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## Environmental determinants of outdoor play in children

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# Environmental Determinants of Outdoor Play in Children

## A Large-Scale Cross-Sectional Study

Marie-Jeanne Aarts, MSc, Wanda Wendel-Vos, PhD, Hans A.M. van Oers, PhD, Ien A.M. van de Goor, PhD, Albertine J. Schuit, PhD

**Background:** Outdoor play is a cheap and natural way for children to be physically active.

**Purpose:** This study aims to identify physical as well as social correlates of outdoor play in the home and neighborhood environment among children of different age groups.

**Methods:** Cross-sectional data were derived from 6470 parents of children from 42 primary schools in four Dutch cities by means of questionnaires (2007–2008). Multivariate sequential Poisson GEE analyses were conducted (2010) to quantify the correlation between physical and social home and neighborhood characteristics and outdoor play among boys and girls aged 4–6 years, 7–9 years, and 10–12 years.

**Results:** This study showed that next to proximal (home) environmental characteristics such as parental education (RR=0.93–0.97); the importance parents pay to outdoor play (RR=1.32–1.75); and the presence of electronic devices in the child's own room (RR=1.04–1.15), several neighborhood characteristics were significantly associated with children's outdoor play. Neighborhood social cohesion was related to outdoor play in five of six subgroups (RR=1.01–1.02), whereas physical neighborhood characteristics (e.g., green neighborhood type, presence of water, diversity of routes) were associated with outdoor play in specific subgroups only.

**Conclusions:** Neighborhood social cohesion was related to outdoor play among children of different age and gender, which makes it a promising point of action for policy development. Policies aimed at improving physical neighborhood characteristics in relation to outdoor play should take into account age and gender of the target population.

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### Background

As in many other Western countries, the majority of primary school children in the Netherlands do not meet the recommended health guidelines for physical activity.<sup>1</sup> Because of the health risks related to physical inactivity,<sup>2,3</sup> it is important to find appropriate ways to stimulate physical activity in children. A natural way for children to be physically active is by means of outdoor play. Time spent outdoors is consistently related

to children's physical activity level,<sup>4–10</sup> which is increased during outdoor play.<sup>11</sup> Moreover, in contrast to organized sports participation, outdoor play is cheap, informal, and easily accessible.<sup>12</sup>

Social cognitive theories state that, next to individual characteristics, environmental characteristics play a role in health behavior such as children's physical activity.<sup>13–15</sup> For example, the neighborhood area available for recreation is positively related to physical activity in children aged 4–7 years.<sup>16</sup> Low-walkable lollipop-style neighborhoods tend to be beneficial for outdoor play among children aged 6–12 years.<sup>17</sup> Conversely, road safety and "stranger danger" are two major sources of parental concern that may inhibit children's outdoor play.<sup>18</sup> Further, social factors are even more important predictors of time spent outdoors among children aged 5–6 years and 10–12 years, then the built environment.<sup>9</sup>

Most studies on the abovementioned topics are conducted in the U.S. or Australia and cannot be easily extrapolated to Europe. One Dutch study<sup>19</sup> showed that

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physical activity was related to the built environment among children aged 6–11 years, but this study did not address social environmental characteristics. Further, different environmental characteristics may be related to physical activity behavior in children of different age groups. Younger children, for example, have less autonomy to travel long distances by themselves and they may experience other environmental barriers or impetuses to be physically active than older children.<sup>20,21</sup> Special attention should therefore be given to the role of different environmental correlates of outdoor play among children of different age groups. The aim of the present study is to identify physical as well as social correlates of outdoor play in the home and neighborhood environment of children of different age groups (4–6, 7–9, and 10–12 years).

## Methods

### Study Setting

Cross-sectional data were collected between September 2007 and January 2008 from parents of children of 42 primary schools in four medium-sized Dutch cities (Tilburg, Breda, 's-Hertogenbosch and Roosendaal) in the Southern part of the Netherlands, which were comparable regarding the number of inhabitants (77,450–201,259); degree of urbanization (727–1716 citizens per km<sup>2</sup>); and composition of their population (e.g., percentage of non-Western immigrants 9.9%–13.4%). The selection procedures and characteristics of the participating cities are described in more detail elsewhere.<sup>22</sup>

### Study Population

Data were collected among parents of children aged 4–12 years. In the Netherlands, children in this age group attend primary school, which in most cases is close to or within the area of residence. With the exception of those schools that were already participating in other (research) projects aimed at physical activity in children ( $n=34$ ), all regular primary schools ( $n=149$ ) in the four cities were invited by letter, followed up by telephone, to participate in the survey. Approximately one third of all invited schools agreed to participate ( $n=42$ ). As outlined elsewhere,<sup>22</sup> the schools in the current study were representative of the total population of schools in the participating municipalities in terms of school size, SES, and the type of neighborhood. In total, 11,094 parents were provided with a questionnaire.

Because no medical or physical measurements were conducted and considering the negligible (psychological) burden to fill in the questionnaire, no ethics approval was required according to the Dutch Central Committee on Research Investigating Human Subjects. Parents were given written information about the study, and by returning the questionnaire they gave consent for the inclusion of their data in the study. Response rate was 60%, resulting in 6624 completed and returned questionnaires. During data entry, 12 questionnaires could not be read and 11 questionnaires were removed because they were completely empty. Questionnaires were excluded from further analyses because of missing values on age or gender of the child ( $n=14$ ) or outdoor play ( $n=82$ ). Further, questionnaires of children living more than 3 days per week on another address than the address described in the questionnaire were removed ( $n=35$ ).

The final database thus encompassed 6470 respondents. Based on our power analysis described elsewhere,<sup>22</sup> the current study provided adequate power to detect small effects ( $f^2=0.02$ ).

### Questionnaire

The questionnaire for parents was based on questionnaires used in previous Dutch research<sup>23</sup> and included the following topics: time spent by the child on outdoor play and several physical and social environmental characteristics in the home and neighborhood environment. In addition, parental SES (education, income, ethnicity) and height and weight of the child were reported by parents.

Throughout the questionnaire, “neighborhood” was defined as the area that could be reached by parents in 10 to 15 minutes by foot or in 5 to 8 minutes by bike from the respondent’s residence (street network distance). This matches the general perception of a typical Dutch neighborhood and, in comparison with distances in meters, distances in minutes are more easily interpreted by the respondents.<sup>24,25</sup> Further, these distances are reasonable for parents to accompany their children for the purpose of outdoor play.

### Measures

In all analyses, the dependent variable outdoor play (minutes per week) was calculated by multiplying the number of days per week the child was involved in outdoor play (considering a typical week in the past month) by the minutes per day the child was involved in outdoor play (exact formulation is given in Appendix A, available online at [www.ajpm-online.net](http://www.ajpm-online.net)). Besides the type of neighborhood and neighborhood SES, which were based on pre-existing databases linked to the respondent’s postal code,<sup>26,27</sup> all independent variables were reported by parents (exact formulation/calculation is given in Appendix A, available online at [www.ajpm-online.net](http://www.ajpm-online.net)). BMI of the children was calculated and percentage of children with overweight and obesity (as determined by age- and gender-specific cutoff points<sup>28</sup>) was determined.

### Statistical Analyses

Analyses were conducted in 2010 and were reported separately for boys and girls in age groups 4–6, 7–9, and 10–12 years. Descriptive analyses were conducted with SPSS, version 17.0. Conceptually related items were summed when internal consistency was acceptable (Cronbach’s  $\alpha>0.6$ ), otherwise items were treated separately. Missing values were not imputed, unless it concerned a missing value on one of the items of a sum score consisting of more than four items. In that case, the missing value was replaced by the mean of the other values. If more than one item was missing within one sum score, the sum score was not calculated. ANOVAs and chi-square tests with Bonferroni post hoc correction were performed to assess differences ( $p<0.05$ ) in characteristics between boys and girls within each age group. Multivariate regression analyses were conducted with SAS, version 9.1.

In order to correct for non-normality of the dependent variable and its error terms and because the outcome measure was a count variable, Poisson distribution was applied.<sup>29,30</sup> As a consequence, exponents of the original regression coefficient estimates were calculated and interpreted as relative rates (RRs). The RR is interpreted as the decrease or increase in the amount of time children spend on outdoor play, as the independent variable increases with 1 unit. Hence, an RR of 1.10 indicates an increase of 10% in outdoor play as the environmental

characteristic increases with 1 unit. An RR of 0.90 likewise indicates a decrease of 10%. Because of the Poisson analysis, the proportion of explained variance could not be reported. All analyses were adjusted for parental education as indicated by highest completed level of education of the parent who filled in the questionnaire; in the majority of cases, this was either the biological mother (81.5%) or father (11.3%). Parental education is considered a good indicator for SES in the Netherlands.<sup>31,32</sup> Because data were collected via primary schools and outdoor play shows clustering within schools (intraclass correlation=0.06,  $F$ -value=14.66,  $p$ -value<0.001), generalized estimating equations (GEE) analysis with school as a clustering variable was applied in order to correct for the multilevel structure of the data.<sup>33,34</sup> In order to quantify the association between the environmental determinants and outdoor play when adjusted for the other environmental determinants, a forward sequential GEE analysis was performed. In a sequential analysis, variables enter the equation in a theory-based order.<sup>35</sup>

It was assumed that the proximal (home) environment is more closely related to children's physical activity than the distal (neighborhood) environment. Based on previous research, it was assumed that social environmental characteristics are more important than physical environmental characteristics.<sup>9</sup> Hence, the first step of the sequential analysis focused on parental education as a covariate. During the second step, a block of proximal (home) social variables was added to the model, followed by the third step

of introducing a block of proximal (home) physical variables. Subsequently, during the fourth step, a block of distal (neighborhood) social variables was added to the model, followed by the fifth step comprising the introduction of a block of distal (neighborhood) physical environmental characteristics. In order to prevent important variables to be excluded from the model in a forward analysis too easily, a more liberal probability level of  $p>0.15$  was chosen to decide on deletion of variables from the model.<sup>35,36</sup> The sequential GEE analysis ended when all variables in the model reached significance. In the final multivariate models, only those variables with a  $p$ -value <0.05 are shown. Prior to entry into the multivariate models, correlations between independent variables were computed and variables with a correlation of  $r>0.5$  were excluded from the analyses in order to prevent collinearity.

## Results

The characteristics of the study population are summarized in Table 1. There were no significant differences in characteristics between boys and girls of the same age groups, except for amount of time spent on outdoor play, which was higher for boys compared to girls in the age groups 7-9 years and 10-13 years ( $p$ -value=0.0000). The

**Table 1.** Characteristics of the study population

Characteristics	Aged 4-6 years <sup>a</sup>		Aged 7-9 years		Aged 10-12 years <sup>a</sup>	
	Boys (n=1067)	Girls (n=1106)	Boys (n=1239)	Girls (n=1144)	Boys (n=937)	Girls (n=977)
Age (years)	5.0 (0.83)	5.0 (0.81)	8.0 (0.81)	8.1 (0.82)	10.7 (0.71)	10.7 (0.71)
BMI (kg/m <sup>2</sup> ) <sup>b</sup>	15.4 (1.98)	15.3 (2.07)	16.2 (2.68)	16.2 (2.58)	17.5 (3.05)	17.4 (2.82)
Overweight (%) <sup>c</sup>	7.5	9.2	9.4	12.6	9.9	9.9
Obesity (%) <sup>c</sup>	3.7	3.5	3.1	3.2	2.2	2.2
Ethnicity (% immigrants) <sup>d</sup>	23.3	21.7	22.1	26.1	23.6	24.6
Parental education (%)						
Low <sup>e</sup>	25.8	24.8	27.3	28.9	33.1	33.6
Intermediate <sup>f</sup>	35.8	38.1	34.8	35.1	34.1	33.5
High <sup>g</sup>	38.4	37.0	38.0	35.9	32.9	32.9
Net household income (euros per month)	2780 (1291)	2882 (1391)	2839 (1327)	2734 (1395)	2727 (1386)	2642 (1335)
Outdoor play (minutes/week)	417 (271)	390 (260)	<b>449 (287)*</b>	<b>396 (272)*</b>	<b>443 (294)*</b>	<b>373 (291)*</b>

Note: Values are M (SD) unless otherwise specified. Boldface indicates significance.

<sup>a</sup>In the Netherlands, children aged 4-12 years are educated together at the same primary school. In the current study sample, three children in the lowest grade were aged 3 years and 14 children in the highest grade were aged 13 years. These children were included in the lowest (4-6 years) and highest (10-12 years) age groups, respectively.

<sup>b</sup>Based on parental report of height and weight of their child

<sup>c</sup>Based on age- and gender-specific cutoff points as provided by Cole et al.<sup>28</sup>

<sup>d</sup>Percentage of children with at least one biological parent not born in the Netherlands

<sup>e</sup>No education, primary education, lower-level general secondary education, or lower-level vocational education

<sup>f</sup>Higher-level general secondary education, pre-university education, or intermediate vocational education

<sup>g</sup>Higher-level vocational education or university

\* $p<0.05$  in ANOVA (continuous variables) or  $\chi^2$  tests (categorical variables) with Bonferroni correction comparing means and percentages between boys and girls of the same age groups.



results of the forward sequential GEE analyses are summarized in Table 2. Parental education was negatively associated with outdoor play in all subgroups (RRs ranging from 0.93 to 0.97).

### Proximal Social Variables

Importance parents pay to outdoor play was positively associated with outdoor play in all subgroups (RRs ranging from 1.32 to 1.75), but the presence of rules in the household and the number of siblings were not significantly associated with outdoor play.

### Proximal Physical Variables

Living in a semidetached or duplex residence was positively associated with outdoor play among boys aged 4–6 years (RR=1.18) and living in a detached residence was negatively associated with outdoor play in girls aged 4–6 years (RR=0.86). Living in a flat or apartment was negatively associated with outdoor play among girls aged 4–6 years (RR=0.73) and boys aged 10–12 years (RR=0.77). Living in a rental property was positively associated with outdoor play among boys aged 4–6 years (RR=1.15), and absence of a garden was positively associated with outdoor play in girls aged 4–6 years (RR=1.13), but was negatively related to outdoor play among girls aged 7–9 years (RR=0.75). Presence of an electronic device in the child's own room was positively related to outdoor play in the highest age groups among boys (RR=1.15 and 1.12 for boys aged 7–9 and 10–12 years, respectively) and girls in all age groups (RR=1.04, 1.13, and 1.14 for girls aged 4–6, 7–9, and 10–12 years, respectively).

### Distal Social Variables

Neighborhood SES was significantly related to outdoor play in boys aged 4–6 years (RR=1.05); girls aged 4–6 years (RR=1.07); and girls aged 7–9 years (RR=1.07), indicating that a higher SES was related to less outdoor play. The degree of unoccupied houses was positively associated with outdoor play in boys aged 10–12 years (RR=1.05), and the presence of dog waste was positively associated with outdoor play in girls aged 4–6 years (RR=1.03).

Social safety was positively related to outdoor play in boys and girls aged 4–6 years (RR=1.02 and RR=1.01, respectively) and social cohesion was positively related to outdoor play in five of six subgroups (RRs ranging from 1.01 to 1.02). Satisfaction with social contacts was not related to outdoor play in any of the subgroups.

### Distal Physical Variables

Living in a city center was negatively associated with outdoor play among boys aged 7–9 years (RR=0.79) and

living in a city green area showed a positive association among girls aged 4–6 years (RR=1.16). The other neighborhood types also showed an association with outdoor play in some subgroups, but these results should be interpreted with caution, because of the low numbers. The degree of low- versus high-rise buildings; the presence of green and water (lake, pool, pond, or river) in the neighborhood; traffic situation; quality of sidewalks and bike lanes; the diversity of routes; and satisfaction with play facilities and public green space were unrelated to outdoor play in most subgroups. The presence of water did however show a positive association for boys aged 4–6 years (RR=1.04) and the diversity of routes was positively associated with outdoor play in girls aged 7–9 years (RR=1.03) and in boys aged 10–12 years (RR=1.08).

### Discussion

The present study showed that next to proximal environmental characteristics such as parental education, the importance parents pay to outdoor play, and the presence of electronic devices in the child's own room, several neighborhood characteristics were associated with children's outdoor play. Neighborhood social cohesion was positively associated with outdoor play in five of the six subgroups. The increase of 1%–2% in outdoor play per unit increase in social cohesion on a scale ranging from 6 to 30, and the fact that this variable is related to outdoor play among boys and girls of different age groups, makes it a potential interesting point of action for policy development. Because (combinations of) environmental characteristics can influence activity behavior of large populations for a prolonged period of time, such strategies to promote active living seem promising. With respect to the physical neighborhood characteristics, the current study showed different characteristics to be related to outdoor play among the different subgroups of age and gender. This warrants caution when generalizing associations between physical neighborhood characteristics and outdoor play from studies conducted within a specific age group of children to the general youth population.

Previous research<sup>16–18</sup> in the U.S. and Australia has shown that access to parks and recreational facilities, walkability of the neighborhood, and safety (either social or physical) can determine physical activity in children. The current study however did not show a consistent association between outdoor play and the presence of water or green in the neighborhood, or the distance to woodlands or parks. Also, parental satisfaction with public space and green space was not consistently associated with outdoor play. These contradictory findings could be due to the specific spatial planning structure in the Neth-

**Table 2.** Association between environmental characteristics and outdoor play for boys and girls: multivariate analyses<sup>a</sup>

Variables	Boys aged 4-6 years <sup>b</sup>	Girls aged 4-6 years <sup>b</sup>	Boys aged 7-9 years	Girls aged 7-9 years	Boys aged 10-12 years <sup>b</sup>	Girls aged 10-12 years <sup>b</sup>
<b>Covariate</b>						
Parental education	0.96 (0.95, 0.98)	0.97 (0.94, 0.99)	0.94 (0.92, 0.96)	0.95 (0.92, 0.97)	0.94 (0.91, 0.97)	0.93 (0.90, 0.96)
<b>Proximal social variables</b>						
Presence of rules in the household	—	—	—	—	—	—
Importance parents ascribe to outdoor play	1.44 (1.12, 1.48)	1.75 (1.42, 2.16)	1.75 (1.49, 2.06)	1.34 (1.12, 1.60)	1.32 (1.09, 1.61)	1.51 (1.26, 1.80)
Number of siblings	—	—	—	—	—	—
<b>Proximal physical variables</b>						
Type of residence: detached	—	0.86 (0.76, 0.98)	—	—	—	—
Type of residence: semidetached/duplex	1.18 (1.07, 1.29)	—	—	—	—	—
Type of residence: corner house	—	—	—	—	—	—
Type of residence: flat/apartment	—	0.73 (0.59, 0.89)	—	—	0.77 (0.59, 0.99)	—
Type of residence: other <sup>c</sup>	—	—	—	—	—	0.70 (0.50, 0.97)
Rental property	1.15 (1.03, 1.28)	—	—	—	—	—
Absence of a garden	—	1.13 (1.01, 1.26)	—	0.75 (0.59, 0.95)	—	—
Number of electronic devices (TVs/computers) in the household	—	—	—	—	—	—
Electronic devices (TV/computers) in child's own room	—	1.04 (1.01, 1.07)	1.15 (1.07, 1.23)	1.13 (1.04, 1.23)	1.12 (1.04, 1.21)	1.14 (1.04, 1.26)
<b>Distal social variables</b>						
Neighborhood SES <sup>d</sup>	1.05 (1.04, 1.09)	1.07 (1.03, 1.11)	—	1.07 (1.03, 1.11)	—	—
Degree of unoccupied houses	—	—	—	—	1.05 (1.02, 1.08)	—
Presence of trash and litter	—	—	—	—	—	—
Presence of dog waste	—	1.03 (1.00, 1.05)	—	—	—	—

(continued on next page)

Table 2. (continued)

Variables	Boys aged 4-6 years <sup>b</sup>	Girls aged 4-6 years <sup>b</sup>	Boys aged 7-9 years	Girls aged 7-9 years	Boys aged 10-12 years <sup>b</sup>	Girls aged 10-12 years <sup>b</sup>
Social safety	1.02 (1.01, 1.03)	1.01 (1.00, 1.03)	—	—	—	—
Social cohesion	1.01 (1.00, 1.02)	1.01 (1.00, 1.02)	1.02 (1.01, 1.03)	1.01 (1.00, 1.02)	—	1.02 (1.01, 1.04)
Satisfaction with social contacts	—	—	—	—	—	—
<b>Distal physical variables</b>						
Type of neighborhood: city center	—	—	0.79 (0.66, 0.94)	—	—	—
Type of neighborhood: city green	—	1.16 (1.02, 1.31)	—	—	—	—
Type of neighborhood: town center <sup>e</sup>	—	2.08 (1.59, 2.72)	1.41 (1.08, 1.86)	1.73 (1.21, 2.46)	—	—
Type of neighborhood: rural area	—	1.39 (1.15, 1.67)	—	—	—	—
Degree of high- vs low-rise buildings	—	—	—	—	—	—
Presence of green in the neighborhood	—	—	—	—	—	—
Presence of water (lake, pool, pond, or river) in the neighborhood	1.04 (1.01, 1.07)	—	—	—	—	—
Traffic situation	—	—	—	—	—	—
Quality of sidewalks and bike lanes	—	—	—	—	—	—
Diversity of routes	—	—	—	1.03 (0.99, 1.06)	1.08 (1.03, 1.13)	—
Distance to facilities	—	—	—	—	—	—
Satisfaction with play facilities	—	—	—	—	—	—
Satisfaction with public space and green space	—	—	—	—	—	—

Note: Values are relative rate (95% CI).  
<sup>a</sup>Sequential Poisson GEE analysis (forward), *p*-value <0.15 was considered significant for entry into the model, but in the final model, only those variables with a *p*-value <0.05 are shown.  
<sup>b</sup>In the Netherlands, children aged 4-12 years are educated together at the same primary school. In the current study sample, three children in the lowest grade were aged 3 years and 14 children in the highest grade were aged 13 years. These children were included in the lowest (aged 4-6 years) and highest (aged 10-12 years) age group respectively.  
<sup>c</sup>Other type of residence was a category containing all types of residences not included in the preprinted answer categories (*n*=79).  
<sup>d</sup>Higher scores represent lower SES.  
<sup>e</sup>Town center is a neighborhood type that was underrepresented in this study (*n*=29), and results should be interpreted with caution. Results for work-area type of neighborhood are not shown because of the extremely low number of respondents living in that type of neighborhood (*n*=10).  
 GEE, generalized estimating equation



erlands, which, in general, already provides for green space and play facilities. Diversity of routes (related to the walkability concept) was related to outdoor play only among girls aged 7–9 years and boys aged 10–12 years, which indicates that the role of walkability in the Netherlands is especially important for older children. This may be explained by the fact that older children gain more independence in getting around their neighborhood by foot or bike, which is also supported by other research.<sup>17,37</sup>

Apart from social safety, which was reported earlier,<sup>38</sup> the current study showed that social cohesion was related to children's outdoor play. The importance of social cohesion in relation to physical activity was shown before<sup>39</sup> among children aged 11–15 years. Likewise, children aged 12–14 years are more likely to report more-intense physical activity when in the company of peers,<sup>40</sup> stressing the importance of the social environment as well. The presence of electronic devices in the child's own room showed a positive association with outdoor play in children in this study. Although this finding appears counterintuitive, sedentary behavior is a conceptually different construct that does not necessarily replace physically active behavior.<sup>41–47</sup> Further, from the current analyses it cannot be concluded whether the presence of electronic devices leads to an actual increase in the time spent using them.

The present study is not without limitations. First, because of the cross-sectional design, no causal relationships could be demonstrated. Because parents reported both the amount of time their child spends on outdoor play and the importance they pay to it, this association could be biased. Although the questions on physical activity were not validated, they were derived from the standard questionnaire for monitoring in the Netherlands, which enhances comparison of the results with other Dutch research. The current study did not include objective measurement of physical activity (accelerometry) because this cannot quantify the amount of time spent on specific types of physical activity (such as outdoor play, sports participation, active commuting), whereas these different types of physical activity are associated with different environmental characteristics.<sup>48</sup> Because objective measurement of social environmental characteristics is problematic, and (social) neighborhood perceptions of parents may be of overriding importance in relation to their child's outdoor play, the present study relied on subjective measurement of environmental characteristics.

Analyses were not adjusted for household income because of collinearity with parental education ( $r = 0.511$ ,  $p < 0.001$ ) and the high number of missing values (21.4%) on this variable. Additional correction for household income however did not drastically modify the results (data not shown). Analyses were not adjusted for ethnicity and

BMI because this would have drastically lowered the numbers because of missing values and may have caused selective dropout. Lastly, because data were collected in four medium-sized cities in the south of the Netherlands, results can only be generalized to other cities with a comparable size and population.

## Conclusion

The current study showed that children's outdoor play was associated with several physical and social environmental characteristics. Neighborhood social cohesion was related to outdoor play among children of different age and gender, which makes it a promising point of action for policy development. Policies aimed at improving physical neighborhood characteristics in relation to outdoor play should take into account age and gender of the target population.

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## Appendix

### Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.amepre.2010.05.008.