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LOW PHYSICAL ACTIVITY IN ADOLESCENCE IS ASSOCIATED WITH INCREASED RISK FOR MENTAL HEALTH PROBLEMS

FINDINGS FROM THE DUTCH SURVEY ON HEALTH BEHAVIOUR IN SCHOOL-AGED CHILDREN (HBSC)

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Abstract

Aim: To investigate physical activity levels in adolescence and to assess the independent association with a wide range of mental health problems.

Methods: Data were used from 7,304 adolescents aged 11-16 years drawn from the 2001 Dutch HBSC school survey. Physical activity and mental health were measured using validated instruments (the moderate-to-vigorous physical activity screening measure (MVPA) and the Youth Self Report (YSR) for use among children and adolescents.

Results: Only 39.8% of the respondents met the guideline for physical activity. Almost one in seven respondents (13.4%) were categorized as inactive, with particular high rates among the 16 year olds (23.8%) and respondents from low socio-economic status families (23.1%). While adjusting for confounding factors, inactive respondents were at greater risk for withdrawn behavior (OR=2.04), anxious/depressed feelings (OR=1.73) and aggressive behavior (OR=1.49) as compared to those who met the physical activity guideline.

Conclusions: This study adds to a small, but growing number of studies reporting evidence for a link between physical inactivity and mental health problems in adolescence. Although results are promising, further research is necessary to assess the possibilities of physical activity as one of the instruments in the treatment and prevention of mental health problems.

Key words: *physical activity, mental health, child, adolescent*

Introduction

Whereas the positive effects of physical activity on physical health have been demonstrated extensively (e.g. 1), the relationship with mental health has received less attention, especially with regard to adolescents. Only recently has research attempted to shed light on this relationship. The results of these studies so far suggest that adolescents who are physically active have higher rates of emotional wellbeing (2) and tend to be less depressed and anxious compared to those who are not active (3-5). In line with this, it has even been suggested that physical activity could be effective in the treatment of mental health problems, as depressed mood seemed to diminish with higher levels of physical activity (6,7). If so, further study on the link between physical activity and mental health would be highly relevant, as it could possibly open up a whole new area for research and for the development of new and innovative treatment as well as prevention activities.

Although initial results seem to be promising, the focus of former research has been rather limited and several methodological aspects hamper sound conclusions. First, most studies have focused on the so-called internalizing problems such as depression and anxiety, while externalizing problems like delinquency, aggression and substance use - and their association with physical activity - have received less attention. Furthermore, the results of studies on externalizing behavior have been ambiguous. For example, one study found that, compared to those with low levels of sporting activity at age 15, girls with moderate or high levels of sporting activity and boys with high levels of sporting activity were significantly more likely to be delinquent at age 18 years, while no significant associations with aggressive behavior were detected (8). Where team sport participation was concerned, no significant associations with delinquent or aggressive behavior were found. A study among 10 to 14 year

olds, found no associations between physical activity and deviant behavior such as fighting or stealing (9). Studies on the association between physical activity and substance use generally conclude that greater levels of physical activity are associated with lower levels of substance use (9-12).

Second, in the current literature, a variety of often non-validated instruments are used to measure physical activity. This impedes a comparison of study results. Therefore there is a need for studies using instruments that are validated for screening physical activity among adolescents. A final issue concerning valid comparison between studies is the fact that studies differ greatly with regard to the adjustment in their analyses for other risk factors known to be related to both mental health and physical activity. This is a major problem, because inadequate control for these factors can lead to incorrect conclusions regarding the (strength of the) relationship between physical activity and mental health which has important implications for the focus of preventive activities. In conclusion, the current literature on the association between physical activity and mental health in adolescence is limited, and has focused only on part of the mental health spectrum, i.e. depression and anxiety. Furthermore, studies often do not apply validated instruments for the measurement of physical activity and they vary in adjustment for confounding factors.

In our paper, we would like to contribute to this line of research by presenting the results of a large representative sample of schoolchildren, using standard validated instruments for the measurement of both physical activity and mental health problems, while seeking to take the effect of confounders into account in a systematic way. The aim of the present study is first, to establish whether there is an association between physical activity and mental health problems, including the whole spectrum of mental health problems (both internalizing and externalizing problems), and second, to investigate to what extent this association is due to underlying factors that may explain both physical activity levels and mental health problems. Finally, because of known gender differences in both physical activity and mental health, we will examine whether the association between physical activity and mental health is modified by gender. To this end we will use a large (N=7304) representative sample of primary and secondary school pupils aged 11-16 years.

Method

Sample

This study was conducted as part of the WHO cross-national study "Health Behaviour in School-aged Children" (HBSC), addressing health behaviors, health and its social context in children and adolescents in Europe and North America (13). In accordance with the HBSC

guidelines, a two-stage random sampling procedure was used (14). First, schools were stratified according to level of urbanization. Second, schools were drawn proportionally to their number in the corresponding urbanization level. Third: within each school for secondary education, one class from every grade (1-4) was selected randomly from a list of all classes provided by every participating school. Fourth, within classes all students were drawn as a single cluster. In primary education, schools and students were sampled in a similar way, but no sampling of classes took place because most schools had only one 8th grade class. In case a school had two 8th grade classes, both classes were invited to participate. This procedure resulted in a sample of 1,826 pupils in the 8th grade of primary education and 5,730 pupils in the first four years of secondary education (a total of 7,556 pupils). In order to assess the representativeness of the sample, the multivariate distribution over the variables urbanization, gender, and (for secondary education) grade and school-level in the sample was compared with the corresponding distribution in the Dutch student population as described by Statistics Netherlands (www.cbs.nl). The small deviations between the sample and the population were corrected by weighting after which the distribution was exactly the same as in the population. An additional check showed that the sample was also representative with regard to ethnicity.

Approximately two weeks before administration of the questionnaires, the parents received a written letter, informing them about the study and the possibility to reject participation of their child. Because of the small number of respondents in the age 10 (0.3%), 17 (1.8%) and 18 (0.3%) year groups, only the 11-16 year olds were included in the analyses (7,304 pupils). Detailed descriptions of the sampling procedure can be found in the international research protocol (14).

Data collection

All data were collected by means of questionnaires, which were distributed in classes and administered by the teachers (at four schools by a research assistant) during a lesson (usually 50 minutes). When introducing the questionnaire, the teachers emphasized the anonymity of the respondents and explained that participation in the study was voluntary. Collecting all questionnaires in one envelope and sealing the envelope in the presence of the respondents further ensured anonymity.

Measures

Mental health

Mental health was measured using the Youth Self Report (15). The Youth Self Report (YSR) is designed to measure behavioral and emotional functioning of adolescents aged 11-18 years and has demonstrated

to have good reliability and validity (15). It has been translated and validated for Dutch use (16). The YSR contains 101 problem items (0 = not true, 1 = somewhat true, 2 = very true or often true, on the basis of the preceding six months). The YSR can be scored on the total problem scores (sum of all scores) and the following eight subscales: withdrawn behavior, somatic complaints and anxious/depressed feelings (internalizing problems); delinquent and aggressive behavior (externalizing problems); social problems, thought problems and attention problems (the latter three are not part of either the internalizing or externalizing scale). Problem scores on the YSR-syndrome scales were computed by using the cut-off points of the Dutch YSR-manual. These cut-off points were calculated according to the YSR-guidelines (15), but were based on the scores in a Dutch norm-population (16). Scores above the normative cut off point were taken as indicative of the presence of borderline or clinical emotional or behavioral problems. A dichotomous variable was created for each of the problem scales: those exceeding the borderline or clinical score of the YSR problem scale were categorized as 1 (index category) and those not meeting the borderline score were coded as 0 (reference category).

Physical activity

Physical activity was measured using the moderate-to-vigorous physical activity (MVPA) screening measure (17). This measure is consistent with current international recommendations for youth to accumulate 60 minutes of moderate to vigorous physical activity on most days of the week (18). The reliability (intra-class correlation coefficient: 0.77, κ value to assess reliability for correct classification of subjects as meeting or not meeting guidelines: 61%) and validity (a correlation of $r=0.40$; $p<0.01$, with accelerometer data) showed that the MVPA measure is a reasonable method for assessing participation in overall physical activity and for compliance with current guidelines (17). The measure consists of two questions, referring to two time frames (the last week and a 'usual week') and informs on the number of days that adolescents undertake physical activity of at least moderate intensity for at least 60 minutes. The questions were preceded by the following definition of physical activity: 'Physical activity is any activity that increases your heart rate and makes you get out of breath some of the time. Physical activity can take place in sports, playing with friends, or walking to and from school. Some examples of physical activity are running, brisk walking, rollerblading, skateboarding, biking, dancing, skateboarding, swimming, soccer, basketball, football and surfing. The question used in the HBSC survey was slightly modified in that it also allowed the inclusion of physical activity within school.

For the purpose of our analyses the average of the last and usual week was computed and recoded into three categories (norm-active, semi-active and inactive). Current Dutch guidelines recommend 60 minutes of moderate activity on all days of the week, with two days of vigorous exercise to enhance or maintain physical fitness (19) while international guidelines recommend 60 minutes of moderate to vigorous activity on five days of the week (17). Applying the Dutch guideline poses problems because the MVPA measure does not allow separate assessment for days of moderate and vigorous activity. Therefore we decided to follow the international guideline and categorize those respondents scoring an average of 5 or more days of 60 minutes of moderate to vigorous physical activity as norm-active. As this study is interested in the relationship between mental health and different levels of physical activity, in addition to the norm-active group, a semi-active and inactive group were defined. Those scoring between 2 and 4.5 were categorized as semi-active and those scoring between 0 and 1.5 days as inactive. This categorization resulted in group-sizes that allowed adequate statistical analyses (norm-active: $N=2859$; semi-active: $N=3355$, inactive: $N=964$).

Confounding factors

The selection of the confounder set included in the multivariate models was based on the outcomes of other studies e.g. (8,10) and the results of an earlier study using the same data set, showing a significant association between socio-demographic and family factors on the one hand and mental health problems on the other (20). Analyses were performed to assess which factors were related to both physical activity and mental health problems and therefore confounding factors in the association between physical activity and mental health. This procedure resulted in the following factors: age (in years), gender, household composition (living with both biological parents: no, yes) and socioeconomic status (SES) (low, medium, high). The SES of children was measured using the Family Affluence Scale, a validated measure on material affluence (21). The variables ethnic status (ethnic minority student: no, yes) and job status of mother and father respectively (unemployed: no, yes) were associated with mental health problems but not with physical activity levels and were therefore not included as confounding factors in the multivariate models.

Data analysis

In order to obtain correct 95% confidence intervals and p-values in a weighted and clustered sample (students are nested within classes and classes are nested within schools), robust standard errors were obtained, i.e. the intra-class correlations embedded in the data-structure were accounted for in the parameter

estimation (22). To investigate the association between physical activity and mental health problems, logistic regression analyses were conducted, resulting in Odds Ratios (OR). Mental health was included in the model as a dichotomized dependent variable, with those not meeting the borderline score of the problem scale serving as reference category (0). Physical activity was entered in the model as an independent three- category variable: norm-active (0, reference category) semi-active (1) and inactive (2). All analyses were conducted for each of the eight problem scales, the two subscales (internalizing problems and externalizing problems) and the total problem scale. Both unadjusted (bivariate) and adjusted (multivariate) logistic analyses were performed. To assess the relative influence of the confounding factors, two multivariate models were tested. In the first model the results were adjusted for age and gender, the second

model additionally adjusted for socio-economic status, urbanization level, and household composition. To analyze whether gender modified the effect of physical activity on mental health, that is, whether gender interacted with physical activity, we used generalized linear models with a binominal distribution and identity link function. All analyses were carried out on the weighted sample using Stata (version 7.0) (23).

Results

Levels of physical activity among demographic sub-groups

The sample consisted of 7,304 respondents, of whom 49.2% were female and 83.7% were of Dutch origin (Table 1). Less than half of the sample (39.8%) reported meeting the guideline of at least 60 minutes of moderate to vigorous physical activity on five or more days of the

Table 1. *Level of physical activity¹ with 95% confidence interval (95% CI), by demographic and family variables (in %)*

	Sample		Inactive		Semi-active		Norm-active	
	N	%	%	95% CI	%	95% CI	%	95% CI
<i>Total sample</i>	7304		13.4	12.4-14.6	46.8	45.1-48.4	39.8	37.9-41.8
<i>Gender</i>								
Boys	3713	50.8	12.1	10.8-13.5	45.9	43.9-47.9	42.0	39.8-44.3
Girls	3590	49.2	14.8	13.4-16.3	47.6	45.5-49.8	37.6	35.1-40.1
<i>Age</i>								
11	1683	23.1	12.2	10.2-14.6	46.6	42.6-50.7	41.2	36.5-46.0
12	1371	18.8	11.4	9.5-13.5	44.7	41.5-48.0	44.0	40.1-47.9
13	1296	17.8	11.2	9.5-13.2	48.1	45.1-51.2	40.7	37.5-44.0
14	1313	18.0	14.2	12.2-16.4	47.5	44.7-50.2	38.4	35.3-41.5
15	1131	15.5	14.8	12.6-17.3	48.5	45.5-51.5	36.7	33.8-39.7
16	508	6.7	23.8	18.7-29.6	43.5	38.8-48.4	32.7	27.6-38.2
<i>Ethnicity</i>								
Ethnic Dutch	5859	83.7	12.9	11.7-14.1	46.9	45.1-48.6	40.3	38.2-42.4
Ethnic minority	1141	16.3	15.1	12.9-17.5	46.4	42.0-50.9	38.5	33.8-43.5
<i>Level of urbanisation</i>								
Very high	1081	14.8	16.0	13.7-18.7	48.0	43.2-52.8	36.0	30.6-41.8
High	1861	25.5	12.4	10.5-14.6	49.4	46.1-52.6	38.2	36.5-41.9
Low	1616	22.1	15.3	13.1-17.7	47.5	44.4-50.6	37.3	33.8-40.8
Very low	2746	37.6	12.0	10.4-13.8	44.1	41.6-48.4	43.9	40.8-47.1
<i>Socio-economic status</i>								
Low	732	10.0	23.1	19.6-26.9	45.1	40.7-49.6	31.8	27.7-36.2
Medium	3275	44.9	14.7	13.3-16.3	46.4	44.3-48.4	38.9	36.5-41.4
High	3281	45.0	9.9	8.3-11.2	47.4	45.3-49.5	42.6	40.4-41.8
<i>Family composition</i>								
Broken family	1385	19.1	16.8	14.6-19.3	46.1	43.0-49.1	37.1	34.0-40.4
Intact family	5861	80.9	12.6	11.5-13.8	46.9	45.2-48.4	40.1	38.5-41.8

¹ Number of physical active days (i.e. physically active during at least 60 minutes) during a week (inactive: 0 to 1.5 day; semi-active: 2 to 4.5 days, norm-active 5 to 7 days)

Bold: significant difference compared to other categories of the same variable (95% CI do not overlap). Age: inactive 16 year olds differ from 11-15 year olds, norm-active 16 year olds differ from 12 year olds. SES: inactive and norm-active respondents from medium and high SES groups differ from low SES groups. *Family composition:* inactive respondents from intact families differ from respondents from broken families.

Table 2. *Mental health problems¹ by level of physical activity² (in %)*

	All problems (total score)	Withdrawn behavior	Somatic complaints	Anxious /Depressed	Internalizing behavior (total score)	Delinquent Behavior	Aggressive Behavior	Externalizing behavior (total score)	Social problems	Thought problems	Attention problems
Norm-active	19.2	3.5	9.6	7.5	18.9	7.9	6.7	17.2	5.8	11.1	4.1
Semi-active	20.3	4.9	9.4	7.5	19.8	8.6	6.5	17.7	5.3	10.7	4.1
Inactive	29.0	8.4	11.5	13.5	27.9	12.7	10.4	23.7	7.6	13.6	6.8

¹ Defined as scores in the borderline or clinical range of the Youth Self Report² Number of physically active days (i.e. physically active for at least 60 minutes) in a week (inactive: 0 to 1.5 day; semi-active: 2 to 4.5 days, norm-active 5 to 7 days)

week and 13.4% of the respondents were categorized as inactive. Table 1 further shows that differences in physical activity level between boys and girls were small and non-significant (95% Confidence Intervals overlap). With regard to age, clear differences were found in activity levels, with rates of inactivity started rising in the older age groups, especially from age 15 (14.8%) to age 16 (23.8%). Differences between ethnic Dutch and ethnic minority groups were small and non-significant. Percentages of inactivity vary between the different levels of urbanization, but no clear pattern can be observed. The variables on family characteristics show that among those living in broken families the percentage of inactivity is significantly higher compared to those living in intact families. Furthermore, there is a strong association between SES and physical activity levels, with highest percentages of inactivity among respondents from families with low SES.

The prevalence of mental health problems by level of physical activity

The descriptive results in table 2 show that the prevalence of mental health problems are considerably higher in the inactive group as compared to the norm-active and the semi-active group (table 2). For example, the percentage of pupils reporting anxious and depressed feelings is almost double in the inactive group (13.5%) as compared to the semi- and norm-active groups (7.5%). Differences between the norm- and semi-active groups are very small and show no clear pattern.

The association between physical activity and mental health problems, adjusting for different sets of confounding factors

Table 3 shows the associations between physical activity and mental health problems. The group that met the physical activity guidelines (the norm-

Table 3. *The association between physical activity (reference: norm-active) and YSR problems (scores in the borderline or clinical range) reported for three models, each adjusted for a different set of confounding factors¹ (odds ratios, OR²)*

	All problems (total score)	Withdrawn behavior	Somatic complaints	Anxious /Depressed	Internalizing behavior (total score)	Delinquent Behavior	Aggressive Behavior	Externalizing behavior (total score)	Social problems	Thought problems	Attention problems
Model 1¹											
Semi-active	1.07	1.41	0.98	1.00	1.06	1.11	0.96	1.03	0.90	0.97	1.00
Inactive	1.72	2.49	1.22	1.93	1.66	1.71	1.60	1.50	1.32	1.27	1.68
Model 2¹											
Semi-active	1.05	1.39	0.96	0.99	1.06	1.05	0.94	1.00	0.92	0.96	0.99
Inactive	1.62	2.37	1.18	1.88	1.64	1.39	1.54	1.37	1.40	1.23	1.64
Model 3¹											
Semi-active	1.03	1.36	0.96	0.99	1.04	1.04	0.92	1.00	0.91	0.94	0.98
Inactive	1.50	2.04	1.09	1.73	1.52	1.34	1.49	1.34	1.26	1.13	1.55

¹ Model 1: unadjusted

Model 2: adjusted for age and gender

Model 3: adds to model 2 controls for SES, urbanization level, and household composition

² Odds ratios in bold are significant at level $p < 0.01$

active group) was used as the reference group. A measure for association is the Odds Ratio (OR). An OR of less than one implies that being semi-active or inactive is associated with a lower risk of mental health problems, an OR greater than one implies an elevated risk compared to the norm-active group. Table 3 shows that the semi-active respondents did not significantly differ from the norm-active group on any of the problem scales (i.e. none of the OR's significantly differed from one, except for withdrawn behavior in the unadjusted model). The results of the unadjusted analyses (model 1) demonstrate that physical inactivity is related to several mental health problems, with the highest odds ratios found for withdrawn behavior (OR=2.49) and anxious/depressed feelings (OR=1.93). In model 2, when the results were adjusted for age and gender, the delinquent behavior syndrome lost significance. Subsequently adjusting for urbanization level, SES and household composition (model 3) led to a further reduction of the ORs, although the differences with the previous model were small. Two variables, the externalizing behavior and attention problem scale, did not retain significance in the third model. The association between physical inactivity and mental health problems retained significance in the full model (model 3) for the problem scales withdrawn behavior (OR=2.04), anxious/depressed feelings (OR=1.73) and aggressive behavior (OR=1.49). Furthermore the total problem scale and the internalizing behavior scale showed significant associations with inactivity. No significant interaction effects ($p < 0.05$) of gender by level of physical activity were found (results not shown). In other words, boys and girls did not differ significantly with regard to the association between physical activity levels and mental health.

Discussion

Key results

Only 40% of the respondents aged 11 to 16 years met the guideline of at least 60 minutes of moderate to vigorous physical activity on 5 or more days of the week. Almost one in seven adolescents (13.4%) was categorized as being inactive. Rates of inactivity were particularly high among 16 year olds and among respondents from low SES families.

Inactive respondents were at higher risk for five out of eight mental health problem syndromes, of which three (withdrawn behavior, anxious/depressed feelings and aggressive behavior) retained significance after adjustment for confounding factors. For the semi-active respondents no significant risk differences compared to the norm-active respondents were found. No significant interaction effects of gender by level of physical activity were found.

Levels of physical activity among demographic sub-groups

Our study found that 39.8% of the respondents met the guideline of at least 60 minutes of moderate to vigorous physical activity on 5 or more days of the week. While taking average age differences between the samples into account, we can say that this percentage is largely in line with results from other studies, finding a somewhat lower (24) or higher percentage (17).

Almost one in seven adolescents (13.4%) was categorized as being inactive, with clear demographic group differences. Age and SES appeared especially strong risk indicators for inactivity. Similar age- and SES-related findings have been reported by others (25, 26). The difference between SES groups is possibly explained by the fact that low socio-economic status groups have reduced access to sports because of fewer sports facilities in their community, which in turn is associated with decreased physical activity (27). Moreover, financial barriers may also result in lower participation in organized sports among children from low SES families or from broken families. Finally, inactivity was more prevalent among adolescents living in highly urbanized areas as compared to areas of very low urbanization. Additional analyses showed that this is partly explained by the fact that respondents living in the highly urbanized areas more often report coming from low SES families who, as stated above, have relatively high rates of inactivity. Additionally, in the Netherlands many children travel to school by bicycle and biking distances will generally be longer in less urban areas as compared to the cities.

Association between physical activity and internalizing problems

This study found clear associations between physical activity levels and internalizing problems, i.e. withdrawn behavior and anxious/depressed feelings. The findings with regard to anxiety and depression are in line with cross-sectional studies among Icelandic students (5), German high school students (3) and American adolescents (4). One of the few longitudinally studies among adolescents found that naturally occurring changes in physical activity over a two year period were negatively associated with changes in depressive symptoms (6). However, in another study change in depressed mood was not significantly associated with team sports involvement (28). Randomized controlled trials would allow more definite conclusions on causality but are lacking.

In the present study, withdrawn behavior showed the strongest association with physical activity levels. No other studies were found with which these results could be compared with. A possible explanation for this association is that adolescents exhibiting with-

drawn behavior are reluctant to participate in activities that involve social interaction and group participation like team sports. The reverse causality is also plausible: sports involvement possibly reduced the symptoms of withdrawn behavior because it gives adolescents increased opportunities to interact socially and may thus be an important environment for learning how to relate with other people.

Association between physical activity and externalizing problems

The results of the present study showed a significant association between physical activity level and aggressive behavior, with inactive respondents being at higher risk as compared to respondents meeting the physical activity guideline. Other studies have failed to detect a relationship with aggressive behavior (8). In the present study no significant associations were found for delinquent behavior and the total externalizing scale, while another study (8) concluded that high levels of physical activity were a risk factor, rather than a protective factor for delinquent behavior: those with high levels of sporting activity at age 15 were more likely to be delinquent at age 18 years than those with low levels of sporting activity. However, when team sports were concerned, physical activity was not related to delinquent behavior. These results possibly indicate that the context of physical activity is important, i.e. whether the physical activity was undertaken as a team sport, individual sport or as daily activities. The underlying assumption is that team sports will involve more social interaction, i.e. positive group interaction and cooperation, than individual sports and daily activities. Is it suggested that these social interaction processes, and not so much the physical activity itself, are the key elements in the association between physical activity and externalizing behavior problems. This theory has contributed to the use of physical activity as a rehabilitative and preventive intervention for youth with behavioral problems (29). Another theory suggests that participation in organized sports lowers the risk for deviant behavior, because these activities are often supervised and structured and thereby expose young people to conforming rather than deviant behaviors (8,9). These context effects may also explain the ambiguous study results on the associations between physical activity and externalizing behavior problems, as definitions of physical activity vary greatly between the studies. A more detailed assessment, especially of the type and context of the physical activity, may possibly help to clarify the link.

Strengths and limitations

This study is one of the few projects investigating the association between physical activity and mental health in a large representative population survey, while applying instruments validated for the

measurement of both physical activity and mental health among adolescents. By using validated instruments comparability of studies is enhanced, which will facilitate the development of knowledge on this topic. Furthermore, our study has generated detailed information by including the whole range of mental health problems (eight syndromes) and investigating associations with three levels of physical activity.

Potential limitations of the study include the reliance on self-report data. First, the reliability of self-reporting of physical activity levels among adolescents is problematic (30). However, the MVPA measure has proven to be among the most reliable and valid self-report instruments for physical activity, and to be adequate for answering research questions as formulated in the present study. A further limitation lies in the fact that this study has no information on the type of the physical activity, while differential effects on mental health have been suggested (7). Finally, there was no information on the context of physical activity, i.e. the study did not assess how much of the total physical activity reported was undertaken as a team sport, individual sport or in the context of daily activities.

Implications

This study adds to a growing body of research reporting evidence for a link between physical activity and internalizing problems in adolescence. Given the high rates of internalizing problems in the adolescent population (20) and the promising results of current literature, further (experimental) research allowing longitudinal and more in-depth analyses seems warranted. Studies on externalizing behavior and physical activity are scarce and ambiguous and further studies using standardized instruments and a detailed assessment of the context of the physical activity are needed to establish whether externalizing behavior is linked to physical activity.

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A – Study Design

B – Data Collection

C – Statistical Analysis

D – Data Interpretation

E – Manuscript Preparation

F – Literature Search

G – Funds Collection