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Physical activity and self-reported health status among adolescents: a cross-sectional population-based study

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ABSTRACT

Objectives: Little is known about the dose–response relationship between physical activity and health benefits among young people. Our objective was to analyse the association between the frequency of undertaking moderate-to-vigorous physical activity (MVPA) and the self-reported health status of the adolescent population.

Design: Cross-sectional study.

Setting: All regions of Spain.

Participants: Students aged 11–18 years participating in the Spanish Health Behaviour in School-aged Children survey 2006. A total of 375 schools and 21 188 students were selected.

Main outcomes: The frequency of undertaking MVPA was measured by a questionnaire, with the following four health indicators: self-rated health, health complaints, satisfaction with life and health-related quality of life. Linear and logistic regression models were used to analyse the association, adjusting for potential confounding variables and the modelling of the dose–response relationship.

Results: As the frequency of MVPA increased, the association with health benefits was stronger. A linear trend (p<0.05) was found for self-rated health and health complaints in males and females and for satisfaction with life among females; for health-related quality of life this relationship was quadratic for both sexes (p<0.05). For self-reported health and health complaints, the effect was found to be of greater magnitude in males than in females and, in all scales, the benefits were observed from the lowest frequencies of MVPA, especially in males.

Conclusions: A protective effect of MVPA was found in both sexes for the four health indicators studied, and this activity had a gradient effect. Among males, health benefits were detected from very low levels of physical activity and the magnitude of the relationship was greater than that for females.

ARTICLE SUMMARY

Article focus

- Although it is recommended that all adolescents should undertake 60 min of daily moderate-to-vigorous physical activity (MVPA), little is known about the nature of the relationship in this population, and whether or not the effect varies depending on age and sex.
- We examined cross-sectional associations between the frequency of undertaking self-reported MVPA and the health status of the adolescent population, using subjective health scales that are considered to be useful tools especially in the stage of adolescence, when psychological aspects are so important in the feeling of well-being among young people.

Key messages

- The protective effect of MVPA on health was detected from very low levels, below those established by current recommendations.
- A linear trend was found for self-rated health, health complaints and for satisfaction with life. For health-related quality of life the relationship was quadratic.
- The positive effect on health produced lower results in females than in males.

Strengths and limitations of this study

- The main strength is the representativeness and large size of the sample. The methodology employed is the standard one for the Behaviour in School-aged Children study in which more than 40 Western countries have participated.
- A major limitation is the cross-sectional nature of the study. Moreover, the measurement of health status using subjective health scales and the estimation of MVPA are both based on self-reported information.

INTRODUCTION

According to the WHO,[1] physical inactivity is the fourth most important risk factor affecting global mortality, to which nearly 6% of all deaths are attributed. In the adolescent population, short-term benefits related to physical activity (PA) are the improvements in lipid profile, blood pressure, metabolic syndrome, muscular strength and bone density, together with a reduction in obesity

and overweight levels, as well as a decrease in emotional problems and depressive symptoms.[2–5] Moreover, young people who undertake PA adopt healthy behaviour more easily and have better levels of academic achievement and cognitive functioning.[4 6–8]

The dose–response relationship between PA and various health indicators has mainly been studied in the adult population,[9–15] where there is still a controversy about whether or not this relationship is linear.[12 16] Ekelund et al[17] in a pooled data analysis of 14 studies in children and adolescents found a direct benefit between three tertiles of moderate-to-vigorous physical activity (MVPA) in relation to cardiometabolic outcomes. Although the WHO recommends that all children of 5–17 years of age take at least 60 min of daily MVPA,[18] little is known about the nature of the relationship in this population. Therefore, finding out the effect on health of several levels of PA could have important implications for improving the recommendations regarding this activity.

It should be emphasised that the concepts underlying the health status in children and adolescents differ from those for adults. As young people are still developing, the measurement of health status must be approached from a global and comprehensive perspective for each individual. Concepts such as 'subjective health' and 'health-related quality of life' cover complex physical, emotional, mental and social aspects.[19 20] Hence, it is important to evaluate if the effect of the PA is distributed in a distinct way for the different dimensions of health status.

Finally, although PA varies considerably depending on age and sex,[21] to our knowledge, there have been very few studies in the literature about the role that these variables play regarding the effect of PA on health.[4]

The objective of this study was to analyse the association between the frequency of undertaking MVPA and the different dimensions of adolescent health status, assessing if this relationship differs according to age and sex.

METHODS
Study population
The source of information was the Health Behaviour in School-aged Children (HBSC) study carried out in 2006.[22] The population was a representative sample of preadolescents and adolescents, with an age range of 11–18 years, resident in Spain and enrolled in school from the fifth year of primary school to the last year of upper secondary school (2nd year of baccalaureate). A multistage stratified random sampling was used, taking into account the age strata (4 groups), region (17 autonomous communities), school site (rural and urban) and type of school (public and private). Initially, 480 schools were contacted of which 377 (103 private and 274 public schools) agreed to participate in the study, which represented a response rate of 78.5%. On average, three classes were selected in each school.

A total of 22 350 questionnaires were collected, although subsequently 539 were excluded because of non-response to questions about sex and age, or lack of response to more than 50% of the questionnaire. The sample size was 21 811 participants. The study was carried out in spring 2006. Previously trained survey technicians visited the selected schools, where the students completed an anonymous questionnaire during normal school hours.

This study was approved by the Institutional Review Board of the Carlos III Institute of Health.

Study variables
Health status was measured using four indicators: (1) self-rated health was measured using the question "Would you say that your health is: excellent, good, fair or bad." Optimal health status was categorised by a response of excellent or good, and suboptimal health status was categorised by a response of fair or bad. (2) The health complaints indicator was assessed using a scale based on the HBSC-Symptom Checklist, which is a list of eight physical and psychological symptoms (headaches, abdominal pain, backache, feeling low, irritability, nervousness, sleeping difficulties and dizziness) to estimate their frequency during the last 6 months. Having two or more symptoms with a frequency of several times a week or daily was considered to define having noticeable subjective health complaints.[19] (3) Satisfaction with life was estimated using the Cantril Ladder,[23] in which, the participant was asked "on which rung of the ladder (scale from 0 to 10) do you feel you stand at this moment in your life?", with 0 being the worst score and 10 the best. A score of 0–5 was categorised as dissatisfied, whereas a score of 6–10 was categorised as satisfied.[19] (4) Health-related quality of life was measured using the Kidscreen-10 index,[24] a series of 10 questions about mood, ability to concentrate, energy, vitality, well-being and ability to have fun with friends. Each question has five categories of response ranging from 'never' to 'always' or from 'not at all' to 'extremely often'. The items fulfil the assumptions of the Rasch model. To make the interpretation more applicable, the scores of the Rasch scales are translated into T-values with scale means of 50 and SD of 10, with higher values indicating higher health-related quality of life.[24]

The frequency of MVPA was measured using the question: "in the last seven days, considering moderate and vigorous activity … On how many days did you feel you were physically active for a total of 60 minutes per day?" The response categories were from 0 to 7 days. This question, when compared with PA assessed by accelerometers in Spanish adolescents, has shown an acceptable validation (Spearman correlation=0.43).[25]

The following factors were considered as potentially confounding variables for the association between health status and frequency of MVPA: (1) personal variables (sex, age, country of birth, current smoker, alcohol consumption, and body mass index (BMI)) calculated as

the ratio of weight in kg/height in m^2 from self-reported weight and height and defining overweight and obesity using the cut-off points proposed by Cole et al,[26] consumption of fruit and vegetables, daily breakfast, number of hours spent each day watching television and using computers or game consoles, number of hours spent each day doing school homework); (2) family variables (employment status of the father, employment status of the mother, family purchasing power—measured by the Family Affluence Scale,[27] an index estimated by four items: number of times that the adolescents have been on holiday with their family in the last 12 months; does the family own a car or van; does the student have his/her own bedroom; number of computers owned by the family; country of birth of the father, country of birth of the mother and type of household; both parents, single parent or blended family; and number of minors in the household and number of adults in the household); and (3) relationships with the school, the family and friends (academic achievement, satisfaction with family relationships and satisfaction with relationships with friends). The variables are categorised in table 1.

Data analysis

The questionnaires with missing values were excluded from data analysis, so that the number of subjects studied was 17 467 for self-rated health; 17 358 for satisfaction with life; 16 803 for health complaints; and 16 560 for health-related quality of life. The sample excluding the missing values was similar to the original (there was no statistically significant difference),

Table 1 Description of the sample and distribution of optimal self-rated health, less health complaints, high satisfaction with life and health-related quality of life, according to individual variables

	Optimal self-reported health N (17467) (%)	Less health complaints N (16803) (%)	High satisfaction with life N (17358) (%)	Health-related quality of life N (16560) (Mean)
Global	91.1	67.4	90.9	47.1
MVPA				
Never	80.1*	54.1*	82.3*	42.6*
1–2 days	87.5	62.8	87.4	44.3
3–4 days	90.8	66.3	91.3	46.2
5–6 days	94.8	72.8	93.1	48.2
7 days	95.9	74.1	95.2	52.5
Sex				
Men	93.3*	76.7*	91.9*	48.3*
Women	89.3	59.5	90.0	46.1
Age				
10–12	95.8*	68.6	94.9*	52.5*
13–16	90.1	67.6	89.8	45.6
17–18	86.8	65.1	87.7	43.2
Born in Spain				
Yes	91.1	67.7*	91.2*	47.2
No	91.2	62.9	85.3	45.7
Smoking				
Non-smoker	94.5*	70.6*	94.0*	49.3*
Smoker	80.9	56.6	83.7	42.8
Ex-smoker	89.2	66.6	86.9	44.1
Consumption of alcohol				
Never	95.4*	70.4*	94.3*	50.7*
Rarely	89.9	65.2	88.9	45.4
Monthly	88.1	66.3	87.2	43.5
Weekly or daily	85.2	64.2	87.9	43.9
Body-mass index				
Normal or underweight	92.5*	68.2*	91.5*	47.0
Overweight	86.7	67.6	90.3	47.1
Obese	77.4	58.0	83.0	46.6
NR	90.4	64.6	89.4	47.2
Consumption of fruit and vegetables				
Quartile 1	88.2*	64.1*	88.8*	45.8*
Quartile 2	91.5	67.5	91.5	46.5
Quartile 3	92.5	69.7	92.2	47.2
Quartile 4	92.6	68.5	91.2	48.7

Table 1 Continued

	Optimal self-reported health N (17467) (%)	Less health complaints N (16803) (%)	High satisfaction with life N (17358) (%)	Health-related quality of life N (16560) (Mean)
Breakfast during the week				
Every day	93.2*	70.4*	92.6*	48.1*
Not every day	85.5	59.1	86.1	44.3
Time spent TV and computers				
Quartile 1	91.1	68.7*	91.5*	48.0*
Quartile 2	91.1	69.4	91.8	47.0
Quartile 3	91.7	68.8	91.5	47.0
Quartile 4	90.2	62.8	88.7	46.2
NR	92.6	65.4	89.3	48.6
Time spent studying/homework				
Quartile 1	89.3*	68.8*	87.1*	46.3*
Quartile 2	92.2	69.3	91.9	47.9
Quartile 3	92.4	68.8	92.5	47.7
Quartile 4	90.5	62.9	91.5	46.3
NR	89.4	69.3	88.6	48.4
Academic achievement				
Very good	96.3*	71.8*	96.4*	52.4*
Good	94.0	69.7	94.2	48.2
Average	87.4	65.3	87.3	44.2
Low	79.7	54.0	75.3	41.7

Spanish adolescents aged 11–18 years, 2006.
*p<0.05.
MVPA, moderate-to-vigorous physical activity; NR, non-response.

comparing the main socioeconomic variables, health status and the frequency of undertaking MVPA.

The complex sampling design was taken into account during analysis by using the 'Survey Data' module of the statistical package Stata V.11. SEs were computed by using the linearised variance estimator based on a first-order Taylor series. Prevalence was calculated for optimal self-rated health, low level of health complaints, high satisfaction with life and the means for the scores on the scale for health-related quality of life, with 95% CIs, both global and for the categories of each one of the exposure variables.

Regression models were used, logistic ones for the estimation of the OR of prevalence and linear ones for the calculation of the regression coefficients, adjusting for the potential confounding variables aforementioned. All covariables were added simultaneously into the models. First, we calculated the association between the frequency of undertaking MVPA and health status by estimating OR for the following categories: 1–2, 3–4, 5–6 and 7 days, using 'never' as the reference. Second, linear and quadratic trends of the association between MVPA and the health indicators were calculated from the regression models. For the linear trend, the average value for each category was used, modelling it as a continuous variable, while for the quadratic trend the squares of these values were used. Statistical significance was set at p<0.05.

To further explore the relationships between MVPA and health-status indicators without imposing any particular functional form for the dose–response trends, the amount of MVPA was entered in regression models using restricted quadratic splines with knots at 1, 3.5 and 6 days/week.[28] Restricted quadratic splines allow for different quadratic trends within each intermediate category and linear trends in boundary categories, and hence they can accommodate a wide variety of smooth dose–response curves, while avoiding implausible shapes at the tails of the exposure distribution.

Interactions between MVPA, age and sex were evaluated. Given that interactions were found in the relationship between the frequency of MVPA and health status according to sex, the results are shown separately for males and females.

RESULTS

Table 1 describes the health status of the questionnaire respondents, as estimated by the four health indicators. A total of 91.1% (CI 95% 90.3% to 92.0%) declared that they had an optimal self-rated health, 67.4% (CI 95% 66.1% to 68.5%) had a low level of health complaints and 90.9% (CI 95% 90.1% to 91.6%) reported a high satisfaction with life. The mean score on the scale for health-related quality of life was 47.1 (CI 95% 46.5 to 47.6).

According to all the indicators used, the level of health was better, in a statistically significant way, for the questionnaire respondents who indicated that they undertook MVPA more frequently, with gradual increases depending on the categories of MVPA

(table 1). The rest of the potentially confounding variables considered were also associated with self-rated health, less health complaints, high satisfaction with life and health-related quality of life (tables 1 and 2).

No statistically significant interactions were found between MVPA and age, whereas statistical significance was reached between MVPA and sex for the indicators self-rated health and satisfaction with life. Tables 3 and 4 and figure 1 show the results of the multivariate analysis that evaluated, for each sex separately, the association of the frequency of undertaking MVPA with the different indicators of health status, controlling the effect on this association of personal and family factors. For both boys and girls, there was a positive, graded and statistically significant association (linear trend, $p < 0.001$) between MVPA and self-rated health (table 3), with ORs that ranged in males from 2.37, for those who undertook MVPA on 1–2 days, to 4.60 and 4.05, for those undertaking it on 5–6 and 7 days, respectively. Moving from less than 5 days to 5–6 days of MVPA, the OR increased from 2.34 to 4.60. In females, although a positive association was also found, the magnitude of the benefits on self-reported health was lower, with values that were half those for the males (OR=2.14, if MVPA undertaken 7 days).

Regarding less health complaints (table 3), an increase in the positive effects was seen in males from small
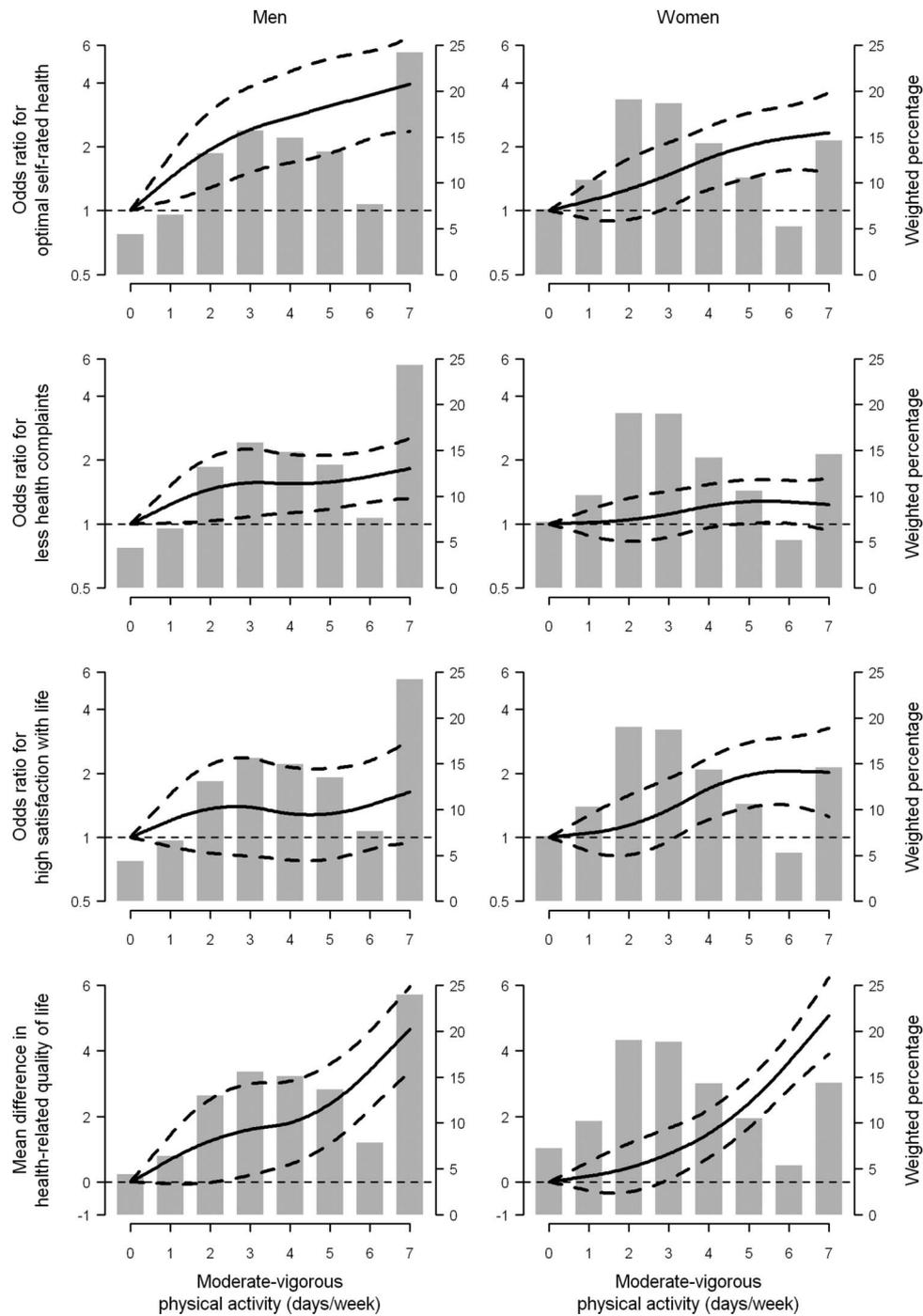
Table 2 Description of the sample and distribution of optimal self-rated health, less health complaints, high satisfaction with life and health-related quality of life, according to family variables

	Optimal Self-reported health N (17467) (%)	Less health complaints N (16803) (%)	High satisfaction with life N (17358) (%)	Health-related quality of life N (16560) (Mean)
Employment situation of father				
Paid employment	91.5*	67.8*	91.3*	47.2*
No paid employment	86.9	63.0	85.4	45.4
Do not know	90.3	52.9	91.5	43.3
No father	85.4	59.8	82.0	44.3
Employment situation of mother				
Paid employment	91.0	67.1	90.8*	47.1*
No paid employment	91.5	68.3	91.4	47.0
Do not know	90.9	59.1	91.4	47.5
No mother	83.7	58.7	78.0	45.2
Socioeconomic status				
Low	86.2*	62.6*	84.5*	45.2*
Average	91.2	66.7	90.9	46.9
High	92.9	69.9	93.2	48.0
Country of birth of father				
Spain	91.1	67.6	91.2*	47.1
Other countries	91.1	64.7	86.2	46.4
Country of birth of mother				
Spain	91.1	67.7*	91.1*	47.1
Other countries	91.9	62.4	87.3	46.1
Type of household				
Both parents	92.0*	68.4*	91.9*	47.3*
Single parent	86.9	62.2	85.0	45.7
Blended	83.0	59.3	82.6	44.2
Others	85.3	61.3	86.8	46.8
Number of adults in the household				
2	91.7*	64.1*	91.2*	47.3
0,1,3,4,5	88.8	68.3	89.3	46.4
Number of minors in the household				
1,2,3	91.1	60.3*	91.0	47.1
>3	90.6	68.0	88.8	46.8
Satisfaction: family relationships†				
Good	93.0*	45.2*	94.2*	48.0*
Fair-bad	75.9	70.1	64.2	39.4
Satisfaction: relationships with friends†				
Good	92.0*	48.5*	92.3*	47.5*
Fair-bad	77.1	68.6	68.5	40.0

Spanish adolescents aged 11–18 years, 2006.
* $p < 0.05$.
†Good: score 7–10; fair-bad: score 0–6.

Figure 1 Dose–response relationship of the amount of self-reported moderate-to-vigorous physical activity (MVPA) with optimal self-rated health, less health complaints, high satisfaction with life and health-related quality of life among Spanish adolescents aged 11–18 years. *Footnote*: Curves represent adjusted ORs or mean differences (solid lines) and their 95% CIs (dashed lines) based on restricted quadratic splines for the amount of MVPA with knots at 1, 3.5 and 6 days/week. The reference value (OR=1 and mean difference=0) was set at 0 days/week of moderate-to-vigorous physical activity. ORs and mean differences were obtained from logistic and linear regression models for the complex survey and adjusted for personal and familial risk factors (see Methods section). Bars represent the weighted bar charts of the amount of MVPA among men and women.

amounts of MVPA on 1–2 days (OR=1.66, p=0.008), which increased further to an OR of nearly 2 for MVPA on 5–6 days. In females, this effect was lower, reaching statistical significance after MVPA on 5–6 days with an OR of 1.46 (p=0.009). The linear trend p value was statistically significant (p<0.001) in both males and females.

The degree of satisfaction with life (table 3) was also shown to be significantly associated with the frequency of undertaking MVPA; among the boys, the OR for high satisfaction increased to 1.99 if PA was undertaken on 1–2 days/week, and satisfaction remained at these values for frequencies of more than 5 days of MVPA.

Table 3 Logistic models

	Men OR* (95% CI)	p Value	Women OR* (95% CI)	p Value
Optimal self-rated health				
Frequency of undertaking MVPA				
Never	1 (ref)		1 (ref)	
1–2 days	2.37 (1.56 to 3.58)	<0.001	1.20 (0.85 to 1.69)	0.282
3–4 days	2.34 (1.44 to 3.81)	0.001	1.51 (1.06 to 2.14)	0.020
5–6 days	4.60 (2.60 to 8.13)	<0.001	2.28 (1.47 to 3.52)	<0.001
7 days	4.05 (2.38 to 6.89)	<0.001	2.14 (1.37 to 3.34)	0.001
Linear trend p value	<0.001		<0.001	
Quadratic trend p value	0.325		0.850	
Less health complaints				
Frequency of undertaking MVPA				
Never	1 (ref)		1 (ref)	
1–2 days	1.66 (1.14 to 2.42)	0.008	1.16 (0.90 to 1.49)	0.226
3–4 days	1.65 (1.14 to 2.39)	0.007	1.21 (0.93 to 1.58)	0.143
5–6 days	2.09 (1.47 to 2.96)	<0.001	1.46 (1.10 to 1.93)	0.009
7 days	1.94 (1.38 to 2.73)	<0.001	1.32 (0.97 to 1.80)	0.076
Linear trend p value	0.001		0.021	
Quadratic trend p value	0.216		0.463	
High satisfaction with life				
Frequency of undertaking MVPA				
Never	1 (ref)		1 (ref)	
1–2 days	1.99 (1.20 to 3.31)	0.007	0.93 (0.63 to 1.36)	0.722
3-4 days	1.52 (0.90 to 2.55)	0.111	1.44 (0.99 to 2.10)	0.056
5-6 days	2.02 (1.17 to 3.49)	0.011	1.56 (0.98 to 2.49)	0.059
7 days	1.94 (1.09 to 3.44)	0.023	2.00 (1.19 to 3.35)	0.008
Linear trend p value	0.128		<0.001	
Quadratic trend p value	0.661		0.975	

Association between the amount of moderate-to-vigorous physical activity (MVPA) and optimal self-rated health, less health complaints and high satisfaction with life. Spanish adolescents aged 11–18 years, 2006.
*Adjusted for age, country of birth, smoking, alcohol consumption, body mass index, consumption of fruit and vegetables, daily breakfast, time spent watching TV using computers, time spent studying, academic achievement, employment situation of the father and mother, socioeconomic status, country of birth of the father and mother, type of household, number of adults and number of minors in the household, satisfaction with family relationships and with friends.

In girls, the magnitude of the effect was similar, but the gradient was steeper. The linear trend p value was statistically significant for females (p<0.001), but not for males.

Table 4 shows the same analysis applied to health-related quality of life, considering it as a continuous variable and using linear regression to analyse it. In males, an increasing dose–response effect was seen,

Table 4 Linear models

	Men β* (95% CI)	p Value	Women β* (95% CI)	p Value
Frequency of undertaking MVPA				
Never	0 (ref)		0 (ref)	
1–2 days	1.61 (0.29 to 2.93)	0.017	0.19 (−0.71 to 1.10)	0.676
3–4 days	1.87 (0.50 to 3.24)	0.007	1.19 (0.37 to 2.02)	0.005
5–6 days	3.03 (1.74 to 4.31)	<0.001	2.79 (1.76 to 3.82)	<0.001
7 days	5.08 (3.73 to 6.43)	<0.001	5.09 (3.86 to 6.32)	<0.001
Linear trend p value	<0.001		<0.001	
Quadratic trend p value	0.006		<0.001	

Association between the amount of moderate-to-vigorous physical activity (MVPA) and health-related quality of life. Spanish adolescents aged 11–18 years, 2006.
*Adjusted for age, country of birth, smoking, alcohol consumption, body mass index, consumption of fruit and vegetables, daily breakfast, time spent watching TV and using computers, time spent studying, academic achievement, employment situation of the father and mother, socioeconomic status, country of birth of the father and mother, type of household, number of adults and number of minors in the household, satisfaction with family relationships and with friends.

especially noticeable after 5 days/week of MVPA (β=3.03), which increased even further, to 5.08, for those undertaking MVPA for 7 days/week. In females, the benefits were lower at low levels of frequency of MVPA, but reached the same magnitude from 5 days of MVPA. Overall, this indicator was the one that showed fewer differences between boys and girls, as can be seen in figure 1. The quadratic trend p value was statistically significant in males (p=0.006) and females (p<0.001).

DISCUSSION
Principal findings
The results of this study clearly show that the benefits of undertaking PA on the health status of adolescents enrolled in schools in Spain. The following results should be highlighted: (1) the magnitude of the effect, with benefits for optimal health reaching OR higher than 4 for males who undertook MVPA daily or on most days, as compared with those who never undertook it; (2) the existence of a dose–response effect, with the positive effects increasing in accordance with the increase in the frequency of MVPA; (3) the consistency of the results with the association present for the four health indicators in both sexes; and (4) the greater positive effect in males, especially at low levels of frequency of MVPA.

Few studies have linked the effect of MPVA on general indicators of health status in adolescents. Using data from the HBSC study for adolescents from North America, Western Europe, Eastern Europe, Northern Europe and Southern Europe, Iannotti et al[29] evaluated the relationship between the frequency of PA and self-rated health, health complaints and satisfaction with life and found, as in our study, beneficial effects for all three indicators.

Dose–response relationship
The dose–response relationship between PA and health implies that increases in PA are related with additional improvements in health status, even when it is not undertaken very frequently. This has also been found in other studies regarding dyslipidaemia, blood pressure, overweight and obesity, metabolic syndrome and mental health.[4 30–32] However, to our knowledge, there are no comparable studies that measure the nature of the relationship on general indicators of health status. Indeed, there is a controversy about whether this relationship is linear or curvilinear, as some studies have found linear patterns, whereas others have not,[4 30–32] probably because the patterns can be different depending on the health effect that is being assessed. In our study, a curvilinear relationship was found with a slight slowdown in the health benefits beyond 3–4 days of MVPA in the following indicators: self-rated health; health complaints; and satisfaction with life. In contrast, for health-related quality of life in both sexes, the benefits increased from these intermediate levels of MVPA. These differences in

the dose–response relationship suggest that the effect varies depending on the different dimensions of health status to which the indicators are related. Although self-rated health has been proposed as a measurement of the summary effect of multiple dimensions of health, it is more closely related to the physical dimension rather than the mental and social ones.[33] Similarly, the scale for health complaints is related to symptoms with psychosomatic components very frequently associated with adolescence.[34] Yet, the scale for the quality of life, besides including such physical and mental dimensions, also incorporates family and social relationships, which could suggest that these additional dimensions may be involved in the achieving of greater health benefits with the maximum frequencies of MVPA.

It should be stressed that the benefits to health status are obtained from low levels of MVPA, especially for boys. Similar results have been reported for self-rated health in a young adult population[35] and regarding blood pressure and dyslipidaemia in adolescents.[31 32] This may have important implications for the preventive recommendations because (although 60 min of PA is currently recommended, if possible on a daily basis) the fact that positive results of a moderate magnitude can be achieved with very small amounts of MVPA may encourage the participation of the more sedentary people. Nevertheless, the maximum benefits were obtained according to public-health recommendations, so the message should be 'even a little is good; more is better'.[36]

Gender differences
The results in health that are derived from undertaking MVPA are greater in males, especially in self-rated health and, to a lesser extent, in having less health complaints. According to our study, females need to undertake more days of MVPA to obtain similar health benefits. However, the effect on satisfaction with life and health-related quality of life was fairly similar in males and females. These differences suggest that the variation of the effect of MVPA according to sex could also be associated to different dimensions of health status. Previous reviews have clearly shown important differences between males and females in the quantity, intensity and type of PA, and that, in part, these distinctions could be explained by biological differences and those relating to sociocultural environment and body image.[21 37] It would, therefore, be interesting for subsequent studies to undertake detailed research about this relationship.

Strengths and weaknesses
To aid correct interpretation of these data, several limitations should be mentioned. First, the limitation in causal inference, stemming from the cross-sectional nature of the study, would theoretically affect the temporality of the association. That is, people who have health problems can have limitations in undertaking physical exercise. However, from the data of the National Health Survey of 2006,[38] only 1.7% of adolescents between 16

and 19 years do not undertake the leisure time physical exercise that they would like to take because of health problems; hence, this figure would not affect the results obtained. Second, the measurement of health status, MVPA and several covariables of the study is based on self-reported information. Although it is difficult to anticipate the magnitude and direction of the bias induced by measurement error in self-reported PA without validity or reproducibility substudies, some degree of attenuation in the underlying trends would be expected if the misclassification of PA status was non-differential with respect to health outcomes. Nevertheless, the measurement of health status using subjective health scales, as in this present study, has been validated in previous studies,[20 23 24 39 40] and such scales are considered to be useful tools especially in the stage of adolescence, when psychological aspects are so important in the feeling of well-being among young people. The variable used for estimating MVPA has been previously validated in an adolescent population of Spain, obtaining an acceptable level of validity when compared with measurement using accelerometers.[25] Other variables, such as self-reported BMI or tobacco consumption, have also been validated in Spain, by comparing them with objective measurements.[41 42] Third, it has not been possible to differentiate the effect of the intensity of PA, which is a dimension independently related with self-rated health.[35]

The main strengths of this study are the representativeness and large size of the sample used, which means that the results can be extrapolated accurately, and that the methodology employed is the standard one for the HBSC study. This is a collaborative WHO study in which more that 40 Western countries (including Spain) have participated.

CONCLUSIONS

To sum up, an association was found between the frequency of undertaking self-reported MVPA and the health status of adolescents enrolled in schools in Spain. A linear trend was found for self-rated health, health complaints and for satisfaction with life. For health-related quality of life the relationship was quadratic. The benefits of MVPA on health were detected from very low levels, below those established by current recommendations. In general, the magnitude of association was lower in females than in males, a finding that needs to be explained by subsequent research.

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REFERENCES
1. World Health Organization. Global Strategy on Diet, Physical Activity and Health. http://www.who.int/dietphysicalactivity/strategy/eb11344/strategy_english_web.pdf (accessed Dec 2012).
2. Biddle SJ, Asare M. Physical activity and mental health in children and adolescents: a review of reviews. *Br J Sports Med* 2011;45:886–95.
3. Hallal PC, Victora CG, Azevedo MR, *et al.* Adolescent physical activity and health: a systematic review. *Sports Med* 2006;36:1019–30.
4. Janssen I, Leblanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *Int J Behav Nutr Phys Act* 2010;7:40.
5. Strong WB, Malina RM, Blimkie CJ, *et al.* Evidence based physical activity for school-age youth. *J Pediatr* 2005;146:732–7.
6. Physical Activity Guidelines Advisory Committee report, 2008. To the Secretary of Health and Human Services. Part A: executive summary. *Nutr Rev* 2009;67:114–20.
7. Janssen I. Physical activity guidelines for children and youth. *Can J Public Health* 2007;98(Suppl 2):109–21.
8. Fedewa A, Ahn S. The effects of physical activity and physical fitness on children's achievement and cognitive outcomes: a meta-analysis. *Res Q Exerc Sport* 2011;82:521–35.
9. Abu-Omar K, Rutten A, Robine JM. Self-rated health and physical activity in the European Union. *Soz Praventivmed* 2004;49:235–42.
10. Haennel RG, Lemire F. Physical activity to prevent cardiovascular disease. How much is enough? *Can Fam Physician* 2002;48:65–71.
11. Kim K, Shin YJ, Nam JH, *et al.* A dose-response relationship between types of physical activity and distress. *J Korean Med Sci* 2008;23:218–25.
12. Lee IM, Skerrett PJ. Physical activity and all-cause mortality: what is the dose-response relation? *Med Sci Sports Exerc* 2001;33(Suppl 6):459–71.
13. Martin CK, Church TS, Thompson AM, *et al.* Exercise dose and quality of life: a randomized controlled trial. *Arch Intern Med* 2009;169:269–78.
14. Mayer-Davis EJ, D'Agostino R Jr., Karter AJ, *et al.* Intensity and amount of physical activity in relation to insulin sensitivity: the Insulin Resistance Atherosclerosis Study. *JAMA* 1998;279:669–74.
15. Ohkawara K, Tanaka S, Miyachi M, *et al.* A dose-response relation between aerobic exercise and visceral fat reduction: systematic review of clinical trials. *Int J Obes (Lond)* 2007;31:1786–97.
16. Lollgen H, Bockenhoff A, Knapp G. Physical activity and all-cause mortality: an updated meta-analysis with different intensity categories. *Int J Sports Med* 2009;30:213–24.
17. Ekelund U, Luan J, Sherar LB, *et al.* Moderate to vigorous physical activity and sedentary time and cardiometabolic risk factors in children and adolescents. *JAMA* 2012;307:704–12.
18. World Health Organization. *Global recommendations on physical activity for health.* World Health Organization, 2010. http://whqlibdoc.who.int/publications/2010/9789241599979_eng.pdf (accessed Feb 2013).

19. Ravens-Sieberer U, Torsheim T, Hetland J, *et al*. Subjective health, symptom load and quality of life of children and adolescents in Europe. *Int J Public Health* 2009;54(Suppl 2):151–9.
20. Ravens-Sieberer U, Erhart M, Wille N, *et al*. Generic health-related quality-of-life assessment in children and adolescents: methodological considerations. *Pharmacoeconomics* 2006;24:1199–220.
21. Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. *Med Sci Sports Exerc* 2000;32:963–75.
22. Currie C, Nic GS, Godeau E. The Health Behaviour in School-aged Children: WHO Collaborative Cross-National (HBSC) study: origins, concept, history and development 1982–2008. *Int J Public Health* 2009;54(Suppl 2):131–9.
23. Curries CE, Gabhainn SN, Godeau E. *Inequalities in young people Health. HBSC International report from the 2005/2006 Survey*. Copenhagen, Denmark: WHO Regional Office for Europe. http://www.euro.who.int/__data/assets/pdf_file/0005/53852/E91416.pdf (accessed Dec 2012).
24. Erhart M, Ottova V, Gaspar T, *et al*. Measuring mental health and well-being of school-children in 15 European countries using the KIDSCREEN-10 Index. *Int J Public Health* 2009;54(Suppl 2):160–6.
25. Martinez-Gomez D, Martinez-De-Haro V, Del-Campo J, *et al*. Validity of four questionnaires to assess physical activity in Spanish adolescents. *Gac Sanit* 2009;23:512–17.
26. Cole TJ, Bellizzi MC, Flegal KM, *et al*. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* 2000;320:1240–3.
27. Currie C, Molcho M, Boyce W, *et al*. Researching health inequalities in adolescents: the development of the Health Behaviour in School-Aged Children (HBSC) family affluence scale. *Soc Sci Med* 2008;66:1429–36.
28. Greenland S. Dose-response and trend analysis in epidemiology: alternatives to categorical analysis. *Epidemiology* 1995;6:356–65.
29. Iannotti RJ, Janssen I, Haug E, *et al*. Interrelationships of adolescent physical activity, screen-based sedentary behaviour, and social and psychological health. *Int J Public Health* 2009;54 (Suppl 2):191–8.
30. Hamer M, Stamatakis E, Steptoe A. Dose-response relationship between physical activity and mental health: the Scottish Health Survey. *Br J Sports Med* 2009;43:1111–14.
31. Leblanc AG, Janssen I. Dose-response relationship between physical activity and dyslipidemia in youth. *Can J Cardiol* 2010;26:201–5.
32. Mark AE, Janssen I. Dose-response relation between physical activity and blood pressure in youth. *Med Sci Sports Exerc* 2008;40:1007–12.
33. Mavaddat N, Kinmonth AL, Sanderson S, *et al*. What determines Self-Rated Health (SRH)? A cross-sectional study of SF-36 health domains in the EPIC-Norfolk cohort. *J Epidemiol Community Health* 2011;65:800–6.
34. Ravens-Sieberer U, Erhart M, Torsheim T, *et al*. An international scoring system for self-reported health complaints in adolescents. *Eur J Public Health* 2008;18:294–9.
35. Galan I, Meseguer CM, Herruzo R, *et al*. Self-rated health according to amount, intensity and duration of leisure time physical activity. *Prev Med* 2010;51:378–83.
36. Lee IM. Dose-response relation between physical activity and fitness: even a little is good; more is better. *JAMA* 2007;297:2137–9.
37. Van Der HK, Paw MJ, Twisk JW, *et al*. A brief review on correlates of physical activity and sedentariness in youth. *Med Sci Sports Exerc* 2007;39:1241–50.
38. Ministry of Health. *National Health Survey 2006*. Social Services and Equality, 2012. http://www.msps.es/estadEstudios/estadisticas/encuestaNacional/encuesta2006.htm (accessed Dec 2012)
39. Boardman JD. Self-rated health among U.S. adolescents. *J Adolesc Health* 2006;38:401–8.
40. Fosse NE, Haas SA. Validity and stability of self-reported health among adolescents in a longitudinal, nationally representative survey. *Pediatrics* 2009;123:e496–501.
41. Galán I, Gandarillas A, Febrel C, *et al*. Validation of self-reported weight and height in an adolescent population. *Gac Sanit* 2001;15:490–7.
42. Galán I, Meseguer CM, León CM, *et al*. Validity of adolescent self-reported smoking [Validez de la medición del consumo de tabaco autodeclarado en población juvenil]. *Gac Sanit* 2000;14 (Suppl 2):85.