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ORIGINAL PUBLICATIONS

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SEASONAL AND DAILY VARIATION IN PHYSICAL ACTIVITY AMONG THREE-YEAR-OLD FINNISH PRESCHOOL CHILDREN

by

Soini, A., Tammelin, T., Sääkslahti, A., Watt, A., Villberg, J., Kettunen, T., Mehtälä, A., & Poskiparta, M. (2014).

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Seasonal and daily variation in physical activity among 3-year-old Finnish preschool children

Abstract

The purposes of this study were to assess seasonal, daily, and gender variations in children's physical activity (PA). ActiGraph GT3X accelerometers were used to record the 3 year-old children's PA levels for five consecutive days in autumn and winter. Complete data for both seasons were obtained for 47 children. Despite a significant difference in seasonal temperatures ($p < .001$), differences were only found for weekdays light PA ($p = .021$). No difference in PA was observed between weekdays and weekend days. Only 20% of the sample had ≥ 120 minutes light-to-vigorous PA (LMVPA), and 46% of children had ≥ 60 minutes moderate-to-vigorous PA (MVPA). Boys spent more minutes in LMVPA ($p = .001$) and MVPA ($p = .004$) than girls. The current findings indicated that season and day of the week only minimally influence children's PA levels, whereas gender continues to be a significant factor.

Keywords: accelerometer; childcare; early childhood; physical activity

Introduction

Early childhood has been identified as an important time for the development of healthy behaviours such as physical activity (PA) (Timmons, Naylor, & Pfeiffer, 2007). Children's engagement in PA plays a key role in their physical growth and biological maturation (Strong et al., 2005) and exerts a positive influence on their cognitive, social, and psychological development (Timmons et al., 2007). Previous studies have demonstrated that PA not only appears to track reasonably well over time (Strong et al., 2005), but that physical inactivity (Telama, 2009) and obesity (Moore et al., 2003) demonstrate even stronger consistency in the transition from childhood to adulthood. In light of this trend, the enhancement of PA and reduction in sedentary behaviour in children are genuinely important from a public health perspective (Tremblay et al., 2011).

Preschool children's (3–5 years) PA may be described as "play" and occurs at various levels of intensity (Timmons et al., 2007). The assessment of young children's PA is demanding, primarily because their behaviour is intermittent and sporadic. Objective measures such as accelerometers can detect these short spurts of activity and determine frequencies, intensities, and duration of PA (Cliff, Reilly, & Okely, 2009; Oliver, Schofield, & Kolt, 2007; Pate, O´Neill, & Mitchell, 2010). Accelerometers have become one of the most widely used methods for assessing preschool-aged children's PA (Pate et al., 2010). Although the use of accelerometers to assess PA in preschool children has increased over the past decade (Bornstein, Beets, Byun, & McIver, 2011), Carson and Spence (2010) reported that there was only a small set of studies where preschool-aged children's PA levels have been determined with accelerometers across different seasons. Carson and Spence found that 29 out of a total of 35 studies assessed seasonal variations in PA among children and/or adolescents, but that only six exclusively examined preschool-aged groups, in which the pattern of findings were less clear. For example, in Scotland (Fisher et al., 2005), Canada

(Carson, Spence, Cutumisu, Boule, & Edwards, 2010) and the United States (Poest, Williams, Witt, & Atwood, 1989) children were less physically active in wintertime compared to summertime, whereas Finn, Johannsen, & Specker (2002) found no seasonal variations in their US study. Burdette, Whitaker, and Daniels (2004) reported that the highest levels of outdoor playtime occurred in the summer and the lowest in the winter and that seasonal differences in children's PA levels, as measured by accelerometers, were less pronounced compared to children's parents' proxy reports. Differences in children's PA have related more to time spent outdoors than to season or weather conditions (Baranowski, Thompson, DuRant, Baranowski, & Puhl, 1993). Seasonality merits study in young preschool children, as lifelong patterns of PA participation throughout the year are adopted in the early years of life (Poest et al., 1989). Because so few of these earlier studies were conducted in locations characterized by very cold winter temperatures, such as experienced in Finland, more knowledge is needed about seasonal variation in young children's PA in environmental conditions of this kind.

In Europe, the average enrolment rate of children aged 3 years in childcare and early education services is 69% (OECD Family Database, 2008). During weekdays, children attend childcare approximately 6–9 hours/day, while on weekend days they spend the whole day typically engaged in activities based within the home setting. There is evidence that children's attendance at childcare influences their levels of PA (Finn et al., 2002; Pate, McIver, Dowda, Brown, & Addy, 2008; Pate, Pfeiffer, Trost, Ziegler, & Dowda, 2004), thereby underlining the importance of examining and comparing children's PA levels during weekdays and weekend days.

To date, studies of objectively measured PA and sedentary behaviour in preschool-aged children have drawn attention to the fact that levels of PA are typically low and sedentary behaviour high (Oliver et al., 2007; Reilly, 2010). On the basis of their

accelerometer-derived meta-analysis, Bornstein et al. (2011), concluded that preschool children accumulate anywhere from 40 to 100 minutes of MVPA daily. Previous early childhood studies have investigated whether preschoolers are meeting PA guidelines, meaning at least 60 minutes of MVPA (Beets, Bornstein, Dowda, & Pate, 2011; Cardon & De Bourdeaudhuij, 2008; Reilly, 2010; Tucker, 2008). Despite the recommendations to engage in PA and its indisputable benefits, many young people do not achieve the guidelines for daily PA (Reilly, 2010; Tucker, 2008). For example, a review of studies from seven different countries found that nearly half of preschool-aged children did not engage in sufficient PA, and only 54% achieved the minimum of 60 minutes of PA daily (Tucker, 2008). Few earlier PA studies have focused exclusively on 3-year-olds, and therefore more research is needed to reach a comprehensive understanding of PA levels and sedentary behaviour during the very early preschool years.

The main purposes of this study were to assess the PA levels and sedentary time of 3-year-old children, paying special attention to the variation in PA and sedentary behaviour between boys and girls, weekdays and weekend days, and the autumn and winter seasons. A secondary purpose was to ascertain whether preschool children achieve the recommended levels of PA proposed within national and international current guidelines (Australian Government, Department of Health and Ageing, 2010; Canadian Society for Exercise Physiology, 2012; Department of Health. UK physical activity guidelines, 2011; Institute of Medicine [IOM], 2011; The National Association for Sport and Physical Education [NASPE], 2009; Recommendations for Physical Activity in Early Childhood Education, 2005; World Health Organization [WHO], 2010).

Method

Participants

Principals of childcare centres in Jyväskylä were provided with information regarding the study at a regional administrative meeting. A total of 14 childcare centres volunteered to be involved in the study. All the families of the 3-year-old children (year of birth 2007) attending the participating childcare centres were invited to participate. One hundred and two (57%) parents of 179 families provided informed consents. The PA data on the children were collected in two phases. The first data collection was in autumn (August to October) and the second during the winter (January to February).

A total of 96 children (48 boys and 48 girls) participated in the data collection in autumn and 94 children (50 boys and 44 girls) took part in winter. Before analysis, the data on 16 children from the autumn sub-sample, and 34 children from winter sub-sample were discarded, as 6 children (autumn) and 14 children (winter) were in homecare, and the remaining 30 participants did not have sufficient complete data. The minimum requirement for valid PA data was at least 8 hours of monitored PA per day (from 7 am to 9 pm) for at least 2 weekdays and 1 weekend day. Complete data were obtained for 81 children (41 boys and 40 girls) during autumn and for 60 children (33 boys and 27 girls) during winter. Complete data for both seasons were obtained for 47 children (26 boys and 21 girls). Body weight and height were measured at the time of each PA data collection and body mass index (BMI: kg/m^2) was calculated for each child. Demographic characteristics of the sample by gender and season are shown in Table 1. Results for BMI indicated, in accordance with the International Obesity Task Force BMI definition, four children (9%) during the autumn assessments and three children (7%) during the winter assessments were evaluated as overweight. All other children were in the normal BMI range (Cole, Bellizzi, Flegal, & Dietz, 2000). [Table 1 near here]

Instruments

PA was quantified with ActiGraph GT3X accelerometers on five consecutive days (from Wednesday to Sunday), which were programmed to save data in 5-s intervals (epochs) as proposed for children this age (Cliff et al., 2009). In the present study, total physical activity (TPA) was expressed as mean counts per minute (cpm). To analyse the amount of the time children spent at different intensity levels, the separate count cut points for preschool-aged children established recently by Van Cauwenberghe, Labarque, Trost, De Bourdeaudhuij, and Cardon, (2011) were adapted for this study. The following cut-points were used: sedentary (≤ 1491 cpm); light (14922339 cpm); moderate (23403523 cpm); vigorous (≥ 3524 cpm); light-to-vigorous physical activity (LMVPA) (≥ 1492 cpm); and moderate-to-vigorous physical activity (MVPA) (≥ 2340 cpm) (Van Cauwenberghe et al., 2011).

Procedures

Before the data collection, all the participants were familiarized with the accelerometer. The children received an accelerometer on the first morning of the study, and all the children, together with their parents, were instructed to wear the accelerometer on an adjustable elastic belt over their right hip for as long as possible during all waking hours, removing it only for water-based activities and sleeping. Parents and early educators were informed about the correct procedures and proper accelerometer use via an information letter.

Parents were asked to record the times at which children woke up, went to bed, and their childcare attendance times. Additionally, parents were asked to report any abnormalities in daily routines, for example, long periods spent sitting (e.g., in a car), swimming, bathing and if the child falls ill during the measurement time. Receptivity to wearing the instrument was rated by the parent on a five-point scale (from very pleasant to very unpleasant). Outdoor times were recorded by the researchers during attendance at childcare. The ethics committee of the University of Jyväskylä, and the Social Affairs and Health officer in city of Jyväskylä approved the study.

147 ***Environmental conditions***

148 The city of Jyväskylä is located in central Finland (62° 15' 36"N, 25° 45'E). The suburbs of
149 the city of Jyväskylä are in close proximity to forests, hills and lakes, with good opportunities
150 for active commuting and leisure time activities. The region experiences four distinct seasons.
151 The average maximum air temperature in autumn (August to October) is around 13.0°C,
152 average precipitation 66 mm/month and duration of sunshine approximately 255 hours/month.
153 During the winter months (January and February) the average air temperature is around -
154 8.4°C, average precipitation of 39 mm/month, duration of sunshine approximately 51
155 hours/month and average snow depth 36 cm (Climatological Statistics of Finland, 1981–
156 2010). In this study, the findings showed significant seasonal variation in mean daily
157 temperature (9.4°C in autumn vs. -13.1°C in winter; $p < .001$). These temperatures were
158 lower than normally recorded for these seasons.

159 **Statistical analyses**

160 All data were checked for normality before statistical analysis. Periods of non-wear time
161 (defined as 20 consecutive minutes of '0' counts) and an upper range of biological
162 plausibility (defined as no more than 15 000 cpm) were removed from the data (Cliff et al.
163 2009). The data reduction was done with using self-customized software.

164 The data were analysed using SPSS for Windows (version 18.0). Means and standard
165 deviations (SD) were calculated for daily TPA expressed as cpm, and time spent (minutes per
166 day) at different intensity levels (sedentary, light, moderate, vigorous, LMVPA and MVPA)
167 to show the extent of activity behaviour for the independent variables of gender and season.
168 Nonparametric tests (Wilcoxon and Mann-Whitney) and General Linear Models (GLM) for
169 repeated measures (MANOVA) were used to analyse gender and seasonal differences in
170 children' s PA on weekdays and weekend days. To compare PA levels on weekdays and
171 weekend days, paired-samples *t*-tests were conducted. Gender differences in TPA and in

engagement at different intensity levels were analysed using independent-samples *t*-test. Effect size was determined using the Cohen's *d* formula. Crosstabs utilizing Pearson Chi-square were used to determine the percentages of children who reached the current recommended levels of PA. Statistical significance was set at an alpha level of .05 for all analyses.

Results

The results showed a significant seasonal variation in mean outdoor time during childcare attendance (178 minutes in autumn vs. 116 minutes in winter; $p = .002$). During the data collection periods, the participants attended childcare settings for an average of 7.6 hours/day. Accelerometers were worn for an average of 4.6 days and 692 minutes/day.

The results indicated that the children engaged in sedentary activity for 85% of the time, in light activity for 6% of the time, and in MVPA for 9% of the time monitored. Mean TPA for the whole sample was 632 cpm ($SD = 145$), boys showing significantly higher TPA than girls (673 vs. 580 cpm; $p = .001$, $d = 0.70$). A paired-samples *t*-test indicated no significant differences in TPA or in PA levels between weekdays and weekend days, except in winter, when the children engaged significantly more in sedentary behaviour on weekdays compared to weekend days (596 vs. 570 min/day; $p = .019$, $d = 0.37$).

No seasonal difference was observed in children's PA levels, except for minor variation on weekdays light PA ($p = .021$; see Table 2). Boys were more physically active than girls. Between-subjects comparisons in PA on weekdays and weekend days indicated significant gender differences for all the dependent variables, except for sedentary time on weekend days (see Table 2). Results of the independent-samples *t*-tests for the comparison of PA levels by gender revealed that especially during winter weekdays boys were physically more active than girls (see Table 3). Seasonal variations between boys and girls were also analysed with GLM for repeated measures. No significant differences were observed for any

of six variables. Due to small sample size, the power of the tests was minimal on all occasions, and therefore the results of the MANOVA are merely indicative. [Tables 2 and 3 near here]

The proportions of children engaging in LMVPA were 1% (under 60 minutes/day), 36% (6089 minutes/day), 43% (90119 minutes/day), 20% (120 minutes or more/day). The proportions of children engaging in MVPA were 53% (3059 minutes/day), 40% (6089 minutes/day, and 6% (90119 minutes/day). None of the children engaged in MVPA 120 minutes or more/day. Pearson Chi-Square tests confirmed the gender differences in the time spent in LMVPA (p = .010) and MVPA (p = .002). According to parents' reports of their children's receptivity to wearing the accelerometer, only 3% of the children reported the experience as "unpleasant" and none as "very unpleasant".

Discussion

The main purposes of this study were to assess seasonal, daily, and gender variations in 3-year-old preschool children's PA and sedentary behaviour. The results indicated only minor seasonal variations in the children's light PA on weekdays, and no difference was observed in PA levels between weekdays and weekend days, except in winter in the children's sedentary behaviour. Boys were more active than girls, particularly in winter and during weekdays. The findings indicated that the children's PA levels were very low and sedentary time very high. Overall, the children did not meet the recommendations of three hours of daily LMVPA (Australian Government, Department of Health and Ageing, 2010; Canadian Society for Exercise Physiology, 2012; Department of Health. UK physical activity guidelines, 2011; IOM, 2011), or two hours of daily brisk PA (Recommendations for Physical Activity in Early Childhood Education, 2005). Approximately 20% of the present sample engaged in at least two hours of daily LMVPA (NASPE, 2009) and 46% fulfilled the requirement of at least 60 minutes of MVPA daily (WHO, 2010).

The mean TPA scores for the children in the present study were slightly lower than those reported in earlier similar studies (Cardon & De Bourdeaudhuij, 2008; Fisher et al., 2005; Jackson et al., 2003). For example, Jackson et al. (2003) found total activity counts of 669 cpm for 3-year-old Scottish children compared to the mean of 632 cpm found in this study. Cardon and De Bourdeaudhuij (2008) reported that a sample of 4- and 5-year-old Belgian children engaged in 9.6 hours per day of sedentary behaviour and in MVPA for only 34 minutes per day. The present sample was similarly sedentary for 9.9 hours per day, although the children also engaged in MVPA for 61 minutes per day. Based on a meta-analysis of accelerometer based studies, Bornstein et al. (2011) indicated substantial variations in children's MVPA times, with no clear pattern emerging on the typical PA levels of preschool children. The pattern of low levels of PA and high levels of sedentary time reported for the present Finnish children as well as in comparable studies, underlines a worrying trend among preschool-aged children regarding their failure to engage in sufficient levels of PA.

Limited previous research has examined seasonal variations in younger age groups, and incorporated the use of accelerometers to evaluate PA (Carson & Spence, 2010). Several studies have shown seasonal variation in young children's PA, with PA levels typically higher and sedentary time lower in summertime (Carson et al., 2010; Fisher et al., 2005; Poest et al., 1989). The highest levels of outdoor playtime occurred in the summer and the lowest in the winter (Burdette et al., 2004). Baranowski et al. (1993) also found seasonal variation in outdoor activity, with all the children showing lower outdoor activity levels during the summer months. Finn et al. (2002) found no effect for season. Similarly, the present study found only minor seasonal variations in children's PA levels. The data revealed that on weekdays in autumn the children engaged significantly more in light PA than on weekdays in winter. Generally, childcare centres' daily schedules do not vary within seasons.

However, in cold weather, such as -20°C or colder, it is possible, that children do not participate in outdoor activities, or recess periods are shorter than normally. Significant seasonal variations in mean temperatures could explain why the average outdoor time during childcare attendance in winter (116 min) was significantly less than in autumn (178 min). Furthermore, in winter, shorter outdoor activity times may explain children's lower engagement in light PA on weekdays. In addition, the amount of daylight hours during the winter months (51 hours/month) is much shorter than in autumn (255 hours/month), and might have an influence on children's outdoor times after childcare attendance. Given the considerable contrast in environmental conditions, such as temperature and the presence of snow, the results were surprisingly similar for the two seasons.

Aside from Finn et al. (2002), who concluded that attendance at the childcare centre was the strongest predictor of activity levels, with more than 50% of the daily activity counts performed during childcare hours, and Strong et al. (2005), who reported that preschools should provide opportunities for children to accumulate 60 minutes and more of MVPA each day, earlier studies have typically indicated that physical activity levels are very low among preschool children during their time in childcare settings (Pate et al., 2008; Reilly, 2010). Cardon and De Bourdeaudhuij (2008) reported higher levels of sedentary behaviour on weekdays compared to weekend days, although MVPA was as low during the weekend days as during the weekdays. In the present study, in wintertime, the children engaged more in sedentary behaviour on weekdays than weekend days. Childcare attendance and outdoor times may in part explain children's greater engagement in sedentary behaviours during weekdays compared to weekend days. The descriptive results revealed that the children tended to be more active on weekdays, although no significant difference in the time spent in different intensity levels was found between weekdays and weekend days. Similarly, Jackson et al. (2003) found no differences in activity levels between weekdays and weekend days.

Interestingly, the present results showed that the variation in PA time (described by standard deviation and range) on weekend days was somewhat higher than on weekdays. In the present study, there were boys and girls who were physically very active, and others who were very inactive. This finding should encourage early educators and parents to make extra effort to promote a healthy lifestyle in their daily activities with children.

Previous preschool PA research has shown boys to be more active than girls (Finn et al., 2002; Hinkley, Crawford, Salmon, Okely, & Hesketh, 2008; Jackson et al., 2003; Pate et al., 2004). In the present study, boys' TPA was significantly higher than girls', and boys also spent significantly more minutes in LMVPA and MVPA. On weekdays, girls spent significantly more minutes sedentary than boys. The gender differences were more pronounced on weekdays and during wintertime. It is possible that boys are more interested in rough and tumble play and winter-oriented physical activities (e.g., snow-based play) or enjoy more time in outdoor environments than girls. One potential explanation may be found in parents' and early educators' attitudes, which may affect children's PA. Boys are regularly encouraged to engage in more physically active play and games, whereas girls are exposed to stationary activities and expected to behave in a calmer manner (Pellegrini & Smith, 1998). Although it is not clear whether the gender difference in PA is biologically based or environmentally determined, it is most likely a combination of both (Timmons et al., 2007). The present findings provide further support for the recommendations that more attention and encouragement are needed to promote PA throughout the year for preschool-age girls (Pate et al., 2004).

Systematic reviews of previous population surveys have shown that many young children do not meet the international guidelines for PA (Bornstein et al., 2011; Reilly, 2010; Tucker, 2008); the results of the present study were in line with these findings. Approximately half of the children engaged in MVPA for at least 60 minutes per day. Only

297 20% of children reached the NASPE standard of at least 120 minutes of PA per day, when
298 light PA was included. In addition, none of the present sample engaged in LMVPA for 180
299 minutes or more (Australian Government, Department of Health and Ageing, 2010; Canadian
300 Society for Exercise Physiology, 2012; Department of Health. UK physical activity
301 guidelines, 2011; IOM, 2011), or achieved the Finnish Recommendations for Physical
302 Activity in Early Childhood Education (2005) of at least 120 minutes of daily brisk PA
303 (defined as MVPA (≥ 2340 cpm)). The current sample of 3 year-olds was sedentary for
304 nearly 10 hours per day. Finnish recommendations for preschool children's PA currently do
305 not include limitations on sedentary time, whereas international guidelines (Australian
306 Government, Department of Health and Ageing, 2010; Canadian Society for Exercise
307 Physiology, 2012; Department of Health. UK physical activity guidelines, 2011; IOM, 2011;
308 NASPE, 2009) specifically state that children should not be sedentary for more than one hour
309 at a time except when sleeping. More research is needed to evaluate the effects of PA on
310 children´s health and wellness in the early years of life and what constitutes sufficient levels
311 of health-enhancing PA (Beets et al., 2011). In particular, it would be very important to
312 determine the quantity and quality of daily PA required to ensure children´s optimal growth
313 and maturation.

314 A major strength of this study was the repeated-measure design, where the same 3-
315 year-old children were measured with accelerometers during two distinct seasons. However,
316 caution should be exercised when comparing PA levels over short time periods (e.g., 3–6
317 months) because children's normal growth and maturation may influence their physical
318 abilities and motor skills in relation to their engagement in physically active play (Fisher et
319 al., 2005). Children's PA was measured over five days in both the childcare and home
320 settings, including weekdays and weekend days. Anecdotal evidence derived from the
321 implementation of the study suggests that childcare centres are suitable places to reach

families with 3-year-old children. Moreover, the children were co-operative and eager to take part in this study. Proxy reports by parents of their child's receptivity to wearing the accelerometer clearly indicated that it was a positive experience for the majority of the children. Although previous data on the receptivity of preschoolers to wearing accelerometers is relatively limited and not well understood (Oliver et al., 2007), the present results are in line with those of earlier studies (Cardon & De Bourdeaudhuij, 2008; Pate et al., 2004).

The present study was limited by the relatively small sample size, although the sample was focused exclusively on 3-year-old children. Furthermore, the generalizability of the findings could be limited by the fact that all the participating childcare centres and children were located in the same city. It is noteworthy that a large number of children did not achieve the required 8 hours of daily data for at least two weekdays and one weekend day during the winter. This may partly have been due to the effect of the cold weather conditions on the functioning of the accelerometers.

A disadvantage of accelerometers is that they do not provide information on the type or context of PA (Pate et al., 2010). In addition, accelerometers are limited in their ability to measure non-weight-bearing activities, such as swimming, cycling, and skating or upper limb movements, (e.g., digging, carrying and pushing objects). They are not able to account for the increased energy cost associated with walking up stairs, on an incline or on soft surfaces (Oliver et al., 2007; Pate et al., 2010; Trost, 2007). Children playing outdoors in Finland during wintertime often climb up and slide down mounds of snow, pushing or pulling sleds, walking in soft snow, or skating on ice. Also, accelerometers do not detect movements, which are sedentary but need balance and/or concentration in order to develop motor skills or are integral to certain low intensity activities (e.g., singing, drawing and completing puzzles), which are particularly important for young preschool children (Cliff et al., 2009).

Although previous research has found that triaxial accelerometers generate data with a higher level of validity than uniaxial accelerometers (Rowlands, 2007), conjecture remains as to whether triaxial accelerometers detect PA better than uniaxial accelerometers in children (Oliver et al., 2007). In this study, we analysed acceleration in the vertical plane, which has been shown to provide the most important assessment of ambulatory movement (Oliver et al., 2007). The choice of cut points significantly influences the amount of PA reported across different intensity levels (Bornstein et al., 2011). Investigators in the field of PA need to resolve the issue of what accelerometer cut points are the most appropriate (Beets et al., 2011; Bornstein et al., 2011) and continue to focus on standardizing methods for the collection, cleaning, analysing and reporting of accelerometer data (De Vries et al., 2009). To date, the majority of validation and calibration studies have reported a strong positive correlation between ActiGraph accelerometer output and intensity of PA in children (Pate et al., 2010; Rowlands, 2007; Trost, 2007). Strong evidence also exists for good reproducibility of the data generated by ActiGraph accelerometers in samples of preschool-aged children (De Vries et al., 2009). Although the strengths and limitations of accelerometers are widely discussed in the literature, accelerometers remain a necessary tool for measuring PA and sedentary behaviour in free-living preschool children (Pate et al., 2010; Trost, 2007; Van Cauwenberghe et al., 2011).

Conclusion

The present findings have valuable implications for developing interventions that could contribute to improvements in preschool children's PA both in the home and childcare setting. Based on the current results the influence of season and day of the week is minimal. However, consistent with previously reported research, gender is shown to be a critical variable in relation to children's PA levels. Finnish children appear to achieve recommended guidelines regarding PA levels and sedentary behaviour, in a similar distribution to other studies (e.g.,

Reilly, 2010; Tucker, 2008). The levels of sedentary behaviour observed in current sample may stimulate early educators and parents to work towards reducing the time children spend in sedentary behaviour and increase time and opportunity for engaging in the recommended levels of PA. This change in practice should particularly target girls. In future research, larger and more heterogeneous samples are required to determine key characteristics of children's PA such as type and context. This could be achieved through combining accelerometer information with other methods, such as direct observation, that describe where and how PA takes place among preschool-aged children.

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Table 1. Demographic information for boys (n = 26) and girls (n = 21) by season.

	Autumn				Winter			
	Boys		Girls		Boys		Girls	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Age (years)	3.3	0.3	3.3	0.3	3.6	0.3	3.7	0.3
Height (cm)	100.0	5.4	98.4	3.3	102.5	5.5	101.2	3.4
Weight (kg)	16.1	2.0	15.6	1.4	17.0	2.0	16.4	1.6
BMI (kg/m^2)	16.2	0.9	16.1	1.2	16.1	0.8	16.0	1.3

Note. *M* = mean, *SD* = standard deviation, BMI = body mass index

Table 2. Gender and seasonal differences in children's weekdays and weekend days' physical activity (PA) (minutes/day).

Physical activity intensity	Total				Season			
	Boys (n = 26) *M* *SD*	Girls (n = 21) *M* *SD*	*p*	*d**	Autumn (n = 47) *M* *SD*	Winter (n = 47) *M* *SD*	*p*	*d**
Sedentary time								
Weekdays	585 51	608 54	.047	0.44	595 48	596 58	.861	0.02
Weekend days	576 71	589 73	.310	0.18	594 58	570 82	.087	0.34
Light PA								
Weekdays	43 8	37 6	.001	0.85	41 7	39 8	.021	0.27
Weekend days	41 12	36 9	.030	0.47	39 10	38 11	.378	0.10
Moderate PA								
Weekdays	34 8	29 6	.001	0.71	32 7	31 8	.668	0.13
Weekend days	33 12	28 8	.028	0.50	30 10	31 11	.866	0.10
Vigorous PA								
Weekdays	32 12	27 9	.021	0.48	31 12	29 11	.331	0.17
Weekend days	33 16	26 12	.036	0.50	29 14	30 16	.767	0.07
LMVPA								
Weekdays	109 26	92 18	.001	0.77	104 24	100 24	.204	0.17
Weekend days	106 37	90 27	.021	0.50	99 32	99 36	.970	0.00
MVPA								
Weekdays	67 19	55 14	.005	0.73	62 18	61 18	.328	0.06
Weekend days	65 27	54 19	.029	0.48	60 23	61 26	.707	0.04

Note. *Effect size (Cohen's *d*)

Table 3. Time (minutes/day) spent in different intensities of physical activity (PA) during weekdays and weekend days for each seasons in boys and girls.

Physical activity intensity	Autumn						Winter					
	Boys (n = 26)		Girls (n = 21)		t	p	d^*	Boys (n = 26)		Girls (n = 21)		t	p	d^*
	M	*SD*	*M*	*SD*				*M*	*SD*	*M*	*SD*			
Sedentary time														
Weekdays	587	48	604	48	1.22	.230	0.35	584	54	612	60	1.69	.097	0.49
Weekend days	594	56	594	62	0.01	.992	0.00	557	80	585	83	1.16	.252	0.34
Light PA														
Weekdays	44	8	39	6	2.36	.023	0.71	42	8	36	5	2.88	.006	0.92
Weekend days	41	11	37	8	1.66	.105	0.42	40	12	36	10	1.14	.260	0.36
Moderate PA														
Weekdays	34	7	30	6	2.00	.052	0.62	35	9	27	5	3.46	.001	1.14
Weekend days	33	11	28	7	1.91	.063	0.56	33	13	28	9	1.54	.131	0.46
Vigorous PA														
Weekdays	33	13	28	10	1.53	.133	0.44	32	12	26	8	2.14	.038	0.60
Weekend days	32	15	25	11	1.74	.088	0.54	33	17	27	14	1.32	.192	0.39
LMVPA														
Weekdays	110	25	96	20	2.11	.041	0.62	108	27	89	15	3.09	.004	0.91
Weekend days	106	36	89	23	1.94	.059	0.58	106	40	91	30	1.43	.160	0.43
MVPA														
Weekdays	66	19	57	16	1.80	.079	0.51	67	20	53	11	2.84	.007	0.90
Weekend days	65	26	53	17	1.93	.060	0.56	66	29	55	22	1.46	.152	0.43

Note. *Effect size (Cohen's *d*)