The contribution of preschool playground factors in explaining children's physical activity during recess

Greet Cardon*1, Eveline Van Cauwenberghe1, Valery Labarque2, Leen Haerens3 and Ilse De Bourdeaudhuij1

Address: 1Department of Movement and Sports Sciences, Ghent University, Watersportlaan 2, 9000 Ghent, Belgium, 2European University College Brussels, Research Center for Education and Welfare, Campus Nieuwland, Nieuwland 168, 1000 Brussels, Belgium and 3Research Foundation Flanders, Ghent University, Watersportlaan 2, 9000 Ghent, Belgium

Email: Greet Cardon* - greet.cardon@ugent.be; Eveline Van Cauwenberghe - eveline.vancauwenberghe@ugent.be; Valery Labarque - valery.labarque@ehsal.be; Leen Haerens - leen.haerens@ugent.be; Ilse De Bourdeaudhuij - Ilse.deboureaudhuij@ugent.be

* Corresponding author

Abstract

Background: Low levels of physical activity are characteristic in preschoolers. To effectively promote physical activity, it is necessary to understand factors that influence young children’s physical activity. The present study aimed to investigate how physical activity levels are influenced by environmental factors during recess in preschool.

Methods: Preschool playground observations and pedometry during recess were carried out in 39 randomly selected preschools (415 boys and 368 girls; 5.3 ± 0.4 years old). In order to examine the contribution of playground variables to physical activity levels, taking adjustment for clustering of subjects within preschools into account, multilevel analyses were conducted.

Results: During recess boys took significantly more steps per minute than girls (65 ± 36 versus 54 ± 28 steps/min). In both genders higher step counts per minute were significantly associated with less children per m² and with shorter recess times. Only in boys a hard playground surface was a borderline significant predictor for higher physical activity levels. In girls higher step counts were associated with the presence of less supervising teachers. Playground markings, access to toys, the number of playing or aiming equipment pieces and the presence of vegetation or height differences were not significant physical activity predictors in both genders.

Conclusion: In preschool children physical activity during outdoor play is associated with modifiable playground factors. Further study is recommended to evaluate if the provision of more play space, the promotion of continued activity by supervisors and the modification of playground characteristics can increase physical activity levels in preschoolers.

Background

The childhood obesity epidemic is affecting even preschool children and reduced physical activity is an important contributor to this problem [1-4]. The National Association for Sport and Physical Education [5] suggests that preschool-aged children accumulate at least 120 min-
utes of physical activity per day, one-half of that time in structured physical activity and the remaining in unstructured free-play settings. However, according to the literature, preschoolers are characterized by low levels of physical activity and high levels of sedentary behaviour [6,7] and in previous research in 76 Flemish children attending preschool, it was shown that only 26% of the children accumulated at least 120 minutes of total physical activity per day [8]. Hence, there is an urgent need for effective interventions aimed at increasing physical activity in preschoolers. However, to effectively promote physical activity, it is necessary to understand the factors that influence physical activity in this young age group.

According to the recent review of Davison and Lawson [9], the role of supportive environment is important as a trigger of physical activity, particularly in children. However, few studies, focusing on environmental correlates of physical activity, included preschool children. Furthermore, these studies mainly focused on the home environment, like availability of home equipment and play spaces [10], and on local conditions, like neighbourhood safety [11,12].

Besides the home environment, the preschool environment may play an important role in achieving adequate physical activity levels for young children since in many countries most children spend extensive time in preschools. However, Pate et al [13], Finn et al [14] and Dowda et al [15] reported low levels of physical activity during preschool attendance. The latter two studies [14,15] also reported significant differences in physical activity levels between children in different preschools and advocated the provision of sufficient space for the children, teacher-training and the organisation of physical activities at preschool. Furthermore, Boldemann et al [16] found in a sample of 197 4- to 6-year-olds that spacious preschool environments with trees, shrubbery, and broken ground triggered physical activity.

In most preschool programs, break times with unstructured free play are scheduled for more periods each day, making it an important environmental factor for the promotion of physical activity. While the terminology of break time at pre-school may differ across countries, in the present study the term "recess" is used. Recess is typically held outdoors and allows children to move freely. However, it was shown that 4- to 5-year-old children spent the majority of recess break time in sedentary activities [17]. In the literature, different opportunities, like playground redesign, paintings of court markings, fun trails and hopscotches [18-20], provision of game equipment [21], and teacher supervision [22], have been evaluated in the scope of activity engagement at recess in elementary school children. However it is unclear which playground factors correlate with physical activity during recess in preschool environments. If policies are to be designed and disseminated for the purpose of increasing physical activity among preschool children, then those policies should be developed on the basis of an improved understanding of basic aspects of physical activity in early childhood. Hence the main purpose of the present study is to determine which environmental factors contribute to physical activity levels during recess in preschool boys and girls. Additionally gender differences in physical activity levels during recess will be explored.

**Methods**

**Subjects**

The study was executed in Flanders, the Dutch speaking part of Belgium, located in the centre of Europe. In Flanders almost all elementary schools have a public preschool program (2213 schools with a preschool program; 95%), which allows children to participate from the age of 2.5 years old. The programs are free and virtually all children attend. Since they are organized in the elementary school settings, large and safe indoor and outdoor spaces to play are available for most preschool programs. Moreover, all preschool programs are lead by college educated teachers. A random sample of 45 preschools from 40 different municipalities in Flanders was asked to participate in the study. A sample of 40 schools agreed to participate. All parents (829) of the 4- and 5-year-old children of the 40 participating schools were informed about the study by an information letter. The evaluations were considered to be part of the psychological, medical and social counselling provided by the school, for which all parents signed a consent form. The study was approved by the Ethical committee of the Institutional Review Board at Ghent University.

One school was excluded due to rainy weather on the three days of measurements attempts. Data for 27 children were omitted due to measurement errors or unrealistic data (< 15 steps recorded), possibly due to resetting. The final sample consisted of 415 boys and 368 girls (see table 1) from 39 preschools (15 to 30 children from each school). Measurements were performed between October 2006 and February 2007, which is winter time in Belgium. The average day temperature during data collection was 7 degrees Celsius.

**Measures and procedure**

**Physical activity levels**

Step counts were assessed using the Yamax Digi-walker pedometer TYPE SW-200 (Yamax corp, Japan), which is an unobtrusive instrument measuring 19 mm × 39 mm × 52 mm that uses a horizontal spring-suspended mechanical lever arm to measure vertical movement. Pedometry has been recommended due to children’s intermittent...
and the numbers of teachers supervising during the PA
of playing equipment (e.g. swings, slides, climbing racks)
(e.g. goals, poles with one or more baskets), the numbers
10% of the children, The numbers of aiming equipments
differences, and availability of toys for a minimum of
faces were also coded as “present”), vegetation, height
tors were recorded: markings, soft surface (partly soft sur-
were not included (e.g. none accessible field due to wet
play space per child. Playground features that were not
preschools, a single-predictor two-level model (pupil-
school) was used. Because most studies in children
showed gender differences in types of physical activity
 correlates [9,27] analyses examining the contribution of
playground variables to physical activity levels were con-
ducted in boys and girls separately. To investigate the Uni-
variate relationships between step counts and each of the
independent variables (number of children per m²,
number of supervising teachers, recess duration, number
of playing equipments, number of aiming equipment
pieces, presence of a soft surface, markings, height differ-
ences, vegetation, and the access to toys) a single-predic-
tor two-level (school-pupil) model was used. To test the
significance of the variance at the school level Z-scores
were calculated. Intra-school correlation was calculated to
assess a measure of similarity between the same pupils in
each of the schools. Intra-school correlations measure the
extent to which step counts of pupils in one school resem-
ble to each other as compared to those from pupils in dif-
ferent schools; it gives a measure of the percentage of
variance in step counts that may be attributed to differ-
ences between schools. The alpha level was set at 0.05 for
all analyses.

Results
The average number of children per m² was 0.15 (± 0.08,
range 0.02–0.44). The average recess duration was 24.27
minutes (± 11.05, range 9–50). The mean number of aim-
ing equipment pieces on the playground was 1.79 (± 1.2,
range 0–4) and schools had on average 2.53 (± 2.15, range
0–9) pieces of playing equipment on the playground.
Markings were present on 24 of the 39 playgrounds, 20
playgrounds had height differences, the playground sur-
face was partly soft in 20 schools, in 23 schools toys were
available for minimum 10 % of the children and in 21
preschools vegetation was present on the playground.

Table 1: Descriptive characteristics and steps per minute of the
sample by sex.

|                          | Boys N= 415 | Girls N= 368 |
|--------------------------|------------|-------------|
| Age (years)              | 5.2 (± 0.4) | 5.3 (± 0.4) |
| Length (m)               | 1.14 (± 0.05) | 1.13 (± 0.05) |
| Weight(KG)               | 20.6 (± 3.5) | 20.2 (± 3.2) |
| Steps per minute         | 65 (± 36)  | 54 (± 28)   |
| Steps per minute square root | 7.7 (± 2.1) | 7.1 (± 1.9) |

Playground factors
Factors of the playground environment served as inde-
pendent variables. All playground features were recorded
by members of the research team, who visited the schools.
The presence or absence of the following playground fac-
tors were recorded: markings, soft surface (partly soft sur-
faces were also coded as "present"), vegetation, height
differences, and availability of toys for a minimum of
10% of the children, The numbers of aiming equipments
(e.g. goals, poles with one or more baskets), the numbers
of playing equipment (e.g. swings, slides, climbing racks)
and the numbers of teachers supervising during the PA
registrations were counted by the researchers. The
researchers measured all playgrounds to determine the
play space per child. Playground features that were not
accessible for the preschoolers during the measurements,
were not included (e.g. none accessible field due to wet
grass). Additionally, all playgrounds were photographed
for verification by the first author.

Statistical analyses
Preliminary analyses consisted of descriptive statistics of
sample characteristics using SPSS for windows (12.0).
Univariate regression analyses were conducted using
MLwiN version 2.02. As the dependent variable was
skewed to the right, the square root was taken to improve
the normality of this variable. To investigate the Univari-
ate relationships between gender and step counts, taking
into account adjustment for clustering of subjects within
preschools, a single-predictor two-level model (pupil-
school) was used. Because most studies in children
showed gender differences in types of physical activity

Pattern of physical activity [23] and findings of McKee et
al [24] supported the utility of the Digiwalker pedometer
for assessing physical activity in young children. They
reported a strong relationship between the Children's
Activity Rating Scale and step counts per 3 minutes in 30
3- to 4-year-olds while undertaking normal school activi-
ties during a 1-hr period in a nursery setting. Furthermore
Eisenmann and Wickel [25] compared the cost of locomo-
tion between a 6-year-old and a 12-year-old and con-
cluded that the number of steps taken is equivalent
among humans of varying body size if taken at the same
speed. Moreover a previous study showed good correla-
tion with accelerometer data (r = 0.73) and good recep-
tivity of a pedometer in preschool children [26]. Pedometers
were attached at the waist, above the right hip. To mini-
mize reactivity, the pedometers were attached to the chil-
dren and the children were familiarized with the
instrument upon arrival at school, thus 90 to 120 minutes
before registration. Pedometers were reset to zero when
leaving the building for recess and step counts were regis-
tered when re-entering after recess. Steps per minute were
calculated, making use of a stop watch to measure recess
durations. The stop watch was started when 50 % of the
children had entered the playground and stopped when
50 % had left the playground. To avoid losing recess time,
pedometers were not sealed, but the children were told
not to open the pedometers. Moreover it was observed in
a previous study that many children have difficulty open-
ing the pedometer [26]. Registrations were only per-
formed when it was not raining during recess, thus when
the weather permitted outdoor play.
Variance at the school level was borderline significant among boys \((Z = 3.4, p < 0.07)\) and girls \((Z = 3.6, p = 0.06)\). Among boys, 27% of the variance in step counts was attributed to the differences between schools, among girls 35% of the variance in step counts was attributed to the differences between schools. Being a girl as compared to a boy was associated with significantly lower activity levels \((\beta = -0.622, SE = 0.280, p \leq 0.05)\). In table 2 Univariate multi-level analyses of the associations between playground factors and step counts per minute (square root transformed) can be found. Among boys step counts were significantly predicted by number of children per m\(^2\) \((\beta = -4.635, SE = 2.104, p \leq 0.05)\) and recession duration \((\beta = -0.001, SE = 0.000, p \leq 0.001)\). The presence of a soft playground surface was a borderline significant predictor \((\beta = -0.687, SE = 0.369, p \leq 0.07)\). Among girls, step counts were significantly predicted by number of children per m\(^2\) \((\beta = -5.411, SE = 2.163, p \leq 0.01)\), number of supervising teachers \((\beta = -0.526, SE = 0.239, p \leq 0.05)\) and recession duration \((\beta = -0.001, SE = 0.000, p \leq 0.001)\). Lower numbers of children per m\(^2\) and shorter recesses were related to increased step counts per minute in both sexes. The presence of hard surfaces was related to higher activity levels among boys. Less supervising teachers on the playground was related to higher activity levels among girls. The number of playing equipments, number of aiming equipment pieces, presence markings, height differences, vegetation and the access to toys were not significantly related to step counts in both genders. Non-transformed data analyses gave identical results, except for a harder playground surface, which was significantly associated with higher step counts in boys \((p \leq 0.05)\).

### Discussion

In the present study in preschools, average step count values per minute were 65 in boys and 54 in girls. The higher step counts in boys \((* p \leq 0.07, ** p \leq 0.05, *** p \leq 0.001)\) can be found. Among boys step counts were significantly predicted by number of children per m\(^2\) \((\beta = -4.635, SE = 2.104, p \leq 0.05)\) and recession duration \((\beta = -0.001, SE = 0.000, p \leq 0.001)\). The presence of a soft playground surface was a borderline significant predictor \((\beta = -0.687, SE = 0.369, p \leq 0.07)\). Among girls, step counts were significantly predicted by number of children per m\(^2\) \((\beta = -5.411, SE = 2.163, p \leq 0.01)\), number of supervising teachers \((\beta = -0.526, SE = 0.239, p \leq 0.05)\) and recession duration \((\beta = -0.001, SE = 0.000, p \leq 0.001)\). Lower numbers of children per m\(^2\) and shorter recesses were related to increased step counts per minute in both sexes. The presence of hard surfaces was related to higher activity levels among boys. Less supervising teachers on the playground was related to higher activity levels among girls. The number of playing equipments, number of aiming equipment pieces, presence markings, height differences, vegetation and the access to toys were not significantly related to step counts in both genders. Non-transformed data analyses gave identical results, except for a harder playground surface, which was significantly associated with higher step counts in boys \((p \leq 0.05)\).

| Factors          | Univariate multi-level analyses \(\beta\) (SE) | Boys       | Girls      |
|------------------|---------------------------------------------|------------|------------|
| Children/m\(^2\) | -4.635 (2.104)*                            | -5.411 (2.163)** |            |            |
| Supervising teachers | -0.347 (0.235)                         | -0.526 (0.239)* |            |            |
| Aiming equipment | 0.106 (0.152)                               | 0.010 (0.016) |            |            |
| Playing equipment | -0.056 (0.084)                             | -0.235 (0.418) |            |            |
| Recess duration  | -0.001 (0.000)**                           | 0.001 (0.000)**|            |            |
| Ground Surface   | -0.687 (0.369)(*)                          | -0.601 (0.392) |            |            |
| Markings         | 0.613 (0.384)                              | 0.424 (0.412) |            |            |
| Vegetation       | -0.044 (0.390)                             | -0.386 (0.403) |            |            |
| Height differences | 0.614 (0.380)                             | 0.459 (0.401) |            |            |
| Toys             | -0.150 (0.392)                             | -0.035 (0.089) |            |            |

\(\ast p \leq 0.07, \ast \ast p \leq 0.05, \ast \ast \ast p \leq 0.001\)

An interesting finding of the present study is the fact that children were less active when more teachers were supervising. However this was only significant in girls. This can be explained by the fact that many teachers supervise sitting down or standing still. Since many children, and presumably especially girls, prefer to stay close to the teachers, more supervising teachers may cause decreased activity levels. Consequently efforts seem useful to inform and encourage present and future preschool teachers to promote activity during recess (e.g. by playing with the children or at least encourage active play). Incorporating physical activity promotion in the training of future pre-
school teachers may enable them to implement the principles in their daily work and to enter into a professional career with a positive attitude toward physical activity promotion. According to the findings of Boldemann et al [8] in environments with trees, shrubbery and broken ground step counts/min were higher than in delimited environments with little vegetation. In the present study height differences and vegetation were present in about half of the schools but the presence was not significantly associated with higher step counts. This can be explained by the fact that the extend of the height differences and vegetation on the playgrounds was only limited. On the other hand a harder ground surface was a borderline significant predictor for higher step counts in boys only. A possible explanation is that the spontaneous behaviour may differ between both sexes, with boys being more triggered by harder ground surfaces, which are mainly used for more sports-related, competitive activities.

A remarkable finding of the present study is the fact that the availability of toys, the presence of aiming or playing equipment, like swings or slides, and the presence of markings was not associated with more physical activity. Possibly the choice of toys (e.g. hoops), equipment pieces (e.g. swing) or markings (mainly field markings) were not optimal in the observed preschools and results may be different when focusing on certain types of toys, equipment or markings. Another explanation may be that toys and equipment often lead to standing in line to use the piece of toy or equipment. In the study of Zask et al [22] equipment availability was also not significant PA predictor in elementary school children, except for balls. Further study is needed to evaluate if specific toys, equipments or markings may be more successful to trigger physical activity and to evaluate if triggering may appear when they are available for all children.

A first limitation of the present study is that all data were collected during winter. Therefore physical activity levels possibly suffered from seasonal influence. However Belgium has a mild climate, measurements were only taken when the weather permitted outdoor playing and according to the findings of Fisher et al [29] seasonality plays only a limited role in physical activity in young children.

A second limitation is the use of pedometers, which may not capture or underestimate some activities among young children, like swinging or crawling. Strengths of the present study are the relatively large sample size, the use of an objective physical activity measure and observation of the playground environment, and the use of multilevel analyses to take into account adjustment for clustering of subjects within preschools.

Conclusion
The present study contributed to the dearth of literature focusing on the correlates of physical activity in preschool children. It can be concluded from the present study that in preschool children physical activity during recess is associated with modifiable playground factors. Since many children attend preschool, there is a great potential to increase activity levels in preschoolers. Studying the effects of intervening on these factors is of interest. Meanwhile it seems plausible to recommend preschools to provide sufficient play space, to encourage supervisors to promote activity during recess, and to organize several recess periods during the day.

Competing interests
The author(s) declare that they have no competing interests.

Authors’ contributions
GC, VL and IDB conceived the study and contributed to the planning and the design of the study. GC, VL and EVC collected the data and conducted data manipulation and analyses. LH contributed to the statistical analyses. GC wrote the manuscript. VL, IDB and EVC supplied comments. All authors read and approved the final manuscript.

Acknowledgements
The authors would like to thank Willem Van Delsen, and Anke Peeters for their assistance in the data collection and all the children and teachers collaborating in this study.

References
1. Dietz WH: Periods of risk in childhood for the development of adult obesity – what do we need to learn? J Nutr 1997;188S-65.
2. Hedley AA, Ogden CL, Johnson CL, Carroll MD, Curtin LR, Flegal KM: Prevalence of overweight and obesity among US children, adolescents, and adults, 1999–2002. JAMA 2004, 291:2847-2850.
3. Jago R, Baranowsky T, Baranowsky JC, Thompson D, Greaves KA: BMI from 3–6 y of age is predicted by TV viewing and physical activity, not diet. Int J Obes 2005, 29:557-564.
4. Janz KF, Levy SM, Burns TL, Turner JC, Willing MC, Warren JJ: Fatness, physical activity, and television viewing in children during the adiposity rebound period: The Iowa bone development study. Prev Med 2002, 35:563-571.
5. National Association for Sport and Physical Education: Active start: A Statement of Physical Activity Guidelines for Children Birth to Five years. Reston, VA: National Association for Sport and Physical Education Publications; 2002.
6. Reilly JJ, Jackson DM, Montgomery C, Kelly LA, Slater C, Grant S, Paton JY: Total energy expenditure and physical activity in young Scottish children mixed longitudinal study. Lancet 2004, 363:211-212.
7. Kelly LA, Reilly JJ, Grant S, Paton JY: Low physical activity levels and high levels of sedentary behaviour are characteristic of rural Irish primary school children. Irish Med J 2005, 98(5):138-141.
8. Cardon G, De Bourdeaudhuij I: Are preschool children active enough? Objectively measured physical activity levels. Res Q Exerc Sport in press.
9. Davison KK, Lawson CT: Do attributes in the physical environment influence children’s physical activity? A review of the literature. *IJBNPA* 2006, 3:19.
10. Sallis JF, Nader PR, Broyes SL, Berry CC, Elder JP, McKenzie TL, Nelsons JA: Correlates of physical activity at home in Mexican-American and Anglo-American preschool children. *Health Psychology* 1993, 12(5):390-398.
11. Burdette H, Whitaker RC: A national study of neighborhood safety, outdoor play, television viewing and obesity in preschool children. *Pediatrics* 2005, 116:657-662.
12. Timperio A, Crawford D, Telford A, Salmon J: Perceptions about the local neighbourhood and walking and cycling among children. *Prev Med* 2004, 38(1):29-47.
13. Pate RR, Pfeiffer KA, Trost SG, Ziegler P, Dowda M: Influences of preschool policies and practices on children's physical activity. *J Com Health* 2004, 29(3):183-196.
14. Boldeman C, Blennow M, Dal H, Martensson F, Raustorp A, Yuen K, Wester U: Impact of pre-school environment upon children’s physical activity and sun exposure. *Prev Med* 2006, 42:301-308.
15. McKenzie TL, Sallis JF, Elder JP, Berry CC, Nader PR, Zive MM, Broyes SL: Physical activity levels and prompts in young children at recess: a two-year study of a bi-ethnic sample. *Res Q Exerc Sport* 1997, 68:195-202.
16. Ridgers ND, Stratton G, Fairclough SJ, Twisk JWR: Children’s physical activity levels during school recess: a quasi-experimental intervention study. *IJBNPA* 2007, 4:19.
17. Stratton G: Promoting children’s physical activity in primary school: an intervention study using playground markings. *Ergonomics* 2000, 43:1538-1546.
18. Stratton G, Mullan E: The effect of multicolour playground markings on children’s physical activity level during recess. *Prev Med* 2005, 41:828-833.
19. Verstraete SJM, Cardon DM, De Clercq DLR, De Bourdeaudhuij IMM: Increasing children's physical activity levels during recess periods in elementary schools: the effects of providing game equipment. *Eur J Public Health* 2006, 16(4):415-419.
20. Zask A, van Beurden E, Barnet L, Brooks LO, Dietrich UC: Active school playgrounds-mytch or reality? Results of the "Move it Groove it" project. *Prev Med* 2001, 33:402-408.
21. Bailey R, Olson J, Pepper S, Porszasz J, Barstow T, Cooper D: The level and tempo of children’s physical activities: an observational study. *Med Sci Sports Exerc* 1995, 27:1033-1041.
22. McKee DK, Boreham CAG, Murphy PH, Nevill AM: Validation of the Digiwalker™ pedometer for measuring physical activity in young children. *Ped Exerc Sci* 2005, 17:345-352.
23. Eisenmann JC, Wickel EE: Moving on land: an explanation of physical activity in young children. *Eur J Appl Physiol* 2005, 93(4):440-446. Epub 2004 Oct 21.
24. Cardon G, De Bourdeaudhuij I: Comparison of pedometer and accelerometer measures of physical activity in pre-school children. *Pediatr Exerc Sci* 2007, 19(2):205-214.
25. Sallis J, Prochaska J, Taylor W: A review of correlates of physical activity of children and adult scents. *Med Sci Sports Exerc* 2000, 32:963-975.
26. Jackson DM, Reilly JJ, Kelly LA, Montgomery C, Grant S, Paton JY: Objectively measured physical activity in a representative sample of 3- to 4-year-old children. *Obes Res* 2003, 11:420-425.
27. Fisher A, Reilly JJ, Montgomery C, Kelly LA, Williamson DM, Jackson DM, Paton JY, Grant S: Seasonality in Physical activity and sedentary behavior in young children. *Ped Exc Sci* 2005, 17:31-40.