPA (Tremblay et al. 2016), based on an average of all valid days (Roberts et al. 2017) and on a daily basis. Average daily steps were calculated and the proportion of children accumulating ≥ 6000 steps/day on an average, and a daily basis was calculated (Gabel et al. 2013).

Statistical analyses

All statistical analyses were performed using IBM SPSS for Windows (version 24; IBM Corp., Armonk, N.Y., USA). Descriptive statistics (mean, range) for PA and SB variables were calculated. Independent samples *t* tests were conducted to examine sex-related differences in PA and SB, and the proportion of children meeting PA and step guidelines. Statistical significance was set as $p < 0.05$.

Results

Participant characteristics are provided in Table 1. Of the 192 children who provided accelerometer data, a total of 140 (73%) had valid accelerometer data. Of those, 124 participants also had valid descriptive data (e.g., age/sex/height/weight). Analyses are therefore based on a sample of 124 children (75 boys, 49 girls). Children were on average 4.2 years old ($SD = \pm 0.6$ years), with 60.5% of the sample being boys. Children wore accelerometers, on average, for 8.3 days (range = 4.0 to 9.0); average accelerometer wear time per day was 660.2 min (11.0 h; range = 7.9 to 14.3).

Demographic characteristics and accelerometer wear time did not differ significantly by sex.

Table 2 describes the accelerometry-measured PA and SB of this sample of Nova Scotia preschoolers aged 3 to 5 years. On average, children accumulated 466.7 min (7.8 h) of TPA per day and spent 193.5 min (29.2%) of their day sedentary, 253.3 min (38.4%) in LPA, and 213.5 min (32.4%) in MVPA. TPA ranged from 333.6 to 651.3 min (54.1% to 86.1%) per day, time spent sedentary from 93.4 to 369.7 min (14.0% to 45.9%) per day, LPA from 155.7 to 356.1 min (25.7% to 49.5%) per day, and MVPA from 147.5 to 320.4 min (21.2% to 47.5%) per day. Children accumulated an average of 7602.2 steps per day (range = 4470.9 to 15 507.8). Only LPA (minutes, % of day) differed according to sex (greater in girls; $p \leq 0.001$).

Children accumulated, on average, 13 short bouts (≥ 5 min) of MVPA (range = 4.6 to 24.6) and 5 long bouts (≥ 10 min) of MVPA (range = 1.0 to 12.0) per day. These short bouts of MVPA lasted, on average, 7.6 min (range = 5.8 to 10.5) and contributed to 101.0 min (range = 27.3 to 220.8) of accumulated MVPA per day. Long bouts of MVPA lasted, on average, 12.9 min (range = 10.9 to 17.8) and contributed to 73.9 min (range = 12.2 to 196.1) of accumulated MVPA per day. Children spent very little of their day in sustained SB (bouts ≥ 10 min); these bouts accounted for (on average) 25 min per day (see Table 2). Significant sex differences emerged for sustained bouts of MVPA and SB. Boys had more, and longer, bouts of MVPA (≥ 5 min and ≥ 10 min) and spent more of their overall day engaged in sustained bouts of MVPA ($p < 0.05$). Girls spent less of their day engaged in sustained SB than boys ($p = 0.009$; see Table 2).

Table 3 presents the proportion of children (by age and sex) meeting the PA and step guidelines. Nearly all children ($\geq 98\%$) met the PA guidelines on an average and a daily basis. The majority (82.3%) of children met the step guidelines (≥ 6000 steps/day) when based on an average of all valid days. However, significantly fewer (21%) accumulated ≥ 6000 steps/day on each day. The proportion of children meeting guidelines did not differ significantly by sex.

Discussion

The purpose of this paper was to describe the PA and SB profiles of a sample of preschoolers aged 3 to 5 years living in Nova Scotia, Canada, and the proportion meeting age-appropriate PA and step guidelines. To the authors' knowledge, this is the first study to provide an account of the time Nova Scotia preschoolers spend physically active and sedentary, and how many meet the recommended guidelines, using objective measures (accelerometry). Our sample of preschoolers ($n = 124$) were highly active, spending the vast majority (70.8%) of their day active (LPA: 38.4%; MVPA: 32.4%), with nearly all ($\geq 98\%$) meeting the age-appropriate PA guidelines, on an average and a daily basis. Time spent in various intensities of PA (time spent sedentary, MVPA, and TPA) did not differ by sex, a finding that is comparable with previous reports of Canadian preschoolers (Borkhoff et al. 2015; Chaput et al. 2017; Kuzik et al. 2015). The exception was LPA, where girls spent significantly more of their day engaged in LPA than boys, a finding that contrasts with previous literature showing no significant sex-related differences in LPA among preschoolers (Borkhoff et al. 2015; Chaput et al. 2017; Kuzik et al. 2015) or greater LPA in boys (Andersen et al. 2017). Systematic observations of preschoolers'

Table 2. Physical activity (PA) and sedentary behaviour (SB) characteristics (total; boys, girls).

Characteristics	Total, n = 124	Boys, n = 75	Girls, n = 49	Sex difference value
Average PA and SB per day, min/steps per day				
Sedentary, min	193.4 (93.4–369.7)	194.4 (93.4–346.1)	191.9 (106.6–369.7)	0.786
LPA, min	253.3 (155.7–356.1)	245.2 (155.7–356.1)	265.7 (205.2–325.9)	0.001*
MVPA, min	213.5 (147.8–320.4)	217.6 (147.5–320.4)	207.2 (150.5–291.7)	0.139
TPA, min	466.8 (333.6–651.3)	462.8 (333.6–651.3)	472.8 (370.8–584.7)	0.275
Steps, per day	7602.2 (4470.9–15 507.8)	7759.0 (4470.9–15 507.8)	7362.3 (5086.2–11 031.6)	0.189
Average PA and SB per day, % of day				
Sedentary, %	29.2 (14.0–45.9)	29.5 (14.0–45.9)	28.7 (16.5–43.2)	0.496
LPA, %	38.4 (25.7–49.5)	37.4 (25.7–48.8)	40.0 (33.0–49.5)	0.000*
MVPA, %	32.4 (21.2–47.5)	33.1 (21.4–47.5)	31.3 (21.2–45.2)	0.072
TPA, %	70.8 (54.1–86.0)	70.5 (54.1–86.0)	71.3 (56.8–83.5)	0.496
Average bouts (MVPA, SB) per day				
No. of ≥5-min bouts of MVPA	13.2 (4.6–24.6)	13.9 (6.7–23.7)	12.2 (4.6–24.6)	0.030*
No. of ≥10-min bouts of MVPA	5.4 (1.0–12.0)	5.9 (2.0–10.0)	4.7 (1.0–10.9)	0.004*
No. of sedentary bouts, ≥10 min	1.7 (0.0–6.6)	1.9 (0.0–6.6)	1.4 (0.3–3.3)	0.006*
Average duration of ≥5-min bouts of MVPA, min	7.6 (5.8–10.5)	7.7 (6.3–10.5)	7.1 (5.8–8.4)	0.000*
Average duration of ≥10-min bouts of MVPA, min	12.9 (10.9–17.8)	13.2 (13.1–17.8)	12.3 (10.9–15.3)	0.000*
Average duration of sedentary bouts, ≥10 min	10.6 (0.0–16.4)	10.6 (0.0–16.4)	10.5 (3.4–16.4)	0.748
Total duration of ≥5-min bouts of MVPA, min	101.0 (27.3–220.8)	108.9 (48.8–220.8)	88.7 (27.3–177.1)	0.003*
Total duration of ≥10-min bouts of MVPA, min	73.9 (12.2–196.1)	82.2 (26.6–196.4)	61.2 (12.2–138.3)	0.001*
Total duration of sedentary bouts (≥10 min), min	24.8 (0.0–101.8)	27.3 (0.0–101.8)	21.0 (5.3–51.2)	0.009*

Note: Values are presented as means (range). **p* ≤ 0.05. LPA, light physical activity; MVPA, moderate to vigorous physical activity; TPA, total physical activity.

Table 3. Percentage of children aged 3 to 5 years meeting physical activity (PA) and step guidelines (total; boys, girls).

Characteristics	Total, n = 124	Boys, n = 75	Girls, n = 49	Sex difference value
Meeting PA guidelines, average	124 (100)	75 (100)	49 (100)	NA
Meeting PA guidelines, daily	123 (99.2)	75 (100)	48 (98.0)	0.22
Meeting step guidelines, average	102 (82.3)	61 (81.3)	41 (83.7)	0.74
Meeting step guidelines, daily	21 (17.0)	13 (17.3)	7 (14.3)	0.65

Note: Values are presented as *n* (%). NA, not applicable (100% of boys and girls meeting guidelines).

play behaviours indicate that girls are more likely to engage in domestic play behaviours such as house/family and nurture/care play than boys, who are more likely to engage in more vigorous-intensity activities such as superhero play, play fighting, and chase games play (Logue and Harvey 2009; Storli and Sandseter 2015), which might partially explain our findings.

Our analyses provide novel insight into sustained bouts of MVPA and SB among preschoolers, of which little information exists (Andersen et al. 2017; Carson et al. 2016; Kuzik et al. 2015). Children accumulated anywhere from 5 to 25 bouts of MVPA lasting 5 min or more, and 1 to 12 bouts lasting 10 min or more, throughout the day, with the highest bout lasting 17.8 min. These contributed to anywhere from 12.2 min, to over 3.5 h, of accumulated MVPA per day. Boys had significantly greater, and longer, bouts of MVPA than girls, which may indicate differences in the play habits of boys and girls in our sample. As mentioned previously, boys are more likely to engage in play types of higher intensities than girls (Logue and Harvey 2009; Storli and Sandseter 2015), which may lead to the accumulation of more, and longer, bouts of MVPA throughout the day. Our data also revealed that boys accumulated significantly more, and longer, bouts of SB than girls, findings that contradict previous research indicating no significant sex differences in preschoolers' bouts of SB (Kuzik et al. 2015). Unfortunately, behavioural observations of preschoolers' PA and SB were not conducted, and therefore we cannot determine the types of PA and SB that preschoolers were engaging in, making it difficult to provide explanations for these differences. Furthermore, the context in which bouts of MVPA and SB were occurring (e.g., indoor or outdoor childcare environment) was not measured in our study. Previous work indicates that indoor environments offer a broader range of affordances for domestic play

themes than rough and tumble play (e.g., play fighting and play chasing) (Logue and Harvey 2009; Pellegrini and Smith 1998; Storli and Sandseter 2015), the latter of which is more likely to be banned, particularly in indoor environments, and ultimately restricting boys and girls from engaging in physically active co-play (Storli and Sandseter 2015). Unfortunately, we do not have data on the play types encouraged/discouraged in participating childcare centres' indoor and outdoor settings. Previous literature has shown that preschool teachers are more likely to afford children with a greater license for independent mobility during free outdoor play than free indoor play, which could result in more sustained bouts of MVPA in outdoor environments. Allowing rough and tumble play and providing environmental supports for this type of play in childcare centres (particularly indoors where preschoolers spend the vast majority of their day) could lead to more sustained bouts of MVPA for both sexes (particularly girls), which could be associated with greater health benefits. Future work is needed to explore Nova Scotia early childhood educators' perspectives on supporting a range of play experiences, indoors and outdoors, and how these relate to children's PA and SB behaviours and associated health outcomes.

Children in the present study spent very little of their day in sustained SB, suggesting that there were frequent transitions between time spent sedentary and time spent active. Our findings align with previous data showing that preschoolers spend very little time in sustained sedentary bouts (≥10 min). Kuzik and colleagues (2015) noted that Alberta children aged 19 to 60 months (*n* = 114) accumulated less than 5 sedentary bouts lasting 10 min or more per day while in childcare. The authors described how SB was mostly accumulated in very short bouts (1–4 min), with almost no bouts lasting more than 15 min. These findings suggest a

rapid transition from time spent sedentary to time spent physically active, which is typical of the spontaneous and sporadic PA behaviour of healthy children (Bailey et al. 1995). There are known health benefits of breaking up sedentary time in the early years (Kuzik et al. 2015); this philosophy is also integrated into the 24-h movement guidelines (Tremblay et al. 2017b). Other research points to the many health benefits associated with short and intermittent bouts of PA, suggesting that the accumulation of PA in a highly sporadic and disordered way should enhance children's metabolic flexibility (Stone et al. 2009). Like Kuzik and colleagues (2015), our findings suggest that our sample of preschoolers seems to be exhibiting typically healthy patterns of PA.

Our overall findings are inconsistent with previous reports of Canadian preschoolers' accelerometry-measured PA and SB showing that the majority of preschoolers' waking hours is spent inactive. Chaput and colleagues (2017), using CHMS data (2009–2015), indicated that Canadian preschoolers aged 3–4 years ($n = 803$) spent, on average, 278.8 min per day active, accounting for 38.7% of their day. Time spent sedentary accounted for 61.4% of their day, LPA for 29.1% of their day, and MVPA for just 9.5% of their day. The PA guidelines of at least 180 min of PA per day, including at least 60 min of MVPA (based on an average of all valid days), were met by 61.8% of children. Findings from an earlier report, also using CHMS data (2009–2011), align with Chaput and colleagues' (2017) findings. Colley et al. (2013) showed that 3–5-year-old children spent approximately 50%–53% of their waking day sedentary, 38%–41% in LPA, and just 9% in MVPA. Just 11% of 3–4-year-old children met these same PA guidelines, with a minority (14%) of 5-year olds achieving ≥ 60 min of MVPA on at least 6 days of the week. The inconsistencies in findings between previous literature and the present study may be a result of differences in accelerometer wear (number of days) and data reduction decisions (e.g., number of days and hours of wear per day required to be considered "valid data", intensity cut points, decisions around defining nonwear time), and sample characteristics (national vs. provincial samples). Chaput and colleagues (2017) and Colley et al. (2013) defined a valid day as ≥ 5 h of wear time during waking hours (present study: ≥ 6 h/day); participants were required to have 3 or more valid days (Chaput et al. 2017) and 4 or more valid days (Colley et al. 2013) to be included in analyses (present study: ≥ 4 days). Decisions around identifying nonwear time differed between these reports and those of the present study. Mean accelerometer wear time per day was, however, similar between these reports and the present study (12 vs. 11 h). Since accelerometer data reduction decisions can significantly influence reported PA and SB, the authors aligned these decisions (as much as possible) with those used in an analysis of Alberta preschoolers' PA and SB (Carson et al. 2017b). Inconsistencies between the 2 datasets still emerged: Alberta preschoolers aged 30 to 59 months ($n = 79$) spent 48.6% of their day sedentary, 38.6% in LPA, and 12.8% in MVPA, whereas Nova Scotia preschoolers spent 29.2% of their day sedentary, 38.4% in LPA, and 32.4% in MVPA. These inconsistencies could be attributed to numerous confounding variables (e.g., demographic, biological, social, and/or cultural factors) that influence young children's PA behaviour (Bingham et al. 2016) that might differ between the 2 respective samples.

Another possible explanation for the discrepancies in findings could be the time of year in which preschoolers' PA and SB habits were assessed. The vast majority of our sample (91%) had their PA and SB assessed in the spring/summer of 2017, with the remaining participants assessed in winter 2018. The difference in sample size between the 2 respective cohorts does not provide us with sufficient statistical power to examine seasonal differences. The previous reports using CHMS data (Chaput et al. 2017; Colley et al. 2013) are based on accelerometry data collected throughout the year, whereas Carson et al. (2017b) assessed the PA and SB of Alberta preschoolers from April 2015 to December 2016. The impact of weather/seasonality on children's PA behaviour is well sup-

ported (Harrison et al. 2017): increased precipitation and wind speed has been associated with lower PA, and better visibility and more hours of daylight with greater PA; the impact of temperature on PA is also greater for younger children. Little is known about how weather/season impacts the PA behaviour of Canadian preschoolers, and whether it influences the proportion of preschoolers meeting PA/step guidelines. Future work is needed to explore this.

The differences in which PA guidelines have been operationalized in previous literature, and in the present study, highlight the importance of clarifying whether guideline adherence is based upon an average, or a daily, basis. Unlike previous literature, the majority of children in the present study met PA guidelines on an average and daily basis. The majority of children also met step guidelines on an average but not a daily basis. Our findings are similar to those reported by Colley et al. (2013), where 91.8% and 87.1% of 3–4-year-old and 5-year-old children, respectively, met these same guidelines on an average basis, yet just 45% met these on a daily basis. In this sample (Colley et al. 2013), average steps per day (age 3–4 years: 9764; age 5 years: 10 202) were slightly higher than the present study (age 3–5 years: 7602).

Strengths

The results presented in this paper provide the first estimate of the PA and SB of a sample of Nova Scotia preschoolers aged 3 to 5 years, which is an under-studied population, using objective measures, and the proportion meeting age-appropriate PA and step guidelines. Our paper is strengthened by the use of a leading, scientifically validated accelerometer (ActiGraph wGT3X+) to describe Nova Scotia preschoolers' PA and SB, and the use of accelerometer wear and data reduction decisions that are consistent with the analysis of Alberta preschoolers' PA and SB (Carson et al. 2017b). Findings are based on baseline data of a randomized, mixed-methods, control study design, and probability sampling.

Limitations

The results of our study are based upon a relatively small sample of Nova Scotia preschoolers ($n = 124$) and modest participation rate, which could indicate selection bias; results therefore cannot be generalized to Nova Scotia preschoolers. Furthermore, various correlates of preschoolers' PA and SB were not investigated. For example: several systematic reviews have explored behavioural, social, cultural, and physical environment variables that could have an influence on PA in the early years (Bingham et al. 2016; De Craemer et al. 2012; Hinkley et al. 2008), some of which include ethnicity, time spent outdoors, and parent behaviour. Future research is needed to determine whether these correlates significantly impact Nova Scotia preschoolers' PA behaviour.

The findings in this study are based upon an average of preschoolers' PA and SB for all valid days of accelerometer wear. Daily and hourly behaviours were not investigated, and we did not examine whether PA and SB varied across the week (i.e., between weekdays and weekends) or during specific periods of the day (i.e., during childcare hours and out-of-childcare hours). These analyses will be explored in future.

Finally, we are not able to determine the types of PA and SB that preschoolers were participating in, or whether PA and SB occurred in indoor or outdoor environments. Future work is needed to understand the types of PA and SB that Nova Scotia preschoolers are participating in, and the environments in which these are occurring (e.g., indoors vs. outdoors; home vs. childcare).

Conclusion

Our sample of Nova Scotia children aged 3 to 5 years spent the vast majority of their day active; a significant proportion of that time was in sustained bouts of MVPA. These children also spent very little of their day sedentary and appeared to transition very quickly from time spent sedentary behaviours to time spent ac-

tive. Boys accumulated more and longer bouts of MVPA, while girls spent less time in sustained sedentary behaviour. Nearly all children met the Canadian PA guidelines as highlighted in the 24-h movement guidelines for the early years (0–4 years) (Tremblay et al. 2017b) and for school-aged children and youth (Tremblay et al. 2016). The majority also met the step guidelines, but not on a daily basis. Future research is needed to explore possible reasons for sex-based PA differences uncovered in our analyses. More attention is also needed to explore how Nova Scotia preschoolers' PA and SB differs according to season, by environment (e.g., home vs. childcare, urban/suburban vs. rural), and during distinct periods of the day/week, and the impact of additional correlates (e.g., time spent outdoors). Future studies with larger samples of preschoolers, representing minority/vulnerable populations, are needed to get a more representative understanding of the PA and SB of preschoolers in our region.

Conflict of interest statement

The authors have no conflicts of interest to report.

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