Do individual cognitions mediate the association of socio-cultural and physical environmental factors with adolescent sports participation?

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Abstract

Objective: To examine the associations of perceived physical environmental factors (availability of physical activity (PA) attributes at home, PA facilities in the neighbourhood, neighbourhood pleasantness and safety) and social environmental factors (parental sports behaviour and parental rule regarding sports participation) with adolescent leisure-time sports participation, and to explore whether the associations found were mediated by individual cognitions as derived from the theory of planned behaviour (TPB).

Design: Cross-sectional study.

Setting: In schoolyear 2005/2006 adolescents from seventeen schools in Rotterdam, the Netherlands, completed a questionnaire during school hours that included self-reported measures of leisure-time sports participation, perceived physical environmental factors and TPB variables. Information about parental sports behaviour and parental rule was obtained from a questionnaire that was completed by one parent of the adolescents.

Subjects: Data were collected from 584 adolescent–parent combinations.

Results: Data were analysed with multi-level logistic regression analyses. Availability of PA attributes at home (OR = 1.26), parents’ sports behaviour (OR = 2.03) and parental rule (OR = 1.64) were associated with a higher likelihood of adolescents' leisure-time sports participation. These associations were partly mediated by attitude and intention.

Conclusions: Adolescents were more likely to engage in leisure-time sports when PA attributes were available at home, when parents participated in sports activities and had a rule about their offspring participation in sports activities. These associations were partly mediated by attitude and intention. These results suggest that parents can importantly promote sports participation among their offspring by making sports activities accessible and a family routine.

Insufficient physical activity (PA) is a risk factor for a range of chronic conditions, including obesity, among adults as well as adolescents(1,2). Most adolescents do not meet the recommended minimum levels of engaging in at least 60 min of moderate-to-vigorous intensity PA each day(3–6). Adolescents are a particularly important target group to improve PA levels since physically active adolescents are more likely to become active adults(7). To be able to increase PA levels among adolescents, it is important to develop interventions that target the most important determinants of PA. In addition to individual cognitions such as attitude, subjective norm, perceived behavioural control and intention, as derived from the theory of planned behaviour (TPB),(8) physical and social environmental factors may be important determinants of PA behaviour. Kremers et al.(9), in their Environmental Research framework for weight Gain prevention (EnRG), suggest that environmental factors may have both a direct and indirect association with behaviour. The direct association reflects a more automatic and unconscious effect of the environment on behaviours. The indirect influence suggests that environmental factors influence PA via the individual cognitions, e.g. environments that offer appealing and easily accessible opportunities for PA may result in more positive attitudes, perceived behavioural control and intentions towards leisure-time PA, which may result in

Keywords

Physical environment

Socio-cultural environment

Adolescents leisure-time sports

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higher PA levels. The TPB also assumes that the impact of various external variables such as physical and social environmental factors on behaviour is mediated by attitude, subjective norm, perceived behavioural control and intention.

Physical environmental factors, such as the availability and accessibility of PA opportunities, have received most attention in exploring environmental determinants of PA (9–11). However, a recent review indicated that the evidence for the role of social environmental factors is stronger (12–14).

Earlier studies have found that among adults the association of perceived environmental aesthetics with walking was mediated by attitude (15) and that associations of perceived environmental aesthetics with walking were mediated by attitude and intention (16). De Bruijn et al. (17) found that the association of environmental aesthetics and distance to PA facilities on PA among adolescents was mediated by the intention to be physically active. Motl et al. (18) found that the association of equipment accessibility with adolescent girls’ PA was mediated by self-efficacy. These previous studies indicate that some TPB variables may be more likely to serve as mediators in environment–behaviour relationships than others (17,18), with the strongest evidence for attitudes as a potential mediating variable (15–17,19,20). Most previous studies have investigated mediation pathways for physical environmental factors.

The aim of the present study was to examine the associations between physical environmental factors (availability of PA attributes at home, PA facilities in the neighbourhood, neighbourhood pleasantness and safety) and social environmental factors (parents’ own sports behaviour and parental rule about sports participation) with adolescents’ leisure-time sports participation and to explore whether these associations are mediated by TPB variables (Fig. 1).

Methods

Study design and sample selection
Baseline data from the ENvironmental Determinants of Obesity in Rotterdam SchoolchildRn (ENDORS) study were used (21) for which data were collected among adolescents in the first (12–13-year-olds) and third (14–15-year-olds) years of secondary school. The Medical Ethics Committee of Erasmus University Medical Center declared no objection to the project. Schools located in the Rotterdam area that participate in the Youth Monitor Rotterdam (n = 56) were invited for participation in the ENDORS study. Subsequently, a random sample of seventeen school locations was drawn from the pool of twenty-four schools that were willing to participate. On average, five classes per school location were randomly selected to participate in the study and 1668 adolescents and their parents were eligible for participation. In the baseline survey, 187 adolescents were absent during the questionnaire assessment. Owing to printing mistakes in the questionnaire, 120 records, including those from one entire school, had to be removed. The response rate for the parent questionnaire was 43%, resulting in 584 adolescent–parent combinations. There were no data available on the parents and adolescents who did not participate in the study and examining response bias was therefore not possible. Compared to the data from the total adolescent sample, in the sample used for the present study adolescents with a non-Western ethnic background (36.6%) compared to 50.5%) and attending vocational schools (49.1% compared to 56.7%) were under-represented.

Procedure
Parents received a letter announcing and explaining the ENDORS study and could refuse participation of their child(ren) by sending a note to the adolescent’s teacher. Between October 2005 and May 2006, the students completed the ENDORS questionnaire in the classroom in the presence of a teacher and a trained research assistant within one school hour (50 min). The adolescents were handed a questionnaire with a pre-addressed and stamped envelope for completion by one of their parents. To increase the participation rates, five I-pods were raffled among the parent respondents and two reminders were sent to the parents.

Measures

Leisure-time sports participation
The relevant questions from the Activity Questionnaire for Adolescents and Adults were used to assess leisure-time sports activities (22). The test–retest reliability of this
questionnaire was moderate (intraclass correlations $= 0.30–0.59$) and validity with accelerometer data was low (Spearman’s correlation coefficient $= 0.21$ for vigorous activities)$^{(23)}$. No validity data were available on sports behaviour. First, the adolescents were asked to write in text boxes in a pre-structured format up to three sports activities that they had engaged in, in the past week. The adolescents were asked to write down the organized and unorganized sports they engaged in. Second, they had to tick on how many days in the past week (1–7 d) they had engaged in this activity. Third, they had to indicate how long, on average, they participated in this activity per occasion, in an open answering format with text boxes to indicate the hours and minutes. The frequency and duration of the activities were multiplied, and then divided by the total number of days to provide the average min/d spent doing leisure-time sports activities. As this variable was highly skewed and the distribution could not be improved through transformation, two categories were created: engaging in leisure-time sports activities for $<30$ min/d (coded as 0), or $\geq 30$ min/d (coded as 1). The cut-off of 30 min was chosen because adolescents are also involved in other activities such as active transport to school and because it was based on the Dutch PA recommendation that children and adolescents should engage in at least moderate activity for 60 min/d$^{(25)}$.

Theory of planned behaviour variables

Attitude, subjective parental norm, perceived behaviour control and intention were specifically assessed in relation to participation in leisure-time sports activities. All questions could be answered on a 5-point bipolar answering scale. Attitude was assessed with two items asking whether the adolescent considers sports and PA in leisure time as very good (+2) or very bad (−2) and as very pleasant (+2) or very unpleasant (−2). The mean item score (Cronbach’s $\alpha = 0.79$, intraclass correlation $= 0.66$) for these items was calculated$^{(25)}$. Subjective norm was assessed with one item: ‘If I engage in sports and PA in leisure time, my parents consider that as very good (+2) or very bad (−2)’. Perceived behaviour control was assessed with one item asking how easy or difficult it is to engage in sports and PA in leisure time with an answering scale ranging from very easy (+2) to very difficult (−2). Intention to perform the behaviour was assessed with a single item: ‘Do you intend to engage in sports and PA in leisure time in the next 6 months?’ with an answering scale ranging from Yes, I certainly do (+2) to no, I certainly do not (−2).

Physical environmental variables

We assessed the availability of PA opportunities at home by providing a list of ten sports ‘attributes’ (i.e. bicycle, dog, home trainer/treadmill, running shoes, stationary aerobic equipment, step aerobics, skates, balls, racquets and jumping rope). This list was translated from Sallis et al.$^{(24)}$. The adolescents could tick which of these were available in their home. A score of PA attributes available at home was calculated by adding up the ‘yes’ responses to these questions. Perceived neighbourhood pleasantness was assessed with two questions: ‘I think my neighbourhood provides a pleasant living environment’, and ‘I think my neighbourhood is attractive’, which could be answered on a 5-point scale ranging from totally agree (+2) to totally disagree (−2). The mean item score (Cronbach’s $\alpha = 0.78$, intraclass correlation $= 0.64$) of these two items was calculated. Perceived neighbourhood safety was assessed with four questions: ‘There is a lot of traffic in my neighbourhood’, ‘It is unsafe to bicycle in my neighbourhood’, ‘I feel safe when I am in my neighbourhood’, and ‘It is unsafe to be outside in my neighbourhood’, using the same 5-point answering scale format as neighbourhood attractiveness. The mean item score (Cronbach’s $\alpha = 0.64$) of these four items was calculated. The perceived availability of PA facilities in the neighbourhood was assessed by asking the adolescents to indicate whether or not (yes/no answering format) there were parks, sports clubs, sports/playing grounds present in the neighbourhood where they lived. The yes responses were summed to form one score for these four items.

Social environmental variables

The parental rule about PA was assessed with one question in the questionnaire for parents: ‘is it a rule in your household that your child has to participate in sports activities?’ in a yes/no answering format. The parent’s own sports behaviour was assessed in the questionnaire for parents with two questions assessing frequency and duration, using relevant questions from the Short QUestionnaire to ASsess Health-enhancing physical activity (SQUASH) questionnaire.$^{(25)}$ Spearman’s correlation for overall reproducibility of the SQUASH was 0.58 (95% CI 0.36, 0.74), and for correlations for the reproducibility of leisure-time sports it was 0.90. Spearman’s correlation coefficient between activity monitor readings and the total activity score was 0.45 (95% CI 0.17, 0.66)$^{(25)}$. Frequency was assessed with: ‘How many d/week do you engage in sports activities?’ on a 7-point scale from 1 = 1 d/week to 7 = every day. The duration was assessed with ‘On a day that you participate in sports activities, how long do you do this on average?’ and hours and minutes could be reported. The frequency and duration of the activities were multiplied, and then divided by the total number of days to provide the average min/d. As this variable was highly skewed, two categories were created: engaging in sports activities (coded as 1) and not engaging in sports activities.

Demographics

To establish ethnicity according to the Statistics Netherlands definition, the adolescents were asked to report in which country their parents were born.$^{(26)}$ Adolescents were considered to be from a Western ethnic background.
if both parents had been born in a European country, North America, Oceania, Indonesia or Japan. Based on the socio-economic and cultural position of immigrants in the Netherlands from Oceania, Japan and Indonesia (a former colony of the Netherlands), children from these immigrants were also included in the Western ethnic group. Adolescents were considered to be from a non-Western ethnic background if one or both parents had been born in other countries. The school type the adolescents attended was categorized into two levels: vocational schools and higher-level secondary education (pre-academic). The schools provided educational level information. Age was determined based on the date of the measurements and the date of birth that were provided by the schools.

**Data analyses**

Possible multi-collinearity problems were examined with bivariate correlations and not encountered; all inter-correlations between predictors were below 0·6. Mediation analyses according to the suggestions of MacKinnon (27) were used to identify the total effects, direct effects and mediated effects in the associations of physical environmental factors (availability of PA attributes at home, availability of PA facilities in the neighbourhood, perceived neighbourhood pleasantness and safety) and socio-cultural environmental factors (parents’ sports behaviour and parental rule about sports participation) with adolescents’ leisure-time sports participation (27). To do so, we explored the associations between the environmental and TPB variables with multivariate linear regression analyses (step 1, path a in Fig. 1). Next, we examined whether the potential mediators from the TPB were associated with leisure-time sports, after adjustment for the environmental variables (step 2, path b in Fig. 1). The total effect of physical environmental and socio-cultural environmental factors on adolescents’ leisure-time sports participation (step 3, path c), and after adjustment for the possible mediator, the direct effect of environmental variables on sports participation (step 4, path c’) were examined in various models. As suggested by MacKinnon (27) and also outlined by Cerin and MacKinnon (28), a significant association between environmental variables (predictor variables) and sports participation (outcome variable) is not a requirement for mediation to occur, since the absence of an overall relationship may be due to suppression effects. Therefore, non-significant environmental factors were also included in the mediation analyses. Steps 2–4 were examined by means of multi-level multivariate logistic regression analyses. All analyses were adjusted for gender, age, ethnicity and school level, as these are possible confounding factors. All analyses were performed with MLwiN version 2.02 (Centre for Multilevel Modelling, University of Bristol, Bristol, UK). A three-level structure was used to take into account that adolescents were nested within classes and classes within schools (29). Owing to the dichotomous outcome variables, there are different scales across the (logistic) regression analyses that make it incorrect to use the ‘difference-of-coefficients estimate’ as an estimate of the mediation effect (28, 30). One solution to overcome this difference in scaling is to standardize the regression coefficients before mediation is estimated (30, 31). The standardized coefficients were subsequently used to estimate the proportion mediated ([(c_standardized − c_standardized)/c_standardized]) and were additionally entered in the Sobel test (32) to formally test the mediation effect.

**Results**

Sixty per cent of the adolescents reported participating in leisure-time sports for at least 30 min/d (Table 1). The adolescents reported positive cognitions regarding leisure-time sports participation. On average, the adolescents reported having four of the listed PA attributes available at home (range: 0–10) and three PA facilities available in their neighbourhood (range: 0–4). They also reported positive perceptions of neighbourhood safety (mean = 0·64, SD = 0·76) and pleasantness (mean = 0·76, SD = 0·99). A majority of parents reported that it was a rule in the household that the adolescent had to participate in some kind of sports (66%) and 59% of the parents themselves participated in leisure-time sports activities.

**Associations between environmental factors and theory of planned behaviour variables**

Multivariate analyses showed that most of the physical and social environmental variables were significantly positively associated with TPB variables (Table 2). No associations were found for neighbourhood facilities with attitude, perceived behaviour control and intention. PA attributes at home and neighbourhood safety were not associated with perceived behaviour control. Parents’ sports behaviour was not associated with subjective parental norm.

**Associations of theory of planned behaviour variables with adolescents’ leisure-time sports participation**

To establish a mediation effect, the potential mediators must be associated with the outcome variable after adjustment for independent environmental variables (28). Multivariate analyses (Table 3) showed that attitude and intention were found to be significantly associated with a higher likelihood of participating in leisure-time sports after adjustment for physical environmental variables (attitude OR = 2·30; intention OR = 2·10) and after adjustment for social environmental variables (attitude OR = 2·24; intention OR = 2·03).

**Mediating effects of theory of planned behaviour variables**

As neighbourhood facilities were not associated with attitude and intention, this factor was not included in the mediation models (Table 4). The association of PA attributes...
Table 1: Behavioural, demographic, cognitive and environmental characteristics of the ENDORSE study population (n 584)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean or %</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Behaviour</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sports participation (≥30 min/week; %)</td>
<td>59.8</td>
<td></td>
<td>–</td>
</tr>
<tr>
<td><strong>Demographics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender (girls; %)</td>
<td>45.2</td>
<td></td>
<td>–</td>
</tr>
<tr>
<td>Ethnicity (non-Western; %)</td>
<td>36.6</td>
<td></td>
<td>–</td>
</tr>
<tr>
<td>Age (years)</td>
<td>13.91</td>
<td>1.13</td>
<td>11-9 to 17-6</td>
</tr>
<tr>
<td>Educational level (vocational schools; %)</td>
<td>49.1</td>
<td></td>
<td>–</td>
</tr>
<tr>
<td><strong>Individual cognitions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude</td>
<td>1.29</td>
<td>0.64</td>
<td>–2 to 2</td>
</tr>
<tr>
<td>Subjective parental norm</td>
<td>1.50</td>
<td>0.61</td>
<td>–2 to 2</td>
</tr>
<tr>
<td>Perceived behaviour control</td>
<td>1.12</td>
<td>0.81</td>
<td>–2 to 2</td>
</tr>
<tr>
<td>Intention</td>
<td>1.57</td>
<td>0.79</td>
<td>–2 to 2</td>
</tr>
<tr>
<td><strong>Physical environment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA attributes at home</td>
<td>3.97</td>
<td>2.08</td>
<td>0 to 10</td>
</tr>
<tr>
<td>Neighbourhood safety</td>
<td>0.64</td>
<td>0.76</td>
<td>–2 to 2</td>
</tr>
<tr>
<td>Neighbourhood pleasantness</td>
<td>0.76</td>
<td>0.99</td>
<td>–2 to 2</td>
</tr>
<tr>
<td>Neighbourhood facilities</td>
<td>3.26</td>
<td>0.95</td>
<td>0 to 4</td>
</tr>
<tr>
<td><strong>Socio-cultural environment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parental rule to play sports (yes; %)</td>
<td>65.8</td>
<td></td>
<td>–</td>
</tr>
<tr>
<td>Parent behaviour (parent does practice sports; %)</td>
<td>59.4</td>
<td></td>
<td>–</td>
</tr>
</tbody>
</table>

ENDORSE, ENvironmental Determinants of Obesity in Rotterdam SchoolchildrEn; PA, physical activity.

Table 2: Results of multivariate linear regression analyses (unstandardized regression coefficients) of physical and social environmental variables with TPB variables as dependent variables, adjusted for age, gender, ethnicity, school type and clustering within classes and schools

<table>
<thead>
<tr>
<th>Variables</th>
<th>Attitude</th>
<th>Perceived behaviour control</th>
<th>Intention</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA attributes at home</td>
<td>0.039**</td>
<td>0.042**</td>
<td>0.026</td>
</tr>
<tr>
<td>Neighbourhood safety</td>
<td>0.146***</td>
<td>0.120***</td>
<td>0.016</td>
</tr>
<tr>
<td>Neighbourhood pleasantness</td>
<td>0.168***</td>
<td>0.090***</td>
<td>0.105**</td>
</tr>
<tr>
<td>Neighbourhood facilities</td>
<td>0.035</td>
<td>0.059**</td>
<td>0.028</td>
</tr>
<tr>
<td>Parental rule</td>
<td>0.141*</td>
<td>0.121*</td>
<td>0.174*</td>
</tr>
<tr>
<td>Parent behaviour</td>
<td>0.135*</td>
<td>-0.001</td>
<td>0.185**</td>
</tr>
</tbody>
</table>

TPB, theory of planned behaviour; PA, physical activity.

Table 3: Results of multivariate logistic regression analysis (OR) examining the association between potential mediators (TPB variables) and leisure-time sports participation (≥30 min), adjusting for the physical (Model 1) and social (Model 2) environmental factors†

<table>
<thead>
<tr>
<th>Variables</th>
<th>OR (95% CI)</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical environmental factors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA attributes at home</td>
<td>1.20 (1.07, 1.35)</td>
<td>–</td>
</tr>
<tr>
<td>Neighbourhood safety</td>
<td>1.22 (0.86, 1.73)</td>
<td>–</td>
</tr>
<tr>
<td>Neighbourhood pleasantness</td>
<td>0.89 (0.68, 1.16)</td>
<td>–</td>
</tr>
<tr>
<td>PA facilities in the neighbourhood</td>
<td>1.02 (0.83, 1.23)</td>
<td>–</td>
</tr>
<tr>
<td><strong>Socio-cultural environmental factors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parental rule</td>
<td>– (–)</td>
<td>1.37 (0.85, 2.00)</td>
</tr>
<tr>
<td>Parents sports behaviour</td>
<td>– (–)</td>
<td>1.79 (1.14, 2.80)</td>
</tr>
<tr>
<td><strong>TPB variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude</td>
<td>2.30 (1.46, 3.61)</td>
<td>2.24 (1.48, 3.39)</td>
</tr>
<tr>
<td>Parental norm</td>
<td>1.21 (0.82, 1.80)</td>
<td>1.29 (0.87, 1.92)</td>
</tr>
<tr>
<td>Perceived behaviour control</td>
<td>1.00 (0.76, 1.33)</td>
<td>0.96 (0.72, 1.27)</td>
</tr>
<tr>
<td>Intention</td>
<td>2.10 (1.47, 3.02)</td>
<td>2.03 (1.42, 2.91)</td>
</tr>
</tbody>
</table>

TPB, theory of planned behaviour; PA, physical activity.
†Multivariate logistic regression analyses adjusted for age, gender, ethnicity, school type and clustering within classes and schools.

at home with a higher likelihood of participating in leisure-time sports was partly mediated by attitude (17-4%) and intention (21-6%), as indicated by the significant Sobel test results. The association between neighbourhood safety and sports participation was significantly mediated by intention; however, both direct and indirect
### Table 4 Results of logistic regression analyses to examine the mediation of the association between physical environmental factors with leisure-time sports participation (≥30 min) by attitude (Model 2) and intention (Model 3)

<table>
<thead>
<tr>
<th>Physical environmental factors</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Sobel test</th>
<th>Proportion mediated</th>
<th>Model 3</th>
<th>Sobel test</th>
<th>Proportion mediated</th>
</tr>
</thead>
<tbody>
<tr>
<td>OR 95 % CI</td>
<td>OR 95 % CI</td>
<td>Z-score</td>
<td>%</td>
<td></td>
<td>OR 95 % CI</td>
<td>Z-score</td>
<td>%</td>
</tr>
<tr>
<td><strong>Physical environmental factors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA attributes at home</td>
<td>1.26</td>
<td>1.13, 1.42</td>
<td>1.24</td>
<td>1.10, 1.39</td>
<td>2.54**</td>
<td>-</td>
<td>17.4</td>
</tr>
<tr>
<td>Neighbourhood safety</td>
<td>1.28</td>
<td>0.93, 1.77</td>
<td>1.32</td>
<td>0.94, 1.86</td>
<td>3.40***</td>
<td>-3.45</td>
<td>-3.45</td>
</tr>
<tr>
<td>Neighbourhood pleasantness</td>
<td>1.06</td>
<td>0.83, 1.36</td>
<td>0.87</td>
<td>0.66, 1.13</td>
<td>4.40***</td>
<td>312.23</td>
<td>312.23</td>
</tr>
<tr>
<td><strong>TPB variables</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude</td>
<td></td>
<td></td>
<td>3.44</td>
<td>2.33, 5.08</td>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Intention</td>
<td></td>
<td></td>
<td>-</td>
<td>-</td>
<td></td>
<td>2.71</td>
<td>1.93, 3.80</td>
</tr>
</tbody>
</table>

PA, physical activity; TPB, theory of planned behaviour.

*Multivariate logistic regression analyses adjusted for age, gender, ethnicity, school type and clustering within classes and schools.

**As calculated with the standardized coefficients (see Methods section).

*Negative results and values > 100% indicate inconsistent mediation models and the results cannot be interpreted.

*P < 0.05; **P < 0.01; ***P < 0.001.

In the present study, associations of socio-cultural and physical environmental factors with adolescents' leisure-time sports participation changed after adjustment for attitude, while associations between environmental factors and cognitions remained of PA attributes at home and parental behaviour with leisure-time sports remained statistically significant, while the association of parental rule lost significance in the mediation models.

The associations of parental rule and parents' sports participation with percentages ranging between 20% and 31% (Table 5) showed that parents' involvement in sports behaviour and availability of PA attributes at home were associated with a higher likelihood of PA attributes at home being engaged in sports behaviour. However, a direct significant association between physical environmental factors and attitude and intention with leisure-time sports remained weak but positive, while the indirect association was also weak but negative.

Evidence was found for the partial mediation of social and physical influences of the environment and more reasoned cognitive processes are important in adolescents' sports participation as suggested in the EnRG framework. The inconsistent mediation model is a result of the fact that the direct association between individual cognitions such as attitudes and intentions and parent behaviour seems to be stronger due to the environmental factors considered in the present study. Adolescents' leisure-time sports participation changed after adjustment for attitude, while associations between environmental factors and cognitions remained of PA attributes at home and parental behaviour with leisure-time sports remained statistically significant, while the association of parental rule lost significance in the mediation models.
cognitions, independent of the environmental factors, is not clearly stated in the EnRG framework that focuses on cognitions as mediators of environmental influences. Two of the four cognitions included in the present study, i.e. parental subjective norm and perceived behavioural control, were not found to be associated with sports behaviour. This might indicate that not all cognitions as suggested by the TPB are important mediators or play a role in the suggested reasoned process for this particular behaviour in this population group. On the other hand, the non-significant results might be caused by the limited assessment of these constructs with only one or two items.

In accordance with other studies, social factors seem to be more strongly associated with PA behaviour than physical environmental factors\(^{(12-14)}\). The direct associations of parents' sports behaviour and the availability of PA equipment at home support earlier evidence that parental example and support (for instance, through providing good sports equipment at home) are important for PA promotion. The range of social factors considered in the present study was narrow, and factors such as social networks, friends' support and behaviour and the perceived behaviour of parents should be included in future studies to provide further insight into specific aspects of the social environment that are most important for adolescents' PA behaviours\(^{(18,34)}\). Next to this, future research should address the moderating effects of socio-demographic factors mentioned in the EnRG framework as there are clear gender differences in sports participation and correlates of PA might be different for boys and girls. For example, mothers' PA appears to be more often associated with girls' rather than boys' physical activity\(^{(12)}\).

One possible limitation of the present study was that we used perceptions of the environment instead of more objective measures of the physical environment. Perceived environmental factors are, of course, also cognitive representations (i.e. of environmental factors), and different mediating pathways may be apparent with more objective assessments of the environment. Evidence points out that perceived and objective environmental factors are different constructs\(^{(35)}\) and that perceptions of the environment only partly depend on what is objectively available in the environment\(^{(36)}\). Studies exploring TPB variables as well as perceived environmental factors as mediators of the associations between objective environmental characteristics and PA behaviour may help to unravel the interplay between individual and environmental factors in influencing energy balance-related behaviours as proposed in the EnRG framework.

The following limitations should be taken into account when interpreting the results of the present study. The cross-sectional design of the study did not allow us to determine causal effects and is an important limitation in research examining mediation pathways. Physically active adolescents might be more aware of PA equipment in their environment and they might select more or less

<table>
<thead>
<tr>
<th>Table 5. Results of logistic regression analyses to examine the mediation of the association between social environmental factors with leisure-time sports participation (≥30 min) by attitude and intention (Model 3).</th>
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</thead>
<tbody>
<tr>
<td><strong>Social environmental factors</strong></td>
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<tr>
<td><strong>Parent behaviour</strong></td>
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<tr>
<td><strong>Model 1</strong></td>
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<tr>
<td><strong>OR</strong></td>
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<tr>
<td><strong>Social environmental factors</strong></td>
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<td><strong>Parent behaviour</strong></td>
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<tr>
<td><strong>TPB variables</strong></td>
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<td><strong>Intention</strong></td>
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<td><strong>TPB, theory of planned behaviour.</strong></td>
</tr>
<tr>
<td><strong>Multivariate logistic regression analyses adjusted for age, gender, ethnicity, school type and clustering within classes and schools.</strong></td>
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<tr>
<td><strong>As calculated with the standardized coefficients (see Methods section).</strong></td>
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<tr>
<td><strong>P &lt; 0.05.</strong></td>
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</table>

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the neighbourhood they are active in by having a specific
definition about how large the neighbourhood is. Having
positive cognitions towards sports might shape the ado-
lescents’ environment. For instance, adolescents might
influence their parents by promoting sports activities and
asking for more equipment. Next to this, the sample size
of the present study was restricted because of the rather
low response rate for the parent questionnaire. The fact
that adolescents from a non-Western ethnic background
and lower educational level were underrepresented in the
sample suggests a selection bias. Several limitations relate
to the measurement instruments used in the study.

First, adolescents’ sports behaviour was based on self-
report and in a validation study with the use of accel-
erometers it was shown that the questionnaire had limited
validity and that adolescents over-reported their activity
levels(22). Second, the TPB variables were assessed with
only one or two items leading to limited reliability. The
TPB variables, particularly perceived behaviour control,
might not have been robust enough to show associations
and to show up as a mediator. Environmental constructs
were often measured with only one or two items with
only moderate reliability. In explorative research, more
effort needs to be made to construct better scales that
examine all aspects of the perceived environmental factors.
More qualitative research is needed to improve the existing
measurement instruments and scales. Next to this, only a
limited set of perceived environmental variables was used in
the present study. Other social environmental influences
such as encouragement of parents and friends might espe-
cially be important in explaining PA behaviours(12,14,37).

Parents’ sports behaviour was also assessed with other
questions compared to adolescents’ sports participation,
and other cut-off points were used. This could also have
affected the associations found. Third, adolescents with
overweight or lack of PA might have given socially desirable
answers on sports behaviour and on the TPB items as well,
which could have influenced the associations between
cognitions and behaviour. Nevertheless, this explorative
study contributes to the structured examination of the
associations between environmental factors and PA and
the suggested mediation by TPB variables as supposed by
the EnRG framework.

Conclusion

Dutch adolescents were more likely to engage in leisure-
time sports when PA attributes were available at home,
when parents participated in sports activities and had
the rule in their household that the child has to play a
sport. These associations were partly mediated by attitude
and intention. This indicates that parents are important
actors in shaping the environmental factors of interest by
making sports activities accessible and a family routine.
Therefore, not only adolescents, but also parents should
be targeted in interventions aiming to improve PA among
adolescents. However, the cross-sectional design of the
present study should be taken into account and the
findings have to be verified in longitudinal and experi-
mental studies. Efforts need to be made construct better
measurement instruments and scales to examine perceived
environmental factors.

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on the manuscript. A.O. and J.B. contributed to the study
set-up, the design of the paper and provided feedback on
the manuscript.

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