Physical activity and school absenteeism due to illness in adolescents

Physical activity and school absenteeism due to illness in adolescents

Renate de Groot, PhD
Full professor
Welten Institute, Faculty of Psychology and Educational Sciences, Open University of the Netherlands
Valkenburgerweg 177, 6419 AT Heerlen, the Netherlands
Phone: +31 45 576 2624
And
Department of Complex Genetics, School for Nutrition, Toxicology and Metabolism (NUTRIM), Faculty of Health, Medicine and Life Sciences, Maastricht University
P.O. Box 616, 6200 MD, Maastricht, the Netherlands
Phone: +31 43 388 1476
Renate.degroot@ou.nl

Martin van Dijk, PhD
Lecturer
Welten Institute, Faculty of Psychology and Educational Sciences, Open University of the Netherlands
Valkenburgerweg 177, 6419 AT Heerlen, the Netherlands
Phone: +31 45 576 2624
And
School of Sport Studies, Fontys University of Applied Sciences, the Netherlands
Theo Koomenlaan 3
5644 HZ Eindhoven
Phone: +31 88 508 1111
martin.vandijk@fontys.nl

Hans Savelberg, PhD
Full Professor
Department of Human Movement Sciences, Maastricht University
P.O. Box 616, 6200 MD Maastricht, the Netherlands
Phone: +31 43 388 1392

Hans.savelberg@maastrichtuniversity.nl

Frederik van Acker, PhD
Associate Professor
Welten Institute, Faculty of Psychology and Educational Sciences, Open University of the Netherlands
Valkenburgerweg 177, 6419 AT Heerlen, the Netherlands
Phone: +31 45 576 2624
Fvacker@gmail.com

Paul Kirschner, PhD
Full Professor
Welten Institute, Faculty of Psychology and Educational Sciences, Open University of the Netherlands
Valkenburgerweg 177, 6419 AT Heerlen, the Netherlands
Phone: +31 45 576 2624
Paul.kirschner@ou.nl

ABSTRACT

BACKGROUND Knowledge about the beneficial role of physical activity (PA) for health and school performance is growing. Studies investigating the link between PA and school absenteeism due to illness are lacking. Therefore we investigated associations between habitual PA and school absenteeism due to illness in adolescents and explored whether mental health and cardiovascular fitness mediated this association.

METHODS 328 students in grades 7 and 9 (mean age 13.8 years; 49% boys) were included. PA was measured objectively by an ActivPAL3™ accelerometer attached on the thigh during one full week (24 hours/day). Depressive symptoms and self-esteem were self-reported by the Center for Epidemiologic Studies Depression Scale (CES-D) and Rosenberg Self-Esteem Scale respectively and included as a proxy for mental health in the analyses. Cardiovascular fitness was measured by the 20-m shuttle run test. School absenteeism due to illness data was provided by the school administration.

RESULTS PA was not significantly associated with school absenteeism, though there was an indirect association between PA and school absenteeism by cardiovascular fitness.

CONCLUSIONS Cardiovascular fitness mediates the association between PA and school absenteeism due to illness. Thus cardiovascular fitness of students should be improved to reduce school absenteeism due to illness.

KEY WORDS physical activity, adolescents, school health, absenteeism

Physical activity (PA) has been shown to have beneficial health effects in adolescents, such as improved mental health[1] and cardiovascular fitness.[2] While many health benefits of PA are well-documented, no study has yet investigated a possible association between PA and decreased school absenteeism due to illness in adolescents. Nonetheless, school absenteeism is a topic of high importance, because high rates of school absenteeism are related to decreased relationships with peers on school[3], learning delays, lower academic achievement[4] and school drop-out.[5] Therefore, the main goal of this study was to investigate the association between PA and school absenteeism due to illness in adolescents.

Thus far the relationship between PA and school absenteeism in adolescents has not been studied. PA, or variables related to PA, associated with illness-related absenteeism in adult workers have been studied though.

Jacobson et al. reported a negative relation between exercise-frequency and illness-related absenteeism in American adult workers.[6] One day of exercise per week was associated with lower absenteeism when compared with no exercise, and two days of exercise per week was more favorable than one day. These data suggest a significant relationship between exercise frequency and illness-related absenteeism. The authors suggested that PA affects certain immune functions and improves mental health, resulting in decreased absenteeism rates. Mental health might be an important mediator in the association between PA and school absenteeism, because PA is positively related to mental health[1]. In turn, mental health outcomes, such as depression[7] and self-esteem[8], play a major role in school absenteeism.[9-10]

Van den Heuvel et al found in a Dutch adult population that employees practicing physical sports take 21% less sick leave days than their colleagues not practicing sports. [11] They suggested that participation in sports enhances physical

capacities, thus facilitating a quick recovery. Surprisingly, no effect was found for the duration of practicing sports (ie, number of years and intensity of sport participation), which might be due to the research method of self-report.[12]

Finally, Tucker, Aldana and Friedman found that high levels of cardiovascular fitness were significantly associated with low levels of absenteeism in American adult workers. [12] Their most plausible explanation is that cardiovascular fitness leads to improved health and healthier employees are less likely to be absent. PA is positively related to cardiovascular fitness,[2,13] therefore cardiovascular fitness might mediate the association between PA and school absenteeism.

The main aim of the present study was to investigate the association between habitual PA levels and school absenteeism due to illness in adolescents. In addition, it explored whether mental health, measured by feelings of depressive symptoms and self-esteem, and cardiovascular fitness mediated the association between PA and school absenteeism. Variables related to PA and school absenteeism include sex, ethnicity, socioeconomic status, and weight status.[2,8,14-18] These variables were measured and controlled for statistically to avoid possible confounding effects.

METHODS

Participants

All participants are derived from The GOALS (Grootschalig Onderzoek naar Activiteiten van Limburgse Scholieren [Large-scale Research of Activities in Dutch Students]) Study. Originally the main goal of this study was to investigate the associations between objectively measured PA and cognitive performance and academic achievement in adolescents.[19] The GOALS Study was conducted at a secondary school in the south of the Netherlands. Data collection took place from

October 2011 to March 2012. Ethical permission was given by the local Ethical Committee of the Open University of the Netherlands.

A sample of 440 Dutch adolescents in grades 7 and 9 of senior general secondary education or university preparatory education was willing to participate. Of this sample, 112 students were excluded from analyses because of health or concentration problems, illness or injuries throughout the entire data-collection week, measurement failures of the accelerometer during the data-collection week, or non-compliance to accelerometer wear-time of at least two weekdays and both weekend days. As a result, 328 participants were included in analyses.

Instrumentation

Physical activity. The ActivPAL3™ accelerometer (Paltechnologies, Glasgow, UK) was used to measure habitual PA levels during a normal school week. This device (53 × 35 × 7 mm) measures body accelerations and identifies the wearer's posture. Data were recorded at 20 Hz and summarized in 15-second time intervals (epochs).

Data were downloaded and processed with ActivPAL™ Professional software (version 6.4.1). A valid day was considered to be a day that the student wore the accelerometer for the whole day (24 hours of wear time). Atypical schooldays (weekdays without school lessons) and days when the student reported being ill or injured in his/her diary were excluded. Because the accelerometer was taped at the thigh of the students, non-wear time was not an issue. Nevertheless, the weekly overviews of the accelerometer data were used to determine whether the accelerometer was removed during the week; see for details and figures Van Dijk et al.[20]

According to prescribed accelerometer testing protocols, at least four valid days were required to determine the total PA volume per week.[21] In addition, complete accelerometer data for both Saturday and Sunday were required to be included in the analyses because PA-levels in adolescents differ significantly between weekdays and both weekend days.[20] Taken together, habitual PA levels were based on at least four complete days (24 hours of wear time), including both weekend days. The total PA volume per week was determined by the total number of accelerometer steps per week.

School absenteeism due to illness. The total number of school days that the participants were absent from school due to illness throughout the entire academic year was used as continuous measure of school absenteeism. School absenteeism data were registered by the school administration and at the end of the academic year provided to the research team. Students were registered absent due to illness in case the parents/guardians called the school administration on the first school day of illness. In addition, when students returned from illness, they had to hand in a signed letter from their parents/guardians confirming their illness. Days were counted only when school absenteeism was registered as ill. Other absences, such as dentist visit or wedding, were not counted as school absenteeism due to illness.

Mental health. Depressive symptoms were measured by the Center for Epidemiologic Studies Depression Scale (CES-D) designed by Radloff.[22] In this self-report scale, participants rated the frequency of 20 depressive symptoms over the previous week. The answers were: (0) Rarely or none of the time (on average less than 1 day), (1) Some or a little of the time (1-2 days), (2) Occasionally or a moderate amount of time (3-4 days), and (3) Most or all of the time (5-7 days). A total severity score was calculated by summing all items (positively worded items

were reverse-scored), ranging from 0 (not depressed) to 60 (a high amount of depressive symptoms).

Self-esteem was measured by the Rosenberg Self-Esteem Scale.[23] The scale consists of ten statements dealing with general feelings about the participant's own self. The statements were answered by: (0) Strongly agree, (1) Agree, (2) Disagree, (3) Strongly Disagree. The self-esteem score is calculated by summing all items (negatively worded items were reverse-scored) and ranges from 0 (minimum score of self-esteem) to 30 (maximum score of self-esteem).

Cardiovascular fitness. The 20-m shuttle run test was used to measure cardiovascular fitness.[24] This test consisted of 1-min stages of continuous incremental pace running. Participants were required to run between two lines placed on the floor 20 meters apart while keeping pace with audio signals. All measurements were carried out under standardized conditions on an indoor rubber-floored gymnasium. The initial speed was 8.5 km/h, which increased by 0.5 km/h each successive minute, reaching the maximum of 18.0 km/h at minute 20. Students were encouraged to continue running as long as possible throughout the course of the test. An extra incentive was given to the students to reach maximal capacity by giving them a mark for their performance, which counted in their final grade for physical education at school. The 20-m shuttle run test was considered to be finished when a student failed to reach the end lines concurrent with the audio signals on two consecutive occasions. Otherwise, the test ended when the participant stopped because of fatigue. The last completed stage or half-stage at which the participant dropped out was recorded. By using this score and the variables sex, age, and BMI, the maximal oxygen consumption (VO_2 max), considered as the best single marker for cardiovascular fitness,[25] was estimated using the equation of Matsuzaka et al.[26]:

VO_2 max (in ml/kg/min) = 25.9 - 2.21 * Sex - 0.449 * Age - 0.831 * BMI + 4.12 * (8 + 0.5 * 20-m shuttle run test score).

This equation was validated in children and adolescents and correlated strongly ($r = .80$, $p < .001$) with maximal oxygen consumption measured directly on a treadmill.[26]

Covariates. Sex (coded as 0 = boys, 1 = girls), ethnicity (coded as 0 = native Dutch, ie, both parents/guardians born in the Netherlands, 1 = non-native Dutch), academic year (coded as 0 = grade 7, 1 = grade 9), and school level (coded as 0 = senior general secondary education [HAVO] and 1 = university preparatory education [VWO]) were dichotomized.

Socioeconomic status was determined by the highest educational level of the parents or guardians, and coded as 'low-medium' = 0 in case the parents and or guardians had at most secondary vocational education level. In all other cases, SES was coded as 'high' = 1, following the Dutch national classification.[27]

Weight status (coded as 0 = normal weight, 1 = overweight/obesity) was classified based on the sex-specific body mass index-for-age percentile defined by the CDC growth charts: normal weight < 85th percentile, overweight/obesity ≥ 85th percentile.[28] Weight in kg (rounded) and height in meters (two decimals) were measured in light clothing without shoes by one of the researchers. The body mass index was then calculated by dividing the weight by the height squared.

Procedure

Before the start of the study, information about the background, goals, and procedure was distributed to the students and parents/guardians of the selected classes. The majority of the invited students (83.7%) participated in the study, a few

were absent during the data-collection week or their parents/guardians had serious objections.

At the begin of the study, ActivPAL3™ accelerometers were taped on the midpoint of the anterior part of the right thigh of the participants using a Tegaderm™ (3M, St. Paul, MN, US) transparent film roll. Participants were requested to wear the device continuously for one full week, 24 hours/day. Participants were allowed to shift the device to the left thigh if it irritated their skin, which might have increased the compliance. To this end, a pilot study employing 23 students wearing an ActivPAL3™ accelerometer for one complete day on both legs found an almost perfect Pearson's correlation ($r = .997$, $p < .001$) in the number of accelerometer steps between the left and right thigh. Then participants took a 20-m shuttle-run test and completed several questionnaires. In addition, participants were asked to keep a diary during the full week in which they reported relevant details such as problems with the accelerometer, illness, or injuries. Exactly one week later, participants returned their accelerometers and diaries. After finishing the study, participants received a gift voucher of 15 euro for their full participation. At the end of the academic year, absence lists throughout the entire academic year were provided by the school.

Data analysis

Analyses were performed with SPSS for Windows (version 19.0; SPSS, Inc, Chicago, Illinois). The level of significance was .05. The distribution of the p-p plots was normal for all tested models. There was no multicollinearity in the regression models (all Pearson's correlations < .80). The reported results of the linear regression analyses exclude outliers (> 3 standard deviations).

Sex differences in school absenteeism, mental health and cardiovascular fitness were analyzed by independent sample t tests.

Associations between PA and school absenteeism, as well as between PA and mental health, and cardiovascular fitness, were analyzed by multiple linear regression analyses. First, associations between covariates and respective outcome variables were modeled (step A). This step allows for the control of possible confounding effects of covariates. Second, PA was added to the model (step B). This step allows investigation of the added explained variance of PA to the model.

Finally, whether the association between PA and school absenteeism was mediated by mental health or cardiovascular fitness was analyzed using the method of Preacher and Hayes.[29] According to Preacher and Hayes tests of mediation are relevant even in the absence of a direct effect between two variables. [30] Therefore mediation analyses were performed even when a direct effect was not present.

RESULTS

The descriptive statistics are shown in Table 5.1. Boys were more active than girls. There was no significant difference between boys and girls in school absenteeism due to illness. Boys reported significantly higher levels of self-esteem and lower levels of depressive symptoms than did girls. In addition, boys had higher levels of cardiovascular fitness than girls.

PA was not significantly associated with school absenteeism due to illness ($\beta = -.06$, $p = .292$), see Table 1.

PA was positively associated with cardiovascular fitness ($\beta = .21$, $p < .001$), see Table 2. Therefore, a basic requirement for an indirection association was fulfilled for cardiovascular fitness in the association between PA and school

absenteeism. In addition, cardiovascular fitness was negatively associated with school absenteeism due to illness (β = -.23, p = .002). As a result, the second requirement for an indirect association was fulfilled. Bootstrap analysis for mediation models showed a negative indirect relationship between PA and school absenteeism through cardiovascular fitness (coefficient= -.0395; bootstrap confidence intervals between -.0136 and -.0756). It can be concluded that there is an indirect relationship between PA and school absenteeism through cardiovascular fitness.

PA was neither significantly associated with depressive symptoms (β = -.05, p = .363) nor with self-esteem (β = .05, p = .390). Therefore, a basic requirement for an indirect association was not fulfilled for mental health in the association between PA and school absenteeism. Moreover, neither the relationships between depressive symptoms (β = .07, p = .163) nor self-esteem (β = .02, p = .639) with absenteeism were significant. It can thus be concluded that there is no indirect association between PA and school absenteeism through mental health.

DISCUSSION

The results of this study in healthy adolescents showed that habitual PA levels were not significantly associated with school absenteeism due to illness. Though, PA was positively associated with cardiovascular fitness and indirectly associated with lower school absenteeism by cardiovascular fitness. In other words, cardiovascular fitness mediated the association between PA and school absenteeism. In addition, PA was not significantly associated with mental health. Consequently, mental health did not mediate the association between PA and school absenteeism. To the best of our knowledge, this is the first study investigating the association

between objectively measured PA and school absenteeism due to illness in adolescents.

Results of this study are not in line with previous studies of Jacobsen et al.[6] and Van Den Heuvel et al.,[11] who reported lower absenteeism rates in adult workers who are physically active. An explanation might be that, in these studies, PA was measured by a questionnaire. This subjective instrument has been found to have several limitations, such as social desirability and recall bias,[31] which might have biased the results. We measured PA objectively, thus our results are not prone to social desirability or recall bias. Though, the contrast between our results and the results of Jacobsen et al.[6] and Van den Heuvel et al.[11] might also be due to differences in age (adolescents versus adults) and context (work versus school absenteeism).

PA was positively associated with cardiovascular fitness, in line with literature.[2,13] In addition, cardiovascular fitness mediated the association between PA and school absenteeism. Because there was no significant direct association between PA and school absenteeism, the mediating role of cardiovascular fitness might be offset by other factors. It is difficult to speculate about factors, which might have impacted the association between PA and school absenteeism, because results were controlled for several potential confounders (sex, ethnicity, academic year, educational level, socioeconomic status and weight status). An explanation might be that long periods of intensive PA, such as training and competing in intensive physically sports, may result in chronic fatigue and injuries[32] and consequently more absence days. Therefore, there might be an optimal PA level related to health and consequently school absenteeism. However, additional analyses of our data showed

no significant inverted U-shaped association between PA and school absenteeism due to illness, therefore this suggestion has to be taken with caution.

Finally, habitual PA was not significantly associated with higher levels of self-esteem and lower levels of depressive symptoms. A previous publication using data of The GOALS Study showed that PA was, in unadjusted models, positively associated with self-esteem and inversely associated with depressive symptoms.[20] Therefore, it is concluded that the association between PA and mental health tend to be positive, but the effect is small, which is in line with many studies in this field.[1] Due to the several factors (genetic factors, personality, socioeconomic status, and other lifestyle habits), which interact and jointly affect mental health,[33] the association between PA and mental health in adolescents seems to be complex and weak at most.

The major strength of our study is that PA was measured objectively by an ActivPAL3™ accelerometer, which has been found to be a reliable and user-friendly instrument to investigate PA in adolescent girls[34] and young adults.[35] In addition, we used stringent inclusion criteria (ie, ≥ 4 complete days of accelerometer wear time including both weekend days), which increases the accuracy and predictability of our independent variable. Finally, results were controlled for several potential confounders.

Our study has some limitations. First, the cross-sectional design makes it impossible to draw causal relations. Second, results cannot be generalized to the whole Dutch population because only one secondary school was used, despite of the study sample was equally distributed by sex and the mean BMI was similar to the overall Dutch adolescent population.[36] Third, cardiovascular fitness levels of the adolescents in our study sample (maximal oxygen consumption of 52 ml/kg/min on

average) were high compared to the fitness levels in several studies in 12 to 18 years old European adolescents (41 ml/kg/min), see review of Ortega et al.[37] However, the participants in our study sample were stimulated to reach maximal capacity on the shuttle-run test by giving them a mark for their performance, which counted in their final grade for physical education at school. This has not been the case in the studies in European adolescents published by Ortega et al.[37] As a consequence, adolescents in our study sample were possibly better motivated to perform well on the shuttle-run test, resulting in higher and more reliable cardiovascular fitness levels in our study sample compared to the study samples reported by Ortega et al.[37] Fourth, school absenteeism due to illness data were provided by the school. Days were counted only when absence days were registered due to illness. However, it is still possible that adolescents faked their illness on some absence dates, for example because of a lack of motivation to go to school.

In conclusion, results of this study show no direct association between habitual PA levels and school absenteeism due to illness in adolescents, however, habitual PA is indirectly associated with school absenteeism by cardiovascular fitness. More research into the relations between PA and school absenteeism is necessary to confirm or reject the results of this first study in this field. We suggest future studies to control the data for potential covariates, such as sex, academic year, and weight status, and take cardiovascular fitness into account as mediator.

IMPLICATIONS FOR SCHOOL HEALTH

This study highlights, that although no direct association between PA and absenteeism due to illness was found, the importance of cardiovascular fitness for reducing school absenteeism stimulated by additional PA should not be forgotten.

The implications should however be interpreted with care as the current study only concerns observational data which does not allow causal interpretation. Randomized controlled trials are necessary to show causal proof and should be the goal of future studies. Keeping this in mind, we recommend that school boards and teachers keep stimulating their students to be physically active. This might not only be beneficial for health in general, but by increasing cardiovascular fitness may also lead to reduced school absenteeism and maybe (but this is only hypothetical) in the end to higher school performance. School boards and teachers can do so by:

- Stimulate active commuting to school
- Have exercise breaks during lessons
- Stimulate standing classes
- Have PA lessons on a high intensity level
- Stimulate sport participation outside school
- Have a school environment which challenges students to be physically active (for example during lunch break, but also during classes)

Human Subjects Approval Statement

The local ethical committee of the Open University of the Netherlands approved the study (reference number: U2013/07405/HVM). The school board officially agreed to provide the students and their parents with all the necessary information. This was achieved by distributing information letters and invitations for an information evening. An objection form could be signed in case parents or students themselves were not willing to participate.

ACKNOWLEDGEMENTS

This research was financially supported by the NIHC (Nationaal Initiatief Hersenen & Cognitie [National Initiative Brain & Cognition]) funded by FES (Fonds Economische Structuurversterking [Fund Economic Structure Reinforcement]).

REFERENCES

1. Biddle SJ, Asare M. Physical activity and mental health in children and adolescents: a review of reviews. *Br J Sports Med.* 2011;45:886-895.

2. Hallal PC, Victora CG, Azevedo MR, Wells JC. Adolescent physical activity and health: a systematic review. *Sports Med.* 2006;36:1019-1030.

3. Weitzman M. School absence rates as outcome measures in studies of children with chronic illness. *J Chronic Dis.* 1986;39(10):799-808.

4. Dunn MC, Kadane JB, Garrow JR. Comparing harm done by mobility and class absence: missing students and missing data. *J Educ Behav Stat.* 2003;28:269-288.

5. Kogan SM, Luo Z, Brody GH, Murry VM. The influence of high school dropout on substance use among African American youth. *J Ethn Subst Abuse.* 2005;4:35-51.

6. Jacobson BH, Aldana SG. Relationship between frequency of aerobic activity and illness-related absenteeism in a large employee sample. *J Occup Environ Med.* 2001;43:1019-1025.

7. Kearney CA. School absenteeism and school refusal behavior in youth: a contemporary review. *Clin Psychol Rev,* 2008;28:451-471.

8. Finn JD. Withdrawing from school. *Rev Educ Res.* 1989;59:117-142.

9. Berg I. Absence from school and mental health. *Br J Psychiatry.* 1992;161:154-166.

10. Jones R, Hoare P, Elton R, Dunhill Z, Sharpe M. Frequent medical absences in secondary school students: survey and case-control study. *Arch Dis Child*. 2009;94;763-767.

11. Van den Heuvel SG, Boshuizen, HC, Hildebrandt VH, Blatter BM, Ariens GA, Bongers PM. Effect of sporting activity on absenteeism in a working population. *Br J Sports Med.* 2005;39:e15.

12. Tucker LA, Aldana SG, Friedman GM. Cardiovascular fitness and absenteeism in 8,301 employed adults. *Am J Health Promot*. 1990;5:140-145.

13. Ortega FB, Ruiz JR, Castillo MJ, Sjostrom M. Physical fitness in childhood and adolescence: a powerful marker of health. *Int J Obes.* 2008;32:1-11.

14. Reid, K. The causes, views and traits of school absenteeism and truancy. *Research in Education.* 2005;79:59-82.

15. Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. *Med Sci Sports Exerc,* 2000;32:963-975.

16. Shore SM, Sachs ML, Lidicker JR, Brett SN, Wright AR, Libonati JR. Decreased scholastic achievement in overweight middle school students. *Obesity*. 2008;16:1535-1538.

17. Taras H, Potts-Datema W. Obesity and student performance at school. *J Sch Health*. 2005;75:291-295.

18. Tremblay MS, Inman JW, Willms JD. The relationship between physical activity, self-esteem, and academic achievement in 12-year-old children. *Pediatr Exerc Sci.* 2000;12:312-323.

19. De Groot RHM, Van Dijk ML, Kirschner PA. Cohort profile of the GOALS study: a large-scale research of physical activity in Dutch students. *Br J Educ Technol.* 2015;46(5):947-952.

20. Van Dijk ML, De Groot RHM, Savelberg HC., Van Acker F, Kirschner PA. The association between objectively measured physical activity and academic achievement in Dutch adolescents: findings from the GOALS Study. *J Sport Exerc Psychol.* 2014;36:460 - 473.

21. Trost SG, McIver KL, Pate RR. Conducting accelerometer-based activity assessments in field-based research. *Med Sci Sports Exerc.* 2005;37(11):S531-543.

22. Radloff LS. The CES-D Scale: A self-report depression scale for research in the general population. *Appl Psychol Meas.* 1997;1:385-401.

23. Rosenberg M. *Conceiving the self*. 1979 New York: Basic Books.

24. Leger LA, Mercier D, Gadoury C, Lambert J. The multistage 20 metre shuttle run test for aerobic fitness. *J Sports Sci.* 1988;6:93-101.

25. Dencker M, Andersen LB. Accelerometer-measured daily physical activity related to aerobic fitness in children and adolescents. *J Sports Sci.* 2011;29:887-895.

26. Matsuzaka A, Takahashi Y, Yamasoe M, Kumakura M, Ikeda A, Wilk B. Validity of the multistage 20-m shuttle-run test for Japanese children, adolescents, and adults. *Pediatr Exerc Sci.* 2004;16:113-125.

27. Dutch Ministry of Public Health, Welfare and Sport. Nationale Atlas Volksgezondheid. Sociaaleconomische status Nederlandse beroepsbevolking. 2011 Available from: http://www.zorgatlas.nl/beinvloedende-factoren/sociale-omgeving/ses. Accessed April 10, 2013.

28. Kuczmarski RJ, Ogden CL, Grummer-Strawn LM, Flegal KM, Guo SS, Wei R, . . . Johnson CL. CDC growth charts: United States. *Adv Data*, 2000:1-27.

29. Preacher KJ, Hayes AF. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behav Res Methods.* 2008;40:879-891.

30. Preacher KJ, Hayes AF. SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behav Res Methods Instrum Comput.* 2004;36:717-731.

31. Shephard RJ. Limits to the measurement of habitual physical activity by questionnaires. *Br J Sports Med.* 2003;37:197-206.

32. Taylor BL, Attia MW. Sports-related injuries in children. *Acad Emerg Med.* 2000;7:1376-1382.

33. Stavrakakis N, Roest AM, Verhulst F, Ormel J, de Jonge P, Oldehinkel AJ. Physical activity and onset of depression in adolescents: a prospective study in the general population cohort TRAILS. *J Psychiatr Res.* 2013;47:1304-1308.

34. Dowd KP, Harrington DM, Donnelly AE. Criterion and concurrent validity of the activPAL professional physical activity monitor in adolescent females. *PloS One.* 2012;7:e47633.

35. Berendsen BA, Hendriks MR, Meijer K, Plasqui G, Schaper NC, Savelberg HH. Which activity monitor to use? Validity, reproducibility and user friendliness of three activity monitors. *BMC Public Health*. 2014;14:749.

36. Snoek HM, van Strien T, Janssens JM, Engels RC. Emotional, external, restrained eating and overweight in Dutch adolescents. *Scand J Psychol.* 2007;48:23-32.

37. Ortega FB, Artero EG, Ruiz JR, Espana-Romero V, Jimenez-Pavon D, Vicente-Rodriguez G,..Castillo MJ. Physical fitness levels among European adolescents: the HELENA study. *Br J Sports Med*. 2011;45:20-29.

Table 1. Descriptive statistics of the study sample.

	All (N=328)	**Boys (N=162)**	**Girls (N = 166)**
Age (years)	13.80 ± 1.22	13.83 ± 1.26	13.77 ± 1.18
Ethnicity			
Native-Dutch	291 (89.5%)	149 (92.5%)	142 (86.6%)
Non-native	34	12	22
Academic year			
Grade 7	178 (54.3%)	86 (53.1%)	92 (55.4%)
Grade 9	150	76	74
Educational level			
Senior general secondary education	118 (36.0%)	58 (35.8%)	60 (36.1%)
University preparatory education	210	104	106
Socioeconomic status			
Low-medium	75 (23.7%)	35 (22.2%)	40 (24.5%)
High	246	123	123
Body mass index (kg/m^2)	19.05 ± 2.81	19.07 ± 2.88	19.02 ± 2.76
Weight status			
Normal weight	289 (88.7%)	138 (86.2%)	151 (91.0%)
Overweight	37	22	15
Depressive symptoms (score CES-D)	11.63 ± 8.71	9.63 ± 7.37*	13.52 ± 9.45
Self-esteem (score Rosenberg Self-Esteem Scale)	21.74 ± 5.16	23.13 ± 4.64*	20.43 ± 5.29
Cardiovascular fitness (VO_2 max)	51.74 ± 5.51	54.26 ± 5.11*	49.30 ± 4.75
Physical activity (accelerometer steps/week)	69103 ± 19135	72285 ± 19896*	65998 ± 17882
School absenteeism due to illness (days per academic year)	3.47 ± 3.89	3.59 ± 3.30	3.35 ± 4.40

CES-D = Center for Epidemiologic Studies Depression Scale. *Statistically significantly different ($p < .05$) from girls.

Table 2. Physical activity associated with mental health, cardiovascular fitness and school absenteeism due to illness.

	Depressive symptoms		Self-esteem		Cardiovascular fitness		School absenteeism due to illness	
	ΔR^2	β	ΔR^2	β	ΔR^2	β	ΔR^2	β
Step A	.10*		.17*		.47*		.06*	
Sex		.23*		-.28*		-.47*		-.10**
Ethnicity		.13*		-.13*		-.12*		.05
Academic year		.09		-.18*		.00		.15*
Educational level		-.12*		-.17*		.07		.11
Socioeconomic status		.03		.07		.05		.03
Overweight		-.01		.06		-.49*		.10**
Step B	.00		.00		.04*		.00	
Habitual PA		-.05		.05		.21*		-.06

Note. Habitual PA = total physical activity volume per week determined by the total number of accelerometer steps.
ΔR^2 = Change in explained variance
β = Standardized linear regression coefficients.
* Statistically significant at $p < .05$.
** Statistically significant at $p < .10$.