



Original research

The impact of a teacher-led structured physical activity session on preschoolers' sedentary and physical activity levels

Eveline Van Cauwenberghe*, Marieke De Craemer, Ellen De Decker, Ilse De Bourdeaudhuij, Greet Cardon

Department of Movement and Sport Sciences, Ghent University, Ghent, Belgium

ARTICLE INFO

Article history:

Received 8 February 2012

Received in revised form

10 September 2012

Accepted 16 November 2012

Keywords:

Preschool child

Accelerometer

Motor activity

Physical education and training

Health promotion

Preschool

ABSTRACT

Objectives: The purpose of this observational study was to examine differences in preschoolers' sedentary time and physical activity (PA) participation between preschool-attending weekdays with and without a teacher-led structured PA session.

Design: A sample of 200 preschoolers (5.3 ± 0.4 y; 113 boys) from 26 preschools in Flanders, Belgium were included in data analysis.

Methods: Participants wore a GT1M ActiGraph accelerometer on one preschool-attending weekday with and on one preschool-attending weekday without the provision of a teacher-led structured PA session. Preschoolers' sedentary time, light PA, and moderate-to-vigorous physical activity (MVPA) during the time in preschool (08:00–16:00 h) and after preschool (16:00–20:00 h) were estimated. To assess differences in the outcome measures between both days, multi-level linear regression models were conducted. **Results:** During the time at preschool, lower sedentary levels ($\beta = 13.0$ min; SE = 1.6; $p < 0.001$) and higher light PA ($\beta = 2.9$ min; SE = 0.7; $p < 0.001$) and MVPA levels ($\beta = 10.1$ min; SE = 1.1; $p < 0.001$) were prevalent on days with a structured PA session compared to days without a structured PA session in both boys and girls. After preschool, no differences were found between both days in sedentary time ($\beta = 0.7$; SE = 1.4; $p > 0.05$), light PA ($\beta = 0.3$; SE = 0.5; $p > 0.05$), and MVPA ($\beta = 0.3$; SE = 0.9; $p > 0.05$).

Conclusions: The results demonstrate that no compensatory changes were found after preschool for the structured PA session during the preschool hours. Therefore, a teacher-led structured PA session integrated in the preschool curriculum is a promising mean to decrease sedentary time and to increase PA in preschool-aged boys and girls.

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1. Introduction

Regular physical activity (PA) is critical for the health and well-being of preschool children (3–5-year olds), including improved motor, musculoskeletal, and psycho-social development and a reduced risk of being overweight or obese.¹ Additionally, high levels of sedentary behavior (i.e., sitting behaviors)² have been positively associated with adiposity and inversely associated with health, cognitive, and behavioral outcomes.³ Therefore, experts have agreed that preschoolers should accumulate several hours of PA of any intensity across the day and limit the time spent sedentary.^{4–6} Despite their importance, evidence suggests that preschoolers' PA engagement is not sufficient and participation in sedentary behaviors is high.^{7,8} Given this, and taken alongside the increasing prevalence of overweight and obesity in children under 5

years of age,⁹ early intervention is crucial to establish and maintain a healthy lifestyle and weight throughout life.

Many preschoolers around the globe spend considerable time at some form of organized out-of-home care, such as preschools, child care centers, and family child care homes (e.g., 80% of US preschool children with employed mothers are in some form of organized out-of-home care for an average of almost 40 h a week).^{10,11} These settings offer thus an excellent opportunity to support and facilitate adequate PA experiences and to limit the time spent sedentary.¹¹ In Flanders, the Dutch speaking part of Belgium, preschools are free and virtually all preschool children attend (98%).¹² One of the PA experiences that Flemish preschools and preschools in many other countries provide, are structured PA sessions.¹³ In Flemish preschools, these sessions are scheduled in the curriculum for two hours per week to realize one of the developmental goals of the preschool curriculum prescribed by the Flemish government, namely physical education of the preschool child.¹⁴ The sessions are delivered by classroom teachers (certified preschool teachers, who are not specialized in physical education) or physical education specialists (certified physical education teachers) and are

* Corresponding author.

E-mail address: Eveline.VanCauwenberghe@UGent.be (E. Van Cauwenberghe).

usually provided indoors.¹⁵ To date, very little observational^{16–19} and experimental²⁰ research has examined how this scheduled PA opportunity affects preschoolers' sedentary and PA levels. Bower et al.¹⁷ and Vale et al.¹⁶ established that increased opportunities in PA through structured PA sessions were associated with higher levels of PA and lower sedentary levels at out-of-home care while Dowda et al.¹⁸ and Gunter et al.¹⁹ found no such relationships. The experimental study of Trost et al.²⁰ demonstrated that the integration of structured PA experiences into classroom resulted in small increases in PA during classroom and total child care time. Taken together, the integration of structured PA in the curriculum appears to be a promising strategy for increasing PA and decreasing sedentary time. However, the latter studies did not monitor sedentary and/or PA levels outside the time at out-of-home care. As a result, the possibility that children compensate or displace this increased PA by decreasing PA levels or increasing sedentary levels after out-of-home care cannot be ruled out. Previous research in elementary school children provides inconsistent evidence for compensatory changes in PA following increased or decreased periods of PA.^{21–23} The purpose of this observational study was, therefore, to investigate if lower sedentary levels and higher PA levels were prevalent on preschool-attending days with the provision of a teacher-led structured PA session, as part of the regular Flemish preschool curriculum, compared to preschool-attending days without the provision of a teacher-led structured PA session. To not miss potential compensatory behavior after preschool, PA and sedentary time were objectively measured during the time attending preschool (08:00–16:00 h) and during the time after-preschool (16:00–20:00 h).

2. Methods

Thirty-eight preschools from Flanders, Belgium were randomly selected from the official database of the Flemish government.²⁴ Following approval from the principal of each school (28 schools consented), information letters and consent forms were distributed to parents of all enrolled children aged 4–6 years ($n = 717$). Of this number, 244 parents (34%) consented for their child to participate. The study was conducted with approval and under the ethical guidelines of the Ethics Committee of the University Hospital of Ghent. The funding source had no role in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

Data collection occurred in two phases due to logistical reasons: from November 2008 till March 2009 and from October 2010 till January 2011. Participants were measured during four consecutive days, including one preschool-attending weekday with and one preschool-attending weekday without the provision of a teacher-led structured PA session. GT1M ActiGraph accelerometers, uniaxial accelerometers designed to detect vertical accelerations, were used to assess sedentary time and PA intensity levels. These monitors have established utility, validity, and reliability in preschool-aged children.²⁵ On the first day of the protocol, participants were fitted with an accelerometer by a researcher at preschool. The accelerometer was attached to an adjustable elastic belt, worn at the waist, and positioned on the right hip. Accelerometers were set to collect data in 15 s epochs and recordings started on the day of fitting. Participants were requested to wear the accelerometer during waking hours, excluding time spent in aquatic activities, such as bathing and swimming. Parents and teachers received the same instructions and were also informed about the correct placement of the accelerometer. Participants were visited 3 days later at preschool by a researcher to collect the accelerometers. To align as closely as possible to the real-life situation, no instructions were provided to the teachers

delivering the structured PA sessions. Teachers and preschools were also not aware that the purpose of this study was to compare a preschool-attending day with a structured PA session with a preschool-attending day without a structured PA session. Instead, teachers and preschools were told that children were wearing the accelerometer to investigate patterns of PA in preschool children. Participants' demographics (gender and date of birth) were acquired from the preschool's database. Teachers were asked to report on which day the structured PA session occurred, the start and ending times of the session, and if children were absent at preschool during one of the measurement days.

After data collection, accelerometers were downloaded and raw data files were then reduced using the software Meterplus version 4.2 (Santech Inc., San Diego, US). Both the first and the fourth day of the measurement period were omitted because these days were incomplete. Periods containing 10 min or more of consecutive zero counts were deleted, as these periods were regarded as non-wearing time.^{25,26} To be included in the analyses, participants were required to have accelerometer recordings on both days for at least 8 h.²⁵ For the purpose of this study, intensity levels during the structured PA session (using the teacher-reported start and ending times) and during both days for the time in preschool (between 8:00 h and 16:00 h) and the time after preschool (between 16:00 h and 20:00 h) were calculated for each participant. Accelerometer cut points applied were the ones developed by Van Cauwenberghe et al.²⁶ in Flemish 4–6-year olds on the basis of structured and unstructured activities. Less than 373 counts per 15 s is considered sedentary time, more than or equal to 373 counts per 15 s light-to-vigorous PA (LMVPA), and more than 584 counts per 15 s moderate-to-vigorous PA (MVPA).²⁶ For ease of understanding, the 15 s data were divided by four to express the outcome measures in minutes.

Preliminary analyses consisted of descriptive statistics of the variables of interest. The contribution of the structured PA session toward preschoolers' overall preschool PA levels was estimated as a percentage. To investigate differences in all the outcome measures between days with and days without a structured PA session, multi-level linear regression models were conducted. All analyses controlled for the nested structure of the data: accelerometer measurements of two days nested within participants and participants nested within preschools. Test for normal distribution revealed that none of the PA outcomes were skewed. All models were adjusted for participants' sex, age, and accelerometer wear time and year of data collection. To establish whether the differences between both days differed by participants' sex and age or year of data collection, interaction effects were examined within these models. All statistical analyses were performed using MLwiN version 2.23 (Center for Multilevel Modeling, University of Bristol, UK). Wald tests²⁷ were used to test statistical significance at the alpha level of 0.05.

3. Results

During one or more of the measurement days, 26 preschoolers did not attend preschool and were excluded. In two schools, the scheduled structured PA session was not conducted during the measurement period, resulting in the exclusion of 15 children. Another three children were removed from further analyses as the accelerometer was worn for less than 8 h on one of the measurement days. Ultimately, the analysis sample included 200 preschool children (113 boys and 87 girls) from 26 preschools with a mean age of 5.3 ± 0.4 years (4.0–6.2 years). Accelerometers were worn on average for 730 ± 82 min per day (482–968 min). The average length of the structured PA session was 48 ± 9 min (30–80 min). All structured PA sessions were given indoors. Table 1 presents that preschoolers spent on average 31.6 min sedentary, 5.8 min in light

Table 1
Activity levels during the structured PA session and the contribution of the session toward preschoolers' overall activity ($n=200$).

Outcome measure	Mean minutes (SD)	Mean percentage (SD)	Mean percentage contribution (SD) of structured PA session toward the overall activity levels in preschool (08:00–16:00 h)
Sedentary	31.6 (9.4)	65.1 (13.0)	8.0 (2.3)
Light PA	5.8 (2.1)	12.2 (3.9)	16.9 (7.2)
MVPA	10.8 (5.6)	22.7 (11.7)	25.6 (12.2)
LMVPA	16.6 (6.5)	34.9 (13.0)	21.6 (8.8)

LMVPA: light-to-vigorous physical activity; MVPA: moderate-to-vigorous physical activity; PA: physical activity.

Table 2
Differences in preschoolers' activity levels ($n=200$) between days with a structured PA session and days without a structured PA session.^a

In preschool (08:00–16:00 h)	Days with a structured PA session Mean minutes (SE)	Days without a structured PA session Mean minutes (SE)	β (SE)	χ^2	p -Value
Sedentary	394.0 (2.0)	407.0 (2.0)	13.0 (1.6)	67.967	<0.001
Light PA	36.1 (0.9)	33.2 (0.9)	2.9 (0.7)	15.072	<0.001
MVPA	44.2 (1.3)	34.1 (1.3)	10.1 (1.1)	92.337	<0.001
LMVPA	80.3 (2.0)	67.3 (2.0)	13.0 (1.6)	67.953	<0.001
After preschool (16:00–20:00 h)	Days with a structured PA session Mean minutes (SE)	Days without a structured PA session Mean minutes (SE)	β (SE)	χ^2	p -Value
Sedentary	165.5 (1.3)	164.8 (1.3)	0.7 (1.4)	0.232	>0.05
Light PA	13.4 (0.4)	13.7 (0.4)	0.3 (0.5)	0.329	>0.05
MVPA	14.9 (0.9)	15.2 (0.9)	0.3 (0.9)	0.138	>0.05
LMVPA	28.3 (1.3)	29.0 (1.3)	0.7 (1.4)	0.232	>0.05

LMVPA: light-to-vigorous physical activity; MVPA: moderate-to-vigorous physical activity; PA: physical activity.

^a Three-level (preschool–participant–measurement) linear regression analyses adjusted for participants' sex, age, and accelerometer wear time and year of data collection.

PA, 10.8 min in MVPA, and 16.6 min in LMVPA during the structured PA sessions. The acquired light PA, MVPA, and LMVPA during the structured PA sessions accounted for 17% of the total light PA, for 26% of the total MVPA, and for 22% of the total LMVPA during preschool time.

When examining the differences between both days, no significant interaction effects were found with participants' sex and age and year of data collection (all $p > 0.05$). Consequently, results are presented in Table 2 for the total sample. During the preschool hours, significantly lower sedentary levels (–13.0 min) and significantly higher light PA (+2.9 min), MVPA (+10.1 min) and LMVPA (+13.0 min) levels were found on days with a structured PA session compared to days without a structured PA session. During the time after preschool, no significant differences were found in sedentary time, light PA, MVPA, and LMVPA between both days.

4. Discussion

In this observational study, preschool children were monitored during a preschool day with an increased opportunity to be physically active through a teacher-led structured PA session scheduled in the curriculum and during a preschool day without this PA opportunity. Compared to previous similar research in preschoolers,^{16–20} the present study is the first to examine preschoolers' sedentary and PA levels not only in preschool but also after preschool, which is essential if compensation following the structured PA session is to be detected. In support of previous observational^{16,17} and experimental research²⁰ in preschool children, more favorable levels of sedentary time, light PA, MVPA, and LMVPA were found during the preschool hours on a day with a structured PA session compared to a day without a structured PA session. After preschool, no significant differences were found in sedentary time, light PA, MVPA, and LMVPA. Thus, the extra PA during the preschool hours did not elicit compensatory decreases in PA or compensatory increases in sedentary time after preschool and in the evening. Taken together, the findings of the present study support that the inclusion of a structured PA session in the preschool curriculum led by preschool classroom teachers or physical education

specialists has the potential to decrease daily sedentary time and increase daily PA in both preschool-aged boys and girls. Based on these results, it can be suggested to incorporate teacher-led structured PA sessions into the daily preschool program. However, these sessions should not be implemented at the expense of preschoolers' important free play time.^{28,29} Hence, integrating short teacher-led activities into classroom time, as documented by Trost et al.,²⁰ instead of adding every day sessions of around 50 min to the preschool curriculum may be a more desirable approach. Nonetheless, research is needed to determine if these short occasions are beneficial to children's daily sedentary and PA levels.

In elementary school children, contrasting results have been found for the evidence of compensatory changes. Frémeaux et al.²¹ have argued that more PA opportunities in school cannot increase children's PA. In their study, PA levels from 206 children from three primary schools, with large variability in sporting facilities and time allocated to physical education, were examined. Children attending the high provision school, providing on average 9.2 h of physical education each week, recorded 64% more PA during school hours but their total weekly PA was no different from the children of the other schools. On the other hand, Dale et al.²³ demonstrated that children did not compensate for school days with restricted PA opportunities by increasing PA levels after school and during the evening. In the latter study, PA levels of 78 children were monitored during the time in school (09:00–15:00 h) and after school (15:00–19:00 h) for two consecutive days, including one restricted school day (i.e., no physical education class was provided and during recess the children remained indoors) and one active school day (i.e., a 30 min physical education class was provided and children spent their recess periods outdoors).

The findings of the present study are especially of great interest and encouraging because no instructions were provided to the teachers of the sessions. In contrast to preschool/child care staff in many other countries, preschool classroom teachers and physical education specialists in Flanders are certified teachers and both have competence in the delivery of structured PA sessions in preschool children, as this is included in their education. Therefore, the present study provided some evidence that it is feasible

to use educated preschool/child care staff to deliver structured PA sessions that produce an overall decrease in daily sedentary time and an overall increase in daily PA. Further, as PA levels during the structured PA sessions were variable, it can be anticipated that educating preschool/child care staff to deliver highly active structured PA sessions (e.g., by decreasing management time during the sessions¹⁵) could result in greater decreases in daily sedentary time and greater increases in daily PA.

Although it can be expected that a great deal of PA during a preschool-attending day is likely to be accumulated outside the structured PA session, the found contribution (i.e., 17% for light PA, 26% for MVPA, and 22% for LMVPA) of the session toward preschoolers' overall preschool PA emphasizes that these sessions were an important opportunity to obtain PA. In line with our results, Verbestel et al.'s³⁰ study, involving 213 Flemish preschoolers, illustrated the importance of active opportunities, both structured and unstructured, throughout the preschool day. Preschoolers' hourly PA patterns were characterized by several troughs in PA, indicating that the present focus on academic preparation in the Flemish preschool curriculum introduces blocks of sedentary classroom time.¹⁴ Vale et al.¹⁶ found in their study a higher contribution of the structured PA sessions toward preschoolers' overall preschool PA (i.e., 33% for MVPA and 28% for LMVPA) compared to our study. However, these findings should be interpreted with care as a different set of accelerometer cut points was used and it is unknown how this contribution was calculated as the PA levels during the session itself were not reported.

Limitations of the current study must also be acknowledged. The sample used is not representative of all preschool children. Furthermore, the measurement period was short in duration (i.e., two days of accelerometer recordings were used per child), limiting the generalizability of the present findings. Second, this study was observational and no evidence of causality could be obtained. A final limitation is that the single axis, hip-mounted GT1M Acti-Graph accelerometer is unable to accurately measure certain types of activities (e.g., riding bikes, climbing, and swimming). A strength of this study is the use of accelerometers, enabling objective quantification of the sedentary and PA levels during the structured PA session, the time at preschool, and the time after preschool. This study had also the advantage of evaluating an existing and realistic situation.

5. Conclusion

The present findings suggested that more PA imposed during preschool time through a teacher-led structured PA session was subsequently not met with correspondingly less PA or more sedentary time after preschool. A structured PA session integrated in the curriculum and delivered by educated preschool/child care staff has the potential to decrease daily sedentary time and increase daily PA in preschool-aged boys and girls. Based on the present findings, it can be recommended to include such sessions daily in the preschool/child care program. However, the ideal amount and frequency of these sessions still needs to be determined.

Practical implications

- A teacher-led structured PA session included in the preschool curriculum is an important opportunity during the preschool day to acquire PA.
- Preschool-aged boys and girls did not compensate for the extra PA in preschool through a teacher-led structured PA session with correspondingly less PA or more sedentary time after preschool.

- The present study provided some evidence that teacher-led structured PA sessions should be included daily in the preschool curriculum.

Acknowledgements

EVC is a recipient of a PhD-scholarship from the Research Foundation – Flanders (FWO B/10525/01).

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