

Changes in Individual and Social Environmental Characteristics in Relation to Changes in Physical Activity: a Longitudinal Study from Primary to Secondary School

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Abstract

Purpose Physical activity (PA) strongly decreases when children make the transition from primary to secondary school. The study aimed to investigate how individual and social environmental factors toward PA changed when children (11–12 years) made the transition from primary to secondary

school (13–14 years) and how changes in these factors were related to changes in different PA domains.

Methods In total, 321 children (48.9 % girls) and one of their parents both filled out a questionnaire concerning individual (i.e., attitude, self-efficacy, perceived benefits, and barriers of PA) and social environmental factors related to PA (parental support, friend’s co-participation, parental trust in child’s ability to be physically active, and social norm) in the last grade of primary school and 2 years later. Children wore an activity monitor for 7 days and self-reported different domains of PA. **Results** Most individual and social factors became less positive toward PA after the transition to secondary school.

Among girls, a more positive attitude and an increase in self-efficacy were related to an increase in average daily steps and sports during leisure, respectively.

Among boys, a decrease in perceived barriers (lack of time and parental reported lack of transportation to sport activities) was related to a decrease in average daily steps. An increase in parental support and a decrease in the parental perceived barrier of not liking sports were related to an increase in sports during leisure.

Conclusions The prevention of adverse changes in individual and social factors toward physical activity may lead to a smaller decrease or an increase in physical activity.

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Introduction

Despite the many health benefits of physical activity (PA) [1], overall PA levels among children decline when they enter adolescence and make the transition from primary (age 11–12 years) to secondary school (age 13–14 years) [2–4].

Furthermore, some sex- and domain-specific changes in PA were found during this transition. Active transportation to school increased and sports during leisure time decreased among boys and girls, whereas total daily step counts decreased among girls and walking for transport during leisure time decreased among boys during this transition [5]. The transition from primary to secondary school can be seen as a critical life event and an experience that greatly influences a child's daily routines.

According to ecological models, PA is influenced by multiple factors such as individual (e.g., age and self-efficacy), social environmental (e.g., social support), and physical environmental factors (e.g., walkability) [6]. It is likely that the transition to secondary school is accompanied by changes in these individual, social, and environmental factors. Insight into these changes, and their relation with changes in PA, is necessary to develop effective interventions to prevent the decrease among children's PA when they make the transition to secondary school [7]. If changes in individual or environmental factors are associated with decreases in PA across the transition from primary to secondary school, minimizing these changes or trying to increase these factors may be an effective intervention strategy for reducing the decline in PA that usually occurs when children make the transition from primary to secondary school.

Different studies have investigated the association between individual [8], social [8, 9], and environmental factors [10, 11] and children's PA. However, the main limitation of these studies is their cross-sectional design, and only few previous studies focused specifically on changes in correlates of PA during the critical life event of the transition from primary to secondary school. In two previous Belgian studies conducted on the current sample, longitudinal associations of changes in the school environment and changes in the perceived neighborhood environment with changes in PA during the transition from primary to secondary school were investigated [5, 12]. It was found that an increase in promotion of active transportation to school (ATS), an increase in availability of school facilities and sport equipment, and the presence of a health education policy at school were related to increased PA in different domains [12]. However, only few changes in children's and parents' perceived neighborhood environment were significantly related to changes in PA [5]. Both previous studies mainly focused on changes in physical environmental (school and neighborhood) factors. Based on the results of these previous studies, it can be concluded that a large part of the variance in PA changes during the transition from primary to secondary school remains unexplained.

As according to ecological models, behavior is not only influenced by physical environmental factors but also by individual and social environmental factors [6]; more insight into these factors in relation to PA during the transition to secondary school is needed. It is likely that individual and

social environmental factors change when children make the transition to secondary school, as this transition occurs around the start of puberty and is accompanied by changes in peer groups. Furthermore, individual (e.g., self-efficacy) and social environmental (e.g., friend support) correlates of PA among children differ from correlates among adolescents. Cross-sectional studies showed that self-efficacy, parental modeling (only among boys), and parental support are positively related to children's PA [9]. Among adolescents, positive associations with PA were found for attitude, self-efficacy, and friend support [9]. To our knowledge, no previous studies investigated if changes in these individual and social environmental factors are related to changes in PA during the transition to secondary school. As different individual and social environmental factors were associated with PA among children and adolescents in cross-sectional studies, it might be that changes in these factors are important to explain changes in PA during the transition from primary to secondary school.

Therefore, the first aim of this study was to investigate how individual (i.e., attitude toward PA, self-efficacy toward PA, and perceived benefits and barriers of PA) and social environmental factors (i.e., parental support, friend co-participation for PA, parental trust in their child's ability to be physically active, and social norm) toward PA change when children (11–12 years) make the transition to secondary school (13–14 years). It was hypothesized that individual and social environmental factors would become less positive, as adolescents probably attach more value to other (academic or leisure) activities and less to PA compared to their childhood. As parents are seen as the main decision makers for their children and parents play an important role in determining children's PA [13, 14], parental report of individual and social environmental factors was also included in the study. The second aim of this study was to investigate how changes in individual and social environmental factors were related to changes in different PA domains. It was hypothesized that an adverse change in individual and social environmental factors would be related to less favorable PA levels. Because changes in PA are dependent on children's sex and the domain of PA [5], changes in PA correlates were investigated in relation to changes in the different PA domains (objectively measured daily steps, sports during leisure, ATS, walking for transportation during leisure, and cycling for transportation during leisure) and for boys and girls separately.

Methods

Participants and Procedure

Data collection of this longitudinal study took place during the school year 2009–2010. Two years later, follow-up measures were collected.

At baseline, primary schools ($n=148$) in East and West Flanders (Belgium) were randomly contacted by phone. In total, 44 principals gave permission to collect data for this study among students of the sixth grade in their school (response rate=29.7 %). In each school, a research assistant visited one class from the sixth grade and all children in these classes (11–12 years, $n=976$) and their parents were invited to participate. This resulted in 749 children who were allowed by their parents to participate in the study (response rate=76.7 %).

The participating children and one of their parents were asked to complete a questionnaire. Children were also asked to wear an activity monitor for seven consecutive days; 297 children received an accelerometer, and due to the limited availability of accelerometers, 439 children received a pedometer.

Two years after baseline measurements, children and parents who participated at baseline were asked by phone if they were willing to participate in the follow-up measurements of the study. In total, 502 children and their parents agreed to participate in the second phase of the study, but 75 of them were not willing to wear an activity monitor.

In total, 420 child questionnaires and 416 parent questionnaires returned after the follow-up measurements; 369 children had complete pedometer or accelerometer step count data for at least three weekdays, and 370 had complete pedometer or accelerometer step count data for at least one weekend day. In total, data of 321 ($321/976=32.9$ %) children were complete and were included in the analyses (157 girls, 48.9 %). Further details of sample selection are published elsewhere [5]. The study protocol was approved by the Ethics Committee of Ghent University Hospital.

Measures

Demographic Factors

Children reported their age and sex in the questionnaire. The educational level of the mother and father was measured using the parental questionnaire and determined based on the following four options: less than secondary school, completed secondary school, completed college, or completed university. The educational levels of mother and father were recorded into “attained a college or a university education level” or “did not attain a college or a university education level.”

Individual and Social Environmental Factors

Children’s attitude toward PA, their perception of parental support, friends’ co-participation, perceived social norm, self-efficacy, perceived benefits (i.e., health, meeting (new) friends, fun, being better than others, not feeling bored, and weight loss), and barriers (i.e., lack of time, not liking sports,

not being good at sports, not being allowed to sport, and lack of transportation to sport activities) toward PA were assessed using questions derived from previous studies in adults and adolescents [15–20] and were based on the theory of planned behavior [21]. Parents reported on their attitude toward their child’s PA, on parental support for their child’s PA, social norm, parental trust in their child’s ability to be physically active, and on the perceived benefits and barriers of PA for their child. Parents answered the questions from their child’s perspective (e.g., perceived benefits, My child thinks that doing sports is good because he/she gets in contact with (new) friends). Table 1 gives an overview of the content and response options of the individual and social environmental factors for children and their parents. Adolescents and parents answered the same questions at follow-up.

Physical Activity

Objectively Measured Step Counts The Yamax Digiwalker SW-200 and the Actigraph accelerometer, model GT1M, were used to measure step counts. The Yamax Digiwalker is valid and reliable to measure free-living step counts among children and adolescents [22]. The GT1M accelerometer has demonstrated good reliability for measuring steps [23]. Although the step counts measured by the Yamax Digi-walker CW-701 (the update of the Yamax Digiwalker SW-200) and the step counts of the GT1M accelerometer have been shown to be highly correlated, the overall agreement between the step counts of both monitors is rather low [24]. Therefore, all analyses including average daily steps were controlled for the type of activity monitor (pedometer or accelerometer) that was worn. The children wore the monitor for seven consecutive days during waking hours and were asked to remove the activity monitor during aquatic activities. Children were also asked to complete an activity diary with activities for which the activity monitor was removed. Children wearing a pedometer were also asked to register the date of their daily steps in the activity diary.

Protocol of Data Reduction for Pedometer and Accelerometer Accelerometer data were downloaded using Actilife, and data were screened, cleaned, and scored using data-reduction software MeterPlus [25].

For each registered minute of moderate- to vigorous-intensity PA for which the activity monitor was removed, 150 steps were added to the daily number of registered step counts [26].

Based on the average daily steps, a weekly average of steps was calculated. Inclusion criteria were set at having at least three valid weekdays and one weekend day (between 1000 and 30,000 steps/day [27]) of monitoring [28, 29].

Self-Reported PA Children filled out the Flemish Physical Activity Questionnaire (FPAQ), which is a reliable and

Table 1 Content and response options of the individual and social environmental factors

	Content of the items	Response options
Attitude (one item)	C: How pleasant is being active and doing sports?	Very unpleasant, unpleasant, neutral, pleasant, very pleasant
	P: Being physically active and doing sports for my child is...	Very unimportant, unimportant, neutral, important, very important
Parental support (one item)	C: How frequently do your parents encourage you to be physically active?	Never, seldom, sometimes, often, very often
	P: How frequently do you encourage your child to be physically active?	
Friend co-participation (one item)	C: How frequently are your friends engaged in doing sports and being physically active with you?	Never, seldom, sometimes, often, very often
Social norm (one item)	C: My parents think that I have to participate regularly in PA. P: My child has to participate regularly in PA.	Strongly disagree, somewhat disagree, neither agree or disagree, somewhat agree, strongly agree
Self-efficacy (four items, Cronbach's alpha children = 0.78)	C: I am sure I will be physically active if I have to get up early, if my friends want to do something else, if I have a lot of work for school, and if it is exhausting and difficult.	
Parental trust in child's ability to be PA (four items, Cronbach's alpha parents = 0.83)	P: I am sure my child will be physically active if he/she has to get up early, if his/her friends want to do something else, if he/she has a lot of work for school, and if it is exhausting and difficult.	
Perceived benefit of health	C: Doing sports is good because I improve my condition and health.	
	P: My child thinks that doing sports is good because he/she improves his/her condition and health.	
Perceived benefit of meeting (new) friends	C: Doing sports is good because I get in contact with (new) friends.	
	P: My child thinks that doing sports is good because he/she gets in contact with (new) friends.	
Perceived benefit of fun	C: Doing sports is good because I enjoy being physically active.	
	P: My child thinks that doing sports is good because he/she enjoys being physically active.	
Perceived benefit of being better than others	C: Doing sports is good because I can show that I am better in sports than others.	
	P: My child thinks that doing sports is good because he/she can show that he/she is better in sports than others.	
Perceived benefit of not feeling bored	C: Doing sports is good because I do not get bored if I am physically active.	
	P: My child thinks that doing sports is good because he/she does not get bored if he/she is physically active.	
Perceived benefit of weight loss	C: Doing sports is good because I lose weight.	
	P: My child thinks that doing sports is good because he/she loses weight.	
Perceived barrier of lack of time	C: I am not able to engage in sports due to lack of time.	
	P: My child is not able to engage in sports due to lack of time.	
Perceived barrier of not liking sports	C: I am not able to engage in sports because I do not enjoy sports.	
	P: My child is not able to engage in sports because he/she does not enjoy sports.	
Perceived barrier of not being good at sports	C: I am not able to engage in sports because I am not good in doing sports.	
	P: My child is not able to engage in sports because he/she is not good in doing sports.	
Perceived barrier of not being allowed to sport	C: I am not able to engage in sports because I am not allowed to sport by my parents.	
	P: My child is not able to engage in sports because he/she is not allowed to sport by his/her parents.	
Perceived barrier of lack of transportation to sport activities	C: I am not able to engage in sports because I do not have transportation to engage in sports.	
	P: My child is not able to engage in sports because my child does not have transportation to engage in sports.	

C question for children, P question for parents

reasonably valid questionnaire for the assessment of different dimensions of PA among children [30] and adolescents

[31]. The FPAQ was used to determine the duration of walking and cycling to and from school and walking and

cycling for transport during leisure time and sports during leisure time.

Data Analysis

Binomial (for parental education and sex) and linear (for PA) regressions in MLwiN (two levels, school and individual) with parental education, children's sex, and PA measures as dependent variables and the availability of data at follow-up (1=yes, 0=no) as independent variable were conducted to analyze differences in socio-demographic variables and PA between children included in the sample and children who dropped out after baseline measures.

All statistical analyses were done separately for boys and girls, as changes in PA and PA correlates differ between sexes [5, 8, 32–36]. To account for clustering of children within primary schools and secondary schools, data were analyzed using MLwiN 2.30. For all analyses, primary schools and secondary schools were treated as cross-classified. The Markov chain Monte Carlo method (MCMC) was used to fit the cross-classified multilevel models applying an orthogonal parameterization [37]. Tests for normal distribution revealed some skewed PA variables; therefore, logarithmic transformations were made to improve normality. The transformed variables were used in the analyses. For ease of interpretation, summary data of untransformed PA variables are reported in minutes per day.

To investigate longitudinal changes in individual and social environmental factors, four-level (time, child, primary school, and secondary school) cross-classified multilevel regression models were conducted. These changes were investigated by regressing the dependent individual and social environmental factors onto the time point variable. Cohen's *d* effect sizes were calculated based on the difference between the score on the individual and social environmental variables in primary and in secondary schools [38]. Effect sizes of ≥ 0.80 were considered large, ≥ 0.50 were considered moderate, and ≥ 0.20 were small effects [39].

Measures of change in individual and social environmental factors and PA between the two time points were computed by regressing the individual and social environmental factors and PA variables at follow-up onto their respective baseline values. Based on these regression outcomes, residualized change scores were computed. These scores represent the amount of decrease or increase in individual and social environmental factors and PA between baseline and follow-up [39, 40]. Before multilevel regression analyses were conducted, multicollinearity within the child and parental individual and social environmental factors residualized change scores was checked by conducting Pearson's correlations in SPSS20. If the magnitude of the correlation coefficients did exceed 0.60, only the factor with the highest correlation with the dependent variable was kept in the regression model. In a next step in SPSS20, correlations of children's and parental individual and social environmental

factors residualized change scores with the dependent PA variables were analyzed and only those child and parental individual and social environmental factors that were related ($p < 0.15$) to the dependent variable were included in the multilevel regression models [41]. One regression model was conducted for each dependent variable. To investigate if the changes in individual and social environmental factors were related to changes in PA, the residualized change scores of the individual and social environmental factors were regressed onto the residualized change scores of PA.

All analyses were controlled for two proxy measures of individual SES (educational attainment of mother and father), and analyses concerning overall steps/day were also controlled for the type of monitor used by entering a variable "type of monitor (accelerometer/pedometer)" in the regression models. Children who did not wear the same type of monitor at both time points ($n = 12$) were excluded from the analyses concerning total daily step counts. To estimate the local effect size of the significant correlates of changes in PA, we calculated the proportional reduction in variance statistic to determine the explained variance of each correlate at the individual level [42].

P values < 0.05 were considered significant.

Results

Descriptive Characteristics

Descriptive sample characteristics at baseline are shown in Table 2. The children who are included in the analyses and those who dropped out after baseline measurements did not differ concerning sex ($p = 0.392$) and father's education level ($p = 0.718$). Mother's education level of children participating at both baseline and follow-up was higher compared to children who did not participate at follow-up ($p = 0.003$).

The children who dropped out after baseline measurements did not differ concerning average daily steps, sports during leisure, walking for transportation during leisure, and cycling for transportation during leisure. Children who dropped out after baseline measurements were less engaged in active transportation to school at baseline compared to children who did not drop out after baseline ($p = 0.018$).

Mean ages at baseline were 11.1 ± 0.5 and 13.4 ± 0.6 years at follow-up. The final sample ($n = 321$) consisted of 164 boys (51.1 %).

Changes in Individual and Social Environmental Factors

Table 3 summarizes changes in PA-related individual and social environmental factors. Among girls, parental support ($p < 0.001$), lack of time ($p < 0.01$), and the perceived barrier of not liking sports ($p < 0.05$) increased from baseline to follow-up. Attitude toward PA ($p < 0.001$), self-efficacy ($p < 0.001$),

Table 2 Descriptive characteristics of the sample

Variable	Participating children	Children who dropped out after baseline	<i>P</i> value
Demographic variables			
Sex (percent of boys)	51.1	52.4	0.392
Percent of mothers with college or university degree	56.6	52.4	0.003
Percent of fathers with college or university degree	47.2	44.5	0.718
Physical activity			
Average daily steps	10,870 ± 3,281	10,665 ± 3,707	0.514
Sports during leisure (min/day)	29.4 ± 24.6	27.3 ± 25.7	0.278
Active transportation to and from school (min/day)	11.6 ± 12.5	9.7 ± 12.2	0.018
Walking for transportation during leisure (min/day)	8.0 ± 11.5	9.4 ± 12.6	0.514
Cycling for transportation during leisure (min/day)	10.2 ± 12.6	12.0 ± 30.5	0.328

perceived benefits of meeting new friends ($p < 0.01$), fun ($p < 0.001$), and not feeling bored ($p < 0.001$) decreased from baseline to follow-up. Also according to their parents, girls' parental support ($p < 0.05$), perceived benefit of weight loss ($p < 0.01$), and perceived barrier of not liking sports ($p < 0.01$) increased and their trust in their child's ability to be physically active ($p < 0.001$), social norm ($p < 0.001$), and perceived benefit of fun ($p < 0.05$) decreased from baseline to follow-up.

Among boys, only perceived benefit of fun ($p < 0.05$) decreased from baseline to follow-up, whereas perceived benefit of being better than others ($p < 0.01$) increased. Boys' parents reported a decrease in social norm ($p < 0.05$), in their trust toward their child's ability to be physically active ($p < 0.01$), in the perceived benefits of meeting (new) friends ($p < 0.01$), fun ($p < 0.001$), and not feeling bored ($p < 0.05$). Boys' parents reported an increase of the perceived benefit of weight loss ($p < 0.05$), the perceived barrier of not liking sports ($p < 0.001$), and not being good at sports ($p < 0.01$).

Associations of Changes in Individual and Social Environmental Factors with Changes in Objectively Measured Daily Steps

An overview of the variables included in the regression analyses concerning objectively measured daily steps is given in Table 4. Among girls, increased attitude (more positive) toward PA was related to an increase in daily steps ($p = 0.007$).

Among boys, a decrease in lack of time ($p = 0.036$) and a decrease in the parental perceived barrier of lack of transportation to sport activities were related to an increase in daily steps.

Associations of Changes in Psychosocial Factors with Changes in Self-Reported PA

An overview of the variables included in the regression analyses concerning self-reported PA is given in Table 5. An

increase in self-efficacy ($p = 0.038$) relates to an increase in sports during leisure among girls. Among girls, increases in the perceived benefit of health ($p = 0.040$), the barrier of not being allowed to sport, and in the parental perceived benefit of being better than others ($p = 0.035$) were related to an increase in active transportation to school.

Among boys, an increase in parental support ($p = 0.018$) and a decrease in the parental perceived barrier of not liking sports ($p = 0.005$) were related to an increase in sports during leisure ($p = 0.018$). An increase in parental reported parental support ($p = 0.033$) and in the parental perceived barrier of not liking sports ($p = 0.030$) were related to an increase among boys' walking for transportation.

Discussion

As expected, the transition from primary to secondary school occurred with changes in individual and social environmental factors toward PA and sports among boys and girls. However, the changes in individual and social environmental factors were small. In general, these factors were less positive in secondary school compared to primary school and these findings were in line with our hypotheses. Most of the factors that changed, changed among girls. Among boys, only a decrease in the perceived benefit of fun was observed. This indicates that boys did not largely change their opinions and feelings toward PA and sports when entering secondary school in contrast to girls, whose individual and social factors toward PA became less positive. It is likely that, compared to boys, girls attach more value to other activities than PA (e.g., academic and social activities) and are less interested in PA when they enter secondary school. The only factor that became more positive toward PA was parental support; this was only reported by girls and their parents. This indicates that parents more frequently encouraged their daughters to be physically active when they were in secondary school compared to primary school. This can be explained by the fact that girls' parents might believe

Table 3 Changes in individual and social environmental factors

Individual and social environmental factors	Baseline mean (SD)	Follow-up mean (SD)	Change score mean (SD)	Chi-squared test	Cohen's <i>d</i>
<i>Girls (n = 157)</i>					
<i>Girls' report</i>					
Attitude	4.42 (0.73)	4.16 (0.88)	-0.26 (1.14)	13.64***	0.24
Parental support	2.87 (1.17)	3.37 (1.15)	0.50 (1.64)	20.77***	0.36
Friend co-participation	3.40 (1.30)	3.42 (1.28)	0.02 (1.82)	0.02	0.01
Social norm	4.10 (0.88)	4.01 (1.14)	-0.09 (1.44)	0.65	0.08
Self-efficacy	3.61 (0.79)	3.30 (0.89)	-0.31 (1.19)	20.72***	0.27
Perceived benefit of health	4.44 (0.75)	4.35 (0.73)	-0.09 (1.05)	2.02	0.10
Perceived benefit of meeting (new) friends	4.20 (0.83)	3.96 (0.95)	-0.24 (1.26)	8.56**	0.23
Perceived benefit of fun	4.47 (0.83)	4.15 (0.95)	-0.32 (1.26)	14.07***	0.31
Perceived benefit of being better than others	2.15 (1.14)	2.13 (1.13)	-0.02 (1.61)	0.08	0.01
Perceived benefit of not feeling bored	4.05 (0.96)	3.71 (1.07)	-0.34 (1.44)	12.92***	0.27
Perceived benefit of weight loss	3.22 (1.33)	3.13 (1.25)	-0.09 (1.83)	0.61	0.05
Perceived barrier of lack of time	2.24 (0.96)	2.53 (1.05)	0.29 (1.42)	7.43**	0.26
Perceived barrier of not liking sports	1.59 (0.91)	1.81 (1.05)	0.22 (1.39)	5.84*	0.18
Perceived barrier of not being good at sports	1.72 (0.89)	1.88 (0.93)	0.16 (1.29)	3.75(*)	0.14
Perceived barrier of not being allowed to sport	1.31 (0.68)	1.24 (0.55)	-0.07 (1.42)	1.11	0.06
Perceived barrier of lack of transportation to sport activities	1.74 (0.91)	1.66 (0.78)	-0.08 (1.20)	0.72	0.08
<i>Girls' parental report</i>					
Attitude toward PA	4.39 (0.62)	4.45 (0.64)	0.06 (0.89)	1.26	0.07
Parental support	3.73 (0.90)	3.92 (0.81)	0.19 (1.21)	5.61*	0.17
Social norm	4.75 (0.51)	4.47 (0.78)	-0.28 (0.93)	16.54***	0.38
Trust in child's ability to be PA	3.54 (0.82)	3.26 (0.94)	-0.28 (1.25)	12.50***	0.25
Perceived benefit of health	3.78 (0.96)	3.78 (1.03)	0.00 (1.41)	0.01	0.00
Perceived benefit of meeting (new) friends	3.88 (0.79)	3.81 (1.00)	-0.07 (1.27)	0.67	0.07
Perceived benefit of fun	4.52 (0.69)	4.30 (0.91)	-0.22 (1.14)	6.62*	0.25
Perceived benefit of being better than others	2.43 (1.05)	2.43 (1.18)	0.00 (1.58)	0.01	0.00
Perceived benefit of not feeling bored	3.47 (1.13)	3.43 (1.10)	-0.04 (1.58)	0.03	0.03
Perceived benefit of weight loss	2.31 (1.19)	2.63 (1.27)	0.32 (1.74)	10.50**	0.19
Perceived barrier of lack of time	2.34 (1.05)	2.51 (1.16)	0.17 (1.56)	2.30	0.13
Perceived barrier of not liking sports	1.89 (0.99)	2.14 (1.20)	0.25 (1.56)	6.81**	0.17
Perceived barrier of not being good at sports	1.84 (0.93)	1.86 (0.89)	0.02 (2.11)	0.06	0.01
Perceived barrier of not being allowed to sport	1.25 (0.70)	1.18 (0.45)	-0.07 (0.83)	1.19	0.11
Perceived barrier of lack of transportation to sport activities	1.97 (1.07)	1.86 (0.95)	-0.11 (1.43)	1.03	0.09
<i>Boys (n = 157)</i>					
<i>Boys' report</i>					
Attitude	4.58 (0.67)	4.44 (0.77)	-0.14 (1.02)	2.31	0.14
Parental support	3.20 (1.28)	3.35 (1.10)	0.15 (1.69)	1.34	0.12
Friend co-participation	3.71 (1.22)	3.78 (1.01)	0.07 (1.58)	1.86	0.05
Social norm	4.15 (0.99)	4.06 (0.99)	-0.09 (1.40)	0.26	0.08
Self-efficacy	3.73 (0.83)	3.67 (0.77)	-0.06 (1.13)	0.47	0.06
Perceived benefit of health	4.46 (0.72)	4.40 (0.63)	-0.06 (0.96)	0.74	0.08
Perceived benefit of meeting (new) friends	4.18 (0.84)	4.04 (0.79)	-0.14 (1.15)	3.22(*)	0.15
Perceived benefit of fun	4.47 (0.73)	4.34 (0.72)	-0.13 (1.03)	4.14*	0.14
Perceived benefit of being better than others	2.48 (1.12)	2.85 (1.14)	0.37 (1.60)	8.45**	0.28
Perceived benefit of not feeling bored	4.15 (0.96)	4.06 (0.89)	-0.09 (1.31)	0.64	0.08
Perceived benefit of weight loss	3.33 (1.21)	3.26 (1.16)	-0.07 (1.68)	1.44	0.05

Table 3 (continued)

Individual and social environmental factors	Baseline mean (SD)	Follow-up mean (SD)	Change score mean (SD)	Chi-squared test	Cohen's <i>d</i>
Perceived barrier of lack of time	2.07 (1.02)	2.26 (1.02)	0.19 (1.44)	2.92(*)	0.16
Perceived barrier of not liking sports	1.47 (0.84)	1.59 (0.81)	0.12 (1.67)	1.04	0.08
Perceived barrier of not being good at sports	1.59 (0.85)	1.64 (0.74)	0.05 (1.13)	0.20	0.05
Perceived barrier of not being allowed to sport	1.31 (0.69)	1.27 (0.52)	-0.04 (0.86)	0.17	0.06
Perceived barrier of lack of transportation to sport activities	1.63 (0.81)	1.60 (0.76)	-0.03 (1.11)	0.08	0.04
<i>Boys' parental report</i>					
Attitude toward PA	4.50 (0.56)	4.53 (0.58)	0.03 (0.81)	0.67	0.04
Parental support	4.03 (0.86)	3.98 (0.95)	-0.05 (1.28)	0.038	0.04
Social norm	4.71 (0.61)	4.57 (0.63)	-0.14 (0.88)	6.33*	0.19
Trust in child's ability to be PA	3.81 (0.86)	3.61 (0.94)	-0.20 (1.27)	7.69**	0.13
Perceived benefit of health	3.93 (1.05)	3.87 (0.97)	-0.06 (1.43)	0.08	0.05
Perceived benefit of meeting (new) friends	4.12 (0.92)	3.84 (1.02)	-0.28 (1.37)	10.77**	0.23
Perceived benefit of fun	4.64 (0.62)	4.34 (0.83)	-0.30 (1.04)	17.56***	0.33
Perceived benefit of being better than others	2.80 (1.23)	2.93 (1.25)	0.13 (1.75)	1.24	0.08
Perceived benefit of not feeling bored	3.90 (1.15)	3.67 (1.18)	-0.23 (1.65)	5.22*	0.17
Perceived benefit of weight loss	2.35 (1.22)	2.56 (1.13)	0.21 (1.66)	3.96*	0.14
Perceived barrier of lack of time	2.18 (1.18)	2.33 (1.11)	0.15 (1.62)	1.71	0.11
Perceived barrier of not liking sports	1.54 (0.99)	1.87 (1.13)	0.33 (1.50)	16.61***	0.20
Perceived barrier of not being good at sports	1.48 (0.86)	1.66 (0.86)	0.18 (1.22)	7.19**	0.14
Perceived barrier of not being allowed to sport	1.09 (0.31)	1.16 (0.45)	0.07 (0.55)	2.95(*)	0.16
Perceived barrier of lack of transportation to sport activities	1.73 (1.08)	1.65 (0.84)	-0.08 (1.37)	0.31	0.07

Analyses controlled for educational level of mother and father

(*) $0.05 \leq p < 0.10$

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

that girls need more encouragement for PA when they enter adolescence, as it was found in a previous study in the current sample that girls' average daily steps and sports during leisure decreased during the transition to secondary school [5]. Among boys, parental support did not change. This can be due to the fact that overall daily steps among boys did not decrease during the transition from primary to secondary school and the decrease in boys' sports during leisure was smaller among boys than among girls [5]. So, it is likely that parents of boys assumed that boys do not need additional support for PA after the transition to secondary school. Another unexpected finding was the fact that the perceived benefit of being better than others increased among boys from primary to secondary school, whereas it was expected that variables would be less positive toward PA after the transition to secondary school.

In general, decreases in individual and social environmental factors toward PA related to a decrease in PA levels and vice versa. This finding is in line with the hypothesis. Among girls, an increase in attitude toward PA was related to an increase in average daily steps and an increase in self-efficacy was related to an increase in sports during leisure. Self-efficacy was found

to be an important correlate of PA in previous cross-sectional [9] and longitudinal studies [43, 44], and this study confirmed this finding but only among girls. Self-efficacy reflects girls' belief in their ability to be physically active in difficult circumstances (e.g., if they have to get up early and if they have a lot of work for school). Attitude toward PA was measured as pleasantness of being physically active. So, girls took more steps per day, if they thought that PA was pleasant, or in other words, when they are autonomously motivated. This is a positive result, as autonomous motivation is related to PA in the long term [45]. Future interventions aiming to increase overall PA and sports among girls should focus on the increase of individual factors such as attitude and self-efficacy toward PA. However, effect sizes that were found in the current study were low, so efforts to increase attitude and self-efficacy should not be conducted as a stand-alone intervention but as part of multicomponent interventions in order to obtain larger effects on PA. Interventions focusing on the enhancement of girls' beliefs in their ability to be physically active may lead to higher PA levels. This can be done using different behavior change techniques such as prompting barrier identification, providing

Table 4 Associations of changes in individual and social environmental factors with changes in objectively measured physical activity

Dependent variable	Independent variables	<i>B</i> (SE)	Chi-squared test	<i>P</i> value	Percent variance explained at individual level
<i>Girls</i>					
Girls' change in average daily steps (steps/day) (<i>n</i> = 136)	<i>Girls' report</i>				
	Attitude	1012.9 (374.9)	7.298	0.007	5.4 %
	Parental support	539.3 (355.6)	2.301	0.129	
	Social norm	−58.0 (236.3)	0.060	0.807	
	Self-efficacy	110.3 (342.1)	0.104	0.747	
	Perceived benefit of health	120.4 (373.3)	0.104	0.747	
	Perceived benefit of not feeling bored	88.7 (258.7)	0.118	0.731	
	Perceived benefit of weight loss	−232.0 (193.3)	1.440	0.230	
	Perceived barrier of not liking sports	266.0 (344.9)	0.595	0.440	
	Perceived barrier of not being good at sports	253.5 (326.9)	0.601	0.438	
	<i>Parental report</i>				
	Attitude	316.474 (425.900)	0.552	0.458	
	Family support	571.696 (405.1)	1.992	0.158	
	Parental trust in children's ability to be physically active	−53.44 (322.6)	0.027	0.869	
	Perceived benefit of health	98.5 (237.7)	0.172	0.678	
	Perceived benefit of meeting (new) friends	172.6 (275.0)	0.394	0.530	
	Perceived benefit of not feeling bored	−170.6 (242.3)	0.496	0.481	
Perceived barrier of not liking sports	−261.0 (269.2)	0.940	0.332		
<i>Boys</i>					
Boys' change in average daily steps (steps/day) (<i>n</i> = 127)	<i>Boys' report</i>				
	Attitude	771.9 (645.4)	1.430	0.232	
	Parental support	172.0 (450.6)	0.146	0.702	
	Friend co-participation	295.6 (323.7)	0.834	0.361	
	Social norm	34.5 (320.3)	0.012	0.913	
	Self-efficacy	777.6 (534.8)	2.114	0.146	
	Perceived benefit of health	682.3 (582.8)	1.371	0.242	
	Perceived benefit of fun	−718.2 (606.2)	1.404	0.236	
	Perceived benefit of not feeling bored	52.0 (379.2)	0.019	0.890	
	Perceived barrier of lack of time	−794.5 (379.5)	4.383	0.036	3.9 %
	Perceived barrier of not being good at sports	−214.8 (573.9)	0.140	0.708	
	Perceived barrier of lack of transportation to sport activities	153.0 (538.3)	0.081	0.776	
	Perceived barrier of not being allowed to sport	−367.8 (766.5)	0.230	0.632	
	<i>Parental report</i>				
	Attitude	−203.1 (775.9)	0.069	0.793	
	Parental support	539.3 (560.9)	0.924	0.336	
	Social norm	−466.4 (647.3)	0.519	0.471	
Parental trust in children's ability to be physically active	432.4 (486.3)	0.791	0.374		
Perceived benefit of health	136.0 (380.5)	0.128	0.721		
Perceived benefit of fun	589.8 (555.3)	1.128	0.288		
Perceived benefit of not feeling bored	−4.9 (297.1)	0.001	0.999		
Perceived barrier of lack of time	−31.6 (321.4)	0.010	0.920		
Perceived barrier of not being good at sports	−211.2 (535.3)	0.156	0.693		
Perceived barrier of lack of transportation to sport activities	−1023.2 (470.7)	4.725	0.030	3.9 %	
Perceived barrier of not being allowed to sport	−128.3 (762.8)	0.028	0.867		

All analyses controlled for education level of mother and father. Analyses concerning average daily steps were also controlled for type of measurement instrument. Bold values indicate significant association

SE standard error

Table 5 Associations of changes in individual and social environmental factors with changes in self-reported physical activity

Dependent variable	Independent variables	B (SE)	Chi-squared test	P value	Percent variance explained at individual level
<i>Girls</i>					
Girls' change in sports during leisure time (<i>n</i> = 132)	<i>Girls' report</i>				
	Attitude	0.893 (2.322)	0.148	0.345	
	Parental support	0.323 (2.278)	0.020	0.888	
	Friend co-participation	0.235 (1.319)	0.032	0.858	
	Social norm	−0.357 (1.579)	0.051	0.821	
	Self-efficacy	4.291 (2.071)	4.295	0.038	3.1 %
	Perceived benefit of health	0.148 (2.12)	0.004	0.950	
	Perceived benefit of meeting (new) friends	0.471 (1.876)	0.063	0.802	
	Perceived benefit of fun	0.649 (2.413)	0.072	0.788	
	Perceived benefit of not feeling bored	−0.587 (1.813)	0.105	0.746	
	Perceived barrier of lack of time	−2.244 (1.621)	1.917	0.166	
	Perceived barrier of not liking sports	−2.166 (2.342)	0.855	0.355	
	Perceived barrier of not being good at sports	−0.090 (2.178)	0.002	0.964	
	<i>Parental report</i>				
	Parental support	1.351 (2.586)	0.273	0.601	
	Parental trust in child's ability to be physically active	−0.779 (2.022)	0.148	0.700	
	Perceived benefit of health	1.901 (1.532)	1.540	0.215	
	Perceived benefit of fun	−1.529 (2.195)	0.485	0.486	
	Perceived benefit of being better than others	2.259 (1.506)	2.252	0.133	
	Perceived benefit of not feeling bored	0.573 (1.557)	0.136	0.712	
Perceived barrier of lack of time	0.210 (1.401)	0.023	0.879		
Perceived barrier of not liking sports	−1.283 (1.908)	0.452	0.501		
Girls' change in active transportation to and from school ^a (<i>n</i> = 140)	<i>Girls' report</i>				
	Attitude	0.007 (0.033)	0.050	0.823	
	Perceived benefit of health	0.070 (0.034)	4.212	0.040	0.0 %
	Perceived barrier of not being allowed to sport	0.099 (0.042)	5.648	0.017	1.8 %
	<i>Parental report</i>				
	Attitude	0.068 (0.043)	2.499	0.114	
	Perceived benefit of being better than others	0.049 (0.023)	4.433	0.035	1.8 %
Girls' change in walking for transport during leisure time ^a (<i>n</i> = 140)	<i>Girls' report</i>				
	Perceived barrier of lack of time	0.004 (0.020)	0.034	0.854	
	Perceived barrier of not liking sports	0.011 (0.023)	0.239	0.625	
	<i>Parental report</i>				
	Perceived benefit of fun	−0.021 (0.022)	0.936	0.333	
Perceived barrier of lack of time	0.021 (0.017)	1.560	0.212		
Girls' change in cycling for transport during leisure time ^a (<i>n</i> = 146)	<i>Girls' report</i>				
	Social norm	0.017 (0.014)	1.385	0.239	
	Perceived benefit of weight loss	0.020 (0.013)	2.300	0.129	
	Perceived barrier of not being allowed to sport	−0.047 (0.029)	2.649	0.104	
<i>Boys</i>					
Boys' change in sports during leisure time (<i>n</i> = 120)	<i>Boys' report</i>				
	Attitude	−3.986 (5.133)	0.603	0.437	
	Parental support	8.147 (3.432)	5.635	0.018	3.9 %
	Friend co-participation	4.228 (2.465)	2.943	0.086	
	Social norm	−2.902 (2.510)	1.336	0.248	
	Self-efficacy	5.523 (4.396)	1.578	0.209	
	Perceived benefit of health	0.770 (4.793)	0.026	0.872	
	Perceived benefit of meeting (new) friends	3.020 (3.296)	0.839	0.360	
	Perceived benefit of fun	0.497 (4.741)	0.011	0.916	
	Perceived benefit of not feeling bored	0.156 (2.852)	0.003	0.956	
	Perceived barrier lack of time	−0.257 (2.473)	0.011	0.916	
	Perceived barrier of not being good at sports	−0.602 (4.287)	0.020	0.888	

Table 5 (continued)

Dependent variable	Independent variables	B (SE)	Chi-squared test	P value	Percent variance explained at individual level	
Boys' change in active transportation to and from school ^a (n = 134)	Perceived barrier of not being allowed to sport	-3.645 (5.130)	0.505	0.477	7.7 %	
	<i>Parental report</i>					
	Attitude	7.400 (6.300)	1.380	0.240		
	Parental support	0.312 (4.220)	0.005	0.944		
	Social norm	2.833 (5.283)	0.293	0.588		
	Parental trust in child's ability to be physically active	2.581 (3.790)	0.464	0.495		
	Perceived benefit of health	-0.665 (2.855)	0.054	0.816		
	Perceived benefit of fun	-0.494 (4.456)	0.012	0.913		
	Perceived benefit of being better than others	1.914 (2.076)	0.850	0.357		
	Perceived benefit of not feeling bored	-2.477 (2.425)	1.044	0.307		
Boys' change in walking for transport during leisure time ^a (n = 140)	Perceived barrier of not liking sports	-8.907 (3.186)	7.817	0.005	4.2 %	
	Perceived barrier of not being allowed to sport	-7.796 (5.336)	0.808	0.369		
	<i>Boys' report</i>					
	Self-efficacy	0.074 (0.054)	1.863	0.172		
	Perceived benefit of health	0.024 (0.054)	0.208	0.648		
	Perceived benefit of fun	0.004 (0.052)	0.005	0.944		
	Perceived barrier of lack of time	-0.038 (0.032)	1.445	0.229		
	Perceived barrier of not liking sports	-0.032 (0.049)	0.434	0.510		
	<i>Parental report</i>					
	Perceived benefit of weight loss	0.044 (0.030)	2.188	0.139		
Boys' change in cycling for transport during leisure time ^a (n = 134)	Perceived barrier of not being good at sports	-0.005 (0.044)	0.016	0.899	4.2 %	
	<i>Boys' report</i>					
	Perceived benefit of health	0.039 (0.026)	2.268	0.132		
	Perceived benefit of weight loss	0.006 (0.014)	0.183	0.669		
	Perceived barrier of lack of time	0.020 (0.016)	1.588	0.208		
	Perceived barrier of lack of transportation to sport activities	0.016 (0.022)	0.530	0.467		
	<i>Parental report</i>					
	Attitude	0.032 (0.031)	1.049	0.306		
	Parental support	0.056 (0.025)	5.194	0.023		
	Perceived benefit of weight loss	0.027 (0.015)	3.274	0.070		
Perceived barrier of not liking sports	0.042 (0.018)	5.386	0.020			
Boys' change in cycling for transport during leisure time ^a (n = 134)	<i>Boys' report</i>					
	Attitude	-0.004 (0.065)	0.005	0.944		
	Friend co-participation	0.056 (0.036)	2.410	0.121		
	Social norm	0.037 (0.035)	1.113	0.291		
	Self-efficacy	0.009 (0.054)	0.029	0.865		
	Perceived benefit of health	-0.019 (0.062)	0.092	0.762		
	Perceived benefit of being better than others	0.029 (0.030)	0.924	0.336		
	Perceived benefit of not feeling bored	0.003 (0.040)	0.006	0.938		
	Perceived barrier of not being good at sports	-0.007 (0.062)	0.014	0.906		
	Perceived barrier of not being allowed to sport	-0.113 (0.075)	2.243	0.134		
	<i>Parental report</i>					
	Attitude	-0.015 (0.085)	0.033	0.856		
	Family support	0.065 (0.055)	1.388	0.239		
	Social norm	0.011 (0.066)	0.028	0.867		
	Parental trust in children's ability to be physically active	-0.008 (0.054)	0.023	0.879		
	Perceived benefit of health	0.011 (0.040)	0.076	0.783		
	Perceived benefit of fun	0.034 (0.057)	0.351	0.534		
	Perceived benefit of not feeling bored	0.011 (0.032)	0.122	0.727		

All analyses controlled for education level of mother and father. Analyses concerning average daily steps were also controlled for type of measurement instrument. Bold values indicate significant association

SE = standard error

^a Log transformed to improve normality

instructions on how to perform the behavior, and setting graded tasks [46]. Offering girls pleasant physical activities and allowing girls to choose in which sport they prefer to participate may lead to a more positive attitude toward PA and consequently to more average daily steps among girls.

Also, increases in the perceived benefits of health and being better than others and the perceived barrier of not being allowed to sport were related to increases among girls' active transportation to school. The positive association between changes in the perceived barrier of not being allowed to sport and changes among girls' active transportation to school was in the other direction than expected. However, the explained variance in active transportation to school due to these factors was very low (<2 %). This might be due to the fact that the individual and social environmental factors were formulated toward PA and sports in general. It is possible that changes in individual and social environmental factors that are specifically formulated toward active transportation would explain more of the variance in active transportation among boys and girls. It is also possible that changes in other factors (e.g., physical environmental factors such as the availability of walk/cycle facilities [5]) are more important to explain changes in active transportation.

Among boys, a decrease in the perceived barriers lack of time and in the parental perceived barrier of lack of transportation to sport activities were related to an increase in boys' average daily steps. Furthermore, an increase in parental support was related to an increase in boys' sports during leisure and to an increase in walking for transportation during leisure. This indicates that, although children's autonomy increases when they make the transition to secondary school, it remains important for parents to encourage their son to be physically active when they grow older and to provide transportation to sport activities, after the transition to secondary school. In another Belgian study, the supportive role of parents during primary school was also identified as an important positive predictor of adolescents' PA in secondary school [47]. As changes in the perceived barrier lack of time were negatively related to changes in average daily steps, action planning might help boys to engage more in PA [46]. An increase in the parental perceived barrier of not liking PA explained a relatively large proportion (7.7 %) of the variance in sports during leisure among boys. So, similar as among girls, it is important to offer sports activities to boys that are attractive and pleasant.

Based on the results of this study, it can be concluded that changes in individual factors (i.e., attitude and self-efficacy) mainly explain the declines among girls' PA, whereas changes in barriers toward sports (i.e., barrier of lack of time, lack of transportation, and not liking sports) and parental support mainly explained changes among boys' PA during the transition from primary to secondary school.

Changes in social norm and friend co-participation were unrelated to changes in any PA domain, indicating that increasing

social norm and friend co-participation would probably not lead to more PA during the transition from primary to secondary school among boys and girls. However, in a longitudinal study in the UK during the transition from primary to secondary school, it was found that an increased number of friends and friend support for physical activity were related to increases in girls' moderate- to vigorous-intensity physical activity [48]. So, it is likely that other forms of friend support than co-participation may be important to explain changes in PA among girls.

The longitudinal design, the relatively high response rate (considering the 2-year time gap and the multiple sources of data), and the combination of self-reported and objective assessment of PA were strengths of this study. A first limitation of the study is the combination of accelerometers and pedometers that was used to determine average daily steps. To overcome this problem, all analyses concerning daily steps were controlled for the type of monitor used, and only children who wore the same device type at baseline and follow-up were included. Furthermore, mothers of children who participated in the follow-up measurements were slightly higher educated compared to parents who did not participate at follow-up. This could limit the generalizability of the current findings. It is possible that children from lower-educated parents were less allowed by their parents to participate at follow-up, as their parents are probably less aware of the benefits of PA research. Besides, children who dropped out were also less engaged in active transportation to and from school at baseline. A possible explanation might be that these children were less interested in PA research than children who were more engaged in active transportation at baseline.

Besides, only individual and social environmental variables were included in the analyses. Previous research has shown that also physical neighborhood environmental [5] and school environmental variables [12] explain changes in PA, so in future studies, including these factors to explain PA levels is important.

Conclusions

Individual and social environmental factors toward PA were less positive toward PA and sports when children made the transition from primary to secondary school. These changes were mainly present among girls. The prevention of adverse changes in attitude and self-efficacy may lead to a smaller decrease or an increase in PA when girls made the transition to secondary school, whereas among boys, more focus is needed on the decrease of barriers and the increase of parental support. However, the explained variance of changes in individual and social environmental factors in changes in PA during the transition from primary to secondary school was small. So, multicomponent interventions that focus on other factors besides individual and social environmental factors are needed, in order to obtain large effects on PA.

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Compliance with Ethical Standards The authors confirm that all procedures were performed in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Parental informed consent was obtained from all individual participants included in the study.

Conflict of Interest Sara D’Haese, Greet Cardon, Ilse De Bourdeaudhuij, Benedicte Deforche, Femke De Meester, and Delfien Van Dyck declare that they have no conflict of interest.

Author’s Contributions All authors read and approved the final version of the manuscript. FDM coordinated the data collection. SDH conducted the statistical analyses and drafted the manuscript. FDM, GC, DVD, BD, and IDB participated in the interpretation of the data, revised the draft versions of the manuscript, and provided critical comments during the process.

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