PEER REVIEW HISTORY

BMJ Open publishes all reviews undertaken for accepted manuscripts. Reviewers are asked to complete a checklist review form (see an example) and are provided with free text boxes to elaborate on their assessment. These free text comments are reproduced below. Some articles will have been accepted based in part or entirely on reviews undertaken for other BMJ Group journals. These will be reproduced where possible.

ARTICLE DETAILS

TITLE (PROVISIONAL)	Physical activity and health status among adolescents: a cross-sectional population-based study
AUTHORS	Galán, Iñaki; Boix, Raquel; Medrano, María José; Ramos, Pilar; Rivera, Francisco; Pastor-Barriuso, Roberto; Moreno, Carmen

VERSION 1 - REVIEW

REVIEWER	Allana LeBlanc PhD (candidate) Healthy Active Living and Obesity Research Group Canada
REVIEW RETURNED	14-Feb-2013

THE STUDY	The author should work with others to improve the overall flow of the manuscript.
RESULTS & CONCLUSIONS	With respect to Tables 1 and Table 2, you've presented a great deal of information that doesn't relate directly to your research question and is not spoken to in-text. This makes the tables very long and takes a great deal of time to work through. It is suggested you either reduce the information you present in the tables such that is reflects more concisely what you have spoken to in the text, or you divide up the tables in such a way that it is easier for the reader to orientate to.
REPORTING & ETHICS	No reporting guidelines were provided therefor unable to tell if they are in line/with which guidelines
GENERAL COMMENTS	I would like to congratulate you on putting together a manuscript that was quite interesting to read. Some considerations... Major points - there is not enough justification for the use of self-report data. You have one sentence to this point in the discussion and it is unclear what you are eluding to ("although it has been an acceptable validation in our geographical coverage"). This was better explained in the "article summary". - to this, I find that at least some of the health related differences between boys and girls is due to gender differences in perception of physical activity and not the associated indicator of health - looking at the data presented in Table 3, it seems that the majority of health effects peak at 5-6 days, this is not addressed. It would have been interesting to see if it's at 5 or 6 days that you see the true peak. - most of your sample reported very high levels of health - it may be that you're only seeing significance in the relationship with MVPA because your sample size is so large - have you calculated if there is a difference in those whom you have complete data on and those whom you have incomplete data (i.e. family SES, activity level, reported health) - this data is almost 7 years old, are you worried it is already out of date?

	- I disagree with your statement on p12l49-57 - you've shown in this manuscript that youth are reporting significantly better health when they engage in 5-6 days of at least 60 min of MVPA, that is actually a considerable amount of PA and may be VERY intimidating to a sedentary individual. The way this is written is quite contradictory to the message you are sending elsewhere in the manuscript. Minor points - there are some formatting errors in the references - headings on your figure for gender are different in tables versus figures (i.e. males/females vs men/women) - many points throughout the manuscript where the writing is awkward and should be worked on (e.g. p1,l24-29, p1l52, p2l3-7, p12l49-57, p13l33-46, p14l29) - you are inconsistent with your use of MVPA vs PA

REVIEWER	Kirsten Corder Position: Investigator Scientist Institution: MRC Epidemiology Unit, Cambridge, UK I have no competing interests to declare.
REVIEW RETURNED	27-Feb-2013

THE STUDY	Methods Study population – more detail about how the multistage sampling, and how that took all of the listed factors into account is necessary as this is not currently clear from the information provided. Page 7, end of first paragraph. More detail about the standardisation of these scores would be relevant. Page 7, second paragraph. Some information about the validity of the MVPA question is necessary here. There are many potential confounders included. It would be helpful to include rationale for the inclusion of these, and more information about their measurement. Data analysis The authors state that the “Survey Data” module of STATA was used for analyses; however, some explanation of what this function actually does is necessary. More detail about how the confounding variables were included in the models is necessary e.g. were these all added at once, were they added/removed stepwise? What happened if they were / were not significant? Clarification of the outcome and exposure variables in each model would be helpful in this section. The authors describe methods for assessing quadratic trends. The data is all self-reported but the data is analysed with complicated models and this limitation should at least perhaps be mentioned in the manuscript. Abstract Abstract results – ‘improvement’ should really be rephrased, perhaps to ‘association’ as this study is cross-sectional.

	Key messages Article focus – clarification of the specific PA guidelines for adolescents (e.g. 60 mins of MVPA) would be helpful. Strengths/limitations – the self-report nature of the data is a major limitation and should be included here. Literature The authors state that there is little previous research examining MVPA and health, however the authors refer to some in the discussion (Iannotti et al) which perhaps should be included here. Additionally, Ekelund et al., JAMA 2012 is relevant to add here. More specific details about the PA recommendations would also be relevant to add here.
RESULTS & CONCLUSIONS	Interpretation / conclusions / presentation Terminology like 'protective effect' (top of page 11) and 'cause' (bottom of Page 11) should be rephrased due to the cross-sectional nature of the study. Bottom of page 13. The limitation regarding measurement bias is probably the major limitation of this study and more explanation about how this may have influenced the results is necessary. First paragraph Page 14. The authors state that the standard methodology across HSBC implies international comparability. A standard methodology does not imply this unless a comparison has been made across this standard methodology. The authors should therefore consider rephrasing this. Conclusions These should be 'toned-down' due to the self-report nature of this data. Tables and figures There is a lot of information presented in Tables 1 and 2. It is hard to get an overview of this information and perhaps simplifying these tables by not presenting this separately for health outcomes may be preferable. It would be helpful to plot the OR and Beta results in Tables 3 and 4 as figures with 95% CI. This would allow the reader a better overview of the main results. It is apparent from the figures that relatively few participants reported doing 60 mins of MVPA 6 days per week (compared to 5 or 7). Could the authors comment on whether this is likely to be an artefact of self-reported data (e.g. participants who think they are active most days select 7 days rather than 6) or due to real differences?
REPORTING & ETHICS	Research ethics approval is not stated.
GENERAL COMMENTS	This paper describes dose response associations between self-reported MVPA and self-reported health indicators among a very large sample of Spanish adolescents. The authors identify positive dose-response associations between self-reported MVPA and health which appear to be stronger among males. This is an interesting research question in a large sample; I have some comments which will hopefully be helpful in clarifying the manuscript. Overall comments Throughout the manuscript, the authors should be careful to clarify that this study examines associations between two sets of self-

	reported variables. Clarification of this in the title, abstract (e.g. objective and outcomes) and throughout would be useful. Specific comments Abstract results – 'improvement' should really be rephrased, perhaps to 'association' as this study is cross-sectional. Article summary Article focus – clarification of the specific PA guidelines for adolescents (e.g. 60 mins of MVPA) would be helpful. Strengths/limitations – the self-report nature of the data is a major limitation and should be included here. Introduction Paragraph 2 – the authors state that there is little previous research examining MVPA and health, however the authors refer to some in the discussion (Iannotti et al) which perhaps should be included here. Additionally, Ekelund et al., JAMA 2012 is relevant to add here. More specific details about the PA recommendations would also be relevant to add here. Paragraph 3 – it would be helpful to elaborate or give examples for 'special characteristics'; this sentence could also benefit from clarification. It is worthy of explanation as to why was only the Spanish HSBC sample used in this analysis. Methods Ethics approval for this study should be stated clearly. Study population – more detail about how the multistage sampling, and how that took all of the listed factors into account is necessary as this is not currently clear from the information provided. Page 7, end of first paragraph. More detail about the standardisation of these scores would be relevant. Page 7, second paragraph. Some information about the validity of the MVPA question is necessary here. There are many potential confounders included. It would be helpful to include rationale for the inclusion of these, and more information about their measurement. Data analysis The authors state that the "Survey Data" module of STATA was used for analyses; however, some explanation of what this function actually does is necessary. More detail about how the confounding variables were included in the models is necessary e.g. were these all added at once, were they added/removed stepwise? What happened if they were / were not significant? Clarification of the outcome and exposure variables in each model would be helpful in this section. The authors describe methods for assessing quadratic trends. The data is all self-reported but the data is analysed with complicated

	models and this limitation should at least perhaps be mentioned in the manuscript. Results It would be helpful to report differences in descriptive data for those with missing data compared to those included in analyses. Authors report no significant interactions between MVPA and age. This is perhaps unexpected due to the previously reported age-related PA decline throughout adolescents. It is therefore relevant to mention this in the discussion. Page 9. End of last paragraph. A brief explanation of the nature of the sex-MVPA interaction would be useful here. Top of Page 10. The authors mention stratified analyses. Presumably analyses were stratified after significant interactions were identified? This should be clarified. Discussion Terminology like 'protective effect' (top of page 11) and 'cause' (bottom of Page 11) should be rephrased due to the cross-sectional nature of the study. Bottom of page 13. The limitation regarding measurement bias is probably the major limitation of this study and more explanation about how this may have influenced the results is necessary. First paragraph Page 14. The authors state that the standard methodology across HSBC implies international comparability. A standard methodology does not imply this unless a comparison has been made across this standard methodology. The authors should therefore consider rephrasing this. Conclusions These should be 'toned-down' due to the self-report nature of this data. Tables and figures There is a lot of information presented in Tables 1 and 2. It is hard to get an overview of this information and perhaps simplifying these tables by not presenting this separately for health outcomes may be preferable. It would be helpful to plot the OR and Beta results in Tables 3 and 4 as figures with 95% CI. This would allow the reader a better overview of the main results. It is apparent from the figures that relatively few participants reported doing 60 mins of MVPA 6 days per week (compared to 5 or 7). Could the authors comment on whether this is likely to be an artefact of self-reported data (e.g. participants who think they are active most days select 7 days rather than 6) or due to real differences?

REVIEWER	David Crawford Head, School of Exercise and Nutrition Sciences Deakin University Australia
REVIEW RETURNED	07-Mar-2013

THE STUDY	This is a well written paper based on findings from a large popultation based study, in an under-studied group, namely adolescents. The major limitation of this paper is its cross-sectional study design, and while this is acknowledged by the authors, it is a major weakness.
RESULTS & CONCLUSIONS	The cross-sectional nature of this study is a major weakness - eg possibility of reverse causality.

VERSION 1 – AUTHOR RESPONSE

Reviewer: Allana LeBlanc
PhD (candidate)
Healthy Active Living and Obesity Research Group
Canada

The author should work with others to improve the overall flow of the manuscript.

With respect to Tables 1 and Table 2, you've presented a great deal of information that doesn't relate directly to your research question and is not spoken to in-text. This makes the tables very long and takes a great deal of time to work through. It is suggested you either reduce the information you present in the tables such that is reflects more concisely what you have spoken to in the text, or you divide up the tables in such a way that it is easier for the reader to orientate to.

Authors:
In these tables, we only describe the characteristics of the sample in relation to dependent variables. As you can see, the information corresponds to the crude analysis of the data, emphasizing that most of the relationships are statistically significant. We did not describe this information in the text because, except for MVPA (the main independent variable), all of them were considered as potentially confounding variables. This has been now stated in the text to make it clear to the reader. Nevertheless, to reduce information, the columns corresponding to the number of individuals have been deleted, maintaining the totals in the subheadings of the columns.

New sentence: The rest of 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 reporting guidelines were provided therefor unable to tell if they are in line/with which guidelines

Authors:
The following text has been added in the Introduction, replacing “Although it is recommended that all adolescents should undertake Moderate-to-Vigorous Physical Activity (MVPA) on most days of the week,…”

New sentence: “Although the World Health Organization (WHO) recommends that all children of 5-17 years of age take at least 60 minutes of daily Moderate-to-Vigorous Physical Activity (MVPA),18 …”
World Health Organization. Global recommendations on physical activity for health. World Health Organization 2010. http://whqlibdoc.who.int/publications/2010/9789241599979_eng.pdf.

I would like to congratulate you on putting together a manuscript that was quite interesting to read. Some considerations...

Major points
- there is not enough justification for the use of self-report data. You have one sentence to this point in the discussion and it is unclear what you are eluding to ("although it has been an acceptable validation in our geographical coverage"). This was better explained in the "article summary".

Authors:
Thank you for pointing out this limitation of the study. We have rewritten the text in the Limitations subsection (Discussion): 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 physical activity without validity or reproducibility substudies, some degree of attenuation in the underlying trends would be expected if the misclassification of physical activity status was nondifferential 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

- to this, I find that at least some of the health related differences between boys and girls is due to gender differences in perception of physical activity and not the associated indicator of health

Authors:
We cannot rule out that some of the health related differences between boys and girls is due to gender differences in perception of physical activity. The evidence in the general population supporting the role of physical activity in the primary prevention of cardiovascular disease and diabetes is now seen to be as strong for women as it is for men, and the evidence supports an inverse dose-response relationship (Brown WJ, Burton NW, Rowan PJ. Updating the evidence on physical activity and health in women. Am J Prev Med. 2007 Nov;33(5):404-411). However, evidence about the effect on health status using subjective health scales is scarce, above all in adolescents.

- looking at the data presented in Table 3, it seems that the majority of health effects peak at 5-6 days, this is not addressed. It would have been interesting to see if it's at 5 or 6 days that you see the true peak.

Authors:
You can see in the Figure 1 the dose-response relationship for each day of undertaking MVPA, using smooth dose-response curves based on restricted quadratic splines. In Tables 3-4, they were grouped into five categories to be able to estimate odds ratios with greater statistical power.

- most of your sample reported very high levels of health - it may be that you're only seeing significance in the relationship with MVPA because your sample size is so large

Authors:
We agree with the reviewer that sample size used in the survey facilitates statistical significance in the relationships. However, the magnitude, dose-response, and consistency between the four indicators support the association.

- have you calculated if there is a difference in those whom you have complete data on and those whom you have incomplete data (i.e. family SES, activity level, reported health)

Authors:
The sample used to analyse the data of this study, excluding missing values, was similar to the original sample. We attach below, comparisons between these two samples by gender, age, socioeconomic status, health status, and the frequency of undertaking MVPA.

The following text has been incorporated at the end of the first paragraph of Data analysis, in Methods section: The sample excluding missing values was similar to the original, comparing the main socioeconomic variables, health status, and the frequency of undertaking MVPA.

Gender. Original sample size

Number of obs = 21811

| Linearized
| Proportion Std. Err.
---|---
Gender |
Male | .4692203 .0093204
Female | .5307797 .0093204

Sample size excluding missing data

Number of obs = 17467

| Linearized
| Proportion Std. Err.
---|---
Gender |
Male | .4560236 .0098674
Female | .5439764 .0098674

Age. Original sample size

Number of obs = 21811

| Linearized
| Mean Std. Err.
---|---
Age | 14.47145 .1519659

Sample size excluding missing data

Number of obs = 17467

| Linearized
| Mean Std. Err.
---+---
Age | 14.61931 .1545347

Socioeconomic status. Original sample size

Number of obs = 21537

| Linearized
| Proportion Std. Err.
---+---
Socioeconomic
Status|
Low | .1579951 .0072041
Average | .4647503 .0079537
High | .3772545 .0126104

Sample size excluding missing data

Number of obs = 17467

| Linearized
| Proportion Std. Err.
---+---
Socioeconomic
Status|
Low | .1503122 .0072175
Average | .465247 .0080808
High | .3844407 .012937

Optimal self-rated health. Original sample size

Number of obs = 21633

| Linearized
| Proportion Std. Err.
---+---
|
No optimal| .0910135 .0041122
Optimal| .9089865 .0041122

Sample size excluding missing data

Number of obs = 17467

| Linearized
| Proportion Std. Err.
---+---
|
No optimal| .0889121 .004322
Optimal| .9110879 .004322

Frequency of undertaking physical activity (MVPA). Original sample size

Number of obs = 21034
| Linearized
| Proportion Std. Err.
---+---
Frequency |
Never | .0598736 .0030626
1-2 days| .2507102 .0054253
2-3 days| .3190528 .00488
5-6 days| .1793832 .0041762
7 days| .1909802 .0058509

Sample size excluding missing data

Number of obs = 17467
| Linearized
| Proportion Std. Err.
---+---
Frequency |
Never | .0587022 .0033718
1-2 days| .2499415 .0060667
2-3 days| .3192562 .0054461
5-6 days| .1821689 .0043098
7 days| .1899313 .0060428

- this data is almost 7 years old, are you worried it is already out of date?

Authors:
It is expected that the mechanism underlying the dose-response relationship between physical activity and health status will not vary in the short or medium term.

- I disagree with your statement on p12l49-57 - you've shown in this manuscript that youth are reporting significantly better health when they engage in 5-6 days of at least 60 min of MVPA, that is

actually a considerable amount of PA and may be VERY intimidating to a sedentary individual. The way this is written is quite contradictory to the message you are sending elsewhere in the manuscript.

Authors:
As suggested, we have clarified the message, adding the following sentence: 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 (Lee IM. Dose-response relation between physical activity and fitness: even a little is good; more is better. JAMA 2007; 297, 2137-2139).

Minor points
- there are some formatting errors in the references

Authors:
We have checked the format of all references.

- headings on your figure for gender are different in tables versus figures (i.e. males/females vs men/women)

Authors:
Thank you for drawing our attention to this inconsistency. We have modified the labels of this variable in the tables.

- many points throughout the manuscript where the writing is awkward and should be worked on (e.g. p1l,24-29, p1l,52, p2l,3-7, p12,49-57, p13,33-46, p14,29)

Following your recommendation, a native-English speaking copy editor and proofreader has again reviewed the manuscript, paying special attention to the lines you mention above. The following are examples of the changes made:

Discussion (first paragraph), the new amended text is: 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 to those who never undertook it;

Discussion: Dose-response relationship (last paragraph), the amended text follows: This could have important implications for the preventive recommendations, because (although 60 minutes of physical activity 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.

Conclusions (first line): The sentence has been clarified by emphasizing that the MVPA is “self-reported”.

- you are inconsistent with your use of MVPA vs PA

Authors:
We have added MVPA instead of PA when referring to our data.

Reviewer: Kirsten Corder
Position: Investigator Scientist
Institution: MRC Epidemiology Unit, Cambridge, UK
I have no competing interests to declare.

This paper describes dose response associations between self-reported MVPA and self-reported health indicators among a very large sample of Spanish adolescents. The authors identify positive dose-response associations between self-reported MVPA and health which appear to be stronger among males. This is an interesting research question in a large sample; I have some comments which will hopefully be helpful in clarifying the manuscript.

Overall comments
Throughout the manuscript, the authors should be careful to clarify that this study examines associations between two sets of self-reported variables. Clarification of this in the title, abstract (e.g. objective and outcomes) and throughout would be useful.

Authors:
As suggested, we have emphasized throughout the manuscript that measurements are self-reported variables.

Specific comments
Abstract results – 'improvement' should really be rephrased, perhaps to 'association' as this study is cross-sectional.

Authors:
As suggested we have modified the text, including the following sentence: As the frequency of MVPA increased, the association with health benefits was stronger.

Article summary
Article focus – clarification of the specific PA guidelines for adolescents (e.g. 60 mins of MVPA) would be helpful.

Authors:
As suggested we have added the following text in the Article summary: "Although it is recommended that all adolescents should undertake 60 minutes of daily Moderate-to-Vigorous Physical Activity (MVPA)…"

Strengths/limitations – the self-report nature of the data is a major limitation and should be included here.

Authors:
This major limitation is included in the last point of the Article summary: "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
Paragraph 2 – the authors state that there is little previous research examining MVPA and health, however the authors refer to some in the discussion (Iannotti et al) which perhaps should be included here. Additionally, Ekelund et al., JAMA 2012 is relevant to add here. More specific details about the PA recommendations would also be relevant to add here.

Authors:
We have included the following paragraph:
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

Paragraph 3 – it would be helpful to elaborate or give examples for 'special characteristics'; this

sentence could also benefit from clarification.

Authors:
The sentence has been rewritten, as follows:
It should be emphasized that concepts underlying 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.

It is worthy of explanation as to why was only the Spanish HSBC sample used in this analysis.

Authors:
We had previously investigated the dose-response relationship between PA and self-reported health in an adult population of Spain. We wanted to reproduce this analysis in adolescents living in a similar environment, so taking into account the large sample size we decided to analyse the information from the HBSC of Spain.

Methods
Ethics approval for this study should be stated clearly.

Authors:
We have included this phrase in Methods section: This study was approved by the Institutional Review Board of the Carlos III Institute of Health.

Study population – more detail about how the multistage sampling, and how that took all of the listed factors into account is necessary as this is not currently clear from the information provided.

Authors:
We have added more information, as follows: “A multistage stratified random sampling was used, taking into account 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 …..”

Page 7, end of first paragraph. More detail about the standardisation of these scores would be relevant.

Authors:
We have added the following text: 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 standard deviation of 10, with higher values indicating higher health-related quality of life.24

Page 7, second paragraph. Some information about the validity of the MVPA question is necessary here.

Authors:
As suggested, we have included the text as follows: This question, when compared with PA assessed by accelerometers in Spanish adolescents, has shown an acceptable validation.25

There are many potential confounders included. It would be helpful to include rationale for the inclusion of these, and more information about their measurement.

Authors:
As can be seen in the article of Sallis et al. (2000), cited in the paper, there are many determinants of physical activity in children and adolescents. These variables are potential confounders because they are also related to health status (see Tables1-2). For this reason, we consider it relevant to include the pool of variables analysed in the study.
We think that we provide sufficient information about these variables, taking into account that they are not the main variables of the study. In Tables 1-2, the categories of the variables are described in detail. However, should the reviewers or the editor consider it to be necessary, we would gladly add more information about their measurement.

Data analysis
The authors state that the "Survey Data" module of STATA was used for analyses; however, some explanation of what this function actually does is necessary.

Authors:
The following sentence has now been added: Standard errors were computed by using the linearized variance estimator based on a first-order Taylor series.

More detail about how the confounding variables were included in the models is necessary e.g. were these all added at once, were they added/removed stepwise? What happened if they were / were not significant?

Authors:
We have included this information: All of these co-variables were added simultaneously into the models.

Clarification of the outcome and exposure variables in each model would be helpful in this section.

Authors:
We consider that the specification of the model can be seen in Tables 3 and 4. Nevertheless, we have changed the text in the Data analysis section (Methods section), as follows: Regression models were used, logistic ones for the estimation of the odds ratio of prevalence (OR) and linear ones for the calculation of the regression coefficients, adjusting for the potential confounding variables mentioned above. All co-variables 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 days, 3-4 days, 5-6 days, 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 square of these values was used. Statistical significance was set at $p<0.05$.

The authors describe methods for assessing quadratic trends. The data is all self-reported but the data is analysed with complicated models and this limitation should at least perhaps be mentioned in the manuscript.

Authors:
In the manuscript, the self-reported nature of the variables used in our study was highlighted as a major limitation. However, nonlinear dose-response models are frequently used to analyze risk trends associated to self-reported life-style and dietary factors (Carroll RJ, Ruppert D, Stefanski LA. Measurement error in nonlinear models. Boca Raton, FL: Chapman and Hall/CRC, 1995). Although it is difficult to anticipate the magnitude and direction of the bias induced by measurement error in self-reported physical activity without validity or reproducibility substudies, some degree of attenuation in

the underlying trends would be expected if the misclassification of physical activity status was nondifferential with respect to health outcomes.

Results
It would be helpful to report differences in descriptive data for those with missing data compared to those included in analyses.

Authors:
Please see the detailed answer given to the first reviewer. The sample used to analyse the data of this study, excluding missing values, was similar to the original sample. We attach comparisons between these two samples by gender, age, socioeconomic status, health status, and the frequency of undertaking MVPA.

Authors report no significant interactions between MVPA and age. This is perhaps unexpected due to the previously reported age-related PA decline throughout adolescents. It is therefore relevant to mention this in the discussion.

Authors:
It is well known that PA declines with age. However, age does not interact with MVPA to change the relationship with health status.

Page 9. End of last paragraph. A brief explanation of the nature of the sex-MVPA interaction would be useful here.

Authors:
We think that the description of the interaction belongs with the results of the study and that, therefore, it is more appropriate to describe it in the Results section.

Top of Page 10. The authors mention stratified analyses. Presumably analyses were stratified after significant interactions were identified? This should be clarified.

Authors:
This is explained in the last paragraph of the Methods section: 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 men and women.

Discussion
Terminology like ‘protective effect’ (top of page 11) and ‘cause’ (bottom of Page 11) should be rephrased due to the cross-sectional nature of the study.

Authors:
This has been carried out with the text rephrased as follows:
- Top of page 11 (original version): “In females, the benefits were lower at low levels of frequency of MVPA”.
- Bottom of Page 11 (original version): “The dose-response relationship between PA and health implies that increases in PA are related with additional improvements in health status”

Bottom of page 13. The limitation regarding measurement bias is probably the major limitation of this study and more explanation about how this may have influenced the results is necessary.

Authors:

We have rewritten the text as follows:
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 physical activity without validity or reproducibility substudies, some degree of attenuation in the underlying trends would be expected if the misclassification of physical activity status was nondifferential 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

First paragraph Page 14. The authors state that the standard methodology across HSBC implies international comparability. A standard methodology does not imply this unless a comparison has been made across this standard methodology. The authors should therefore consider rephrasing this.

Authors:
We have deleted this phrase in the new version of the manuscript.

Conclusions
These should be 'toned-down' due to the self-report nature of this data.

Authors:
As suggested, we have toned-down the words taking into account the self-reported nature of the data:
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.

Tables and figures
There is a lot of information presented in Tables 1 and 2. It is hard to get an overview of this information and perhaps simplifying these tables by not presenting this separately for health outcomes may be preferable.

Authors:
To reduce information, the columns corresponding to the number of individuals have been deleted, maintaining the totals in the subheadings of the columns.

It would be helpful to plot the OR and Beta results in Tables 3 and 4 as figures with 95% CI. This would allow the reader a better overview of the main results.

Authors:
We preferred to plot the relationship between PA and health status without imposing any particular function form the dose-response trends, based on regression models using restricted quadratic splines (Figure 1).

It is apparent from the figures that relatively few participants reported doing 60 mins of MVPA 6 days

per week (compared to 5 or 7). Could the authors comment on whether this is likely to be an artefact of self-reported data (e.g. participants who think they are active most days select 7 days rather than 6) or due to real differences?

Authors:
We do not have arguments to consider this to be an artefact of self-reported data although we cannot rule out this possibility. Males and females of all ages describe this distribution.

Literature
The authors state that there is little previous research examining MVPA and health, however the authors refer to some in the discussion (Iannotti et al) which perhaps should be included here. Additionally, Ekelund et al., JAMA 2012 is relevant to add here. More specific details about the PA recommendations would also be relevant to add here.

Authors:
We have included these references in the manuscript.

Reviewer: David Crawford
Head, School of Exercise and Nutrition Sciences
Deakin University
Australia

This is a well written paper based on findings from a large popultation based study, in an under-studied group, namely adolescents. The major limitation of this paper is its cross-sectional study design, and while this is acknowledged by the authors, it is a major weakness.

The cross-sectional nature of this study is a major weakness - eg possibility of reverse causality.

Authors:
We agree with the reviewer. We have highlighted this major limitation in the manuscript, especially in the Discussion section (first paragraph of Strengths and weaknesses).

VERSION 2 – REVIEW

REVIEWER	Kirsten Corder, Investigator Scientist, MRC Epidemiology Unit, UK.
REVIEW RETURNED	08-Apr-2013

GENERAL COMMENTS	The authors have thoroughly responded to the reviewers' comments. However I have two minor comments which relate to my previous comments on the previous version of the manuscript. The authors now report 'validity' of the physical activity question in the manuscript (top of page 8) however, it would be preferable to present some numeric values to support 'acceptable validation'. Similarly, the reporting of comparisons between missing and included data at the top of page 9 could benefit from some p values (or similar) for the comparisons.

VERSION 2 – AUTHOR RESPONSE

Reviewer: Kirsten Corder, Investigator Scientist, MRC Epidemiology Unit, UK.

The authors have thoroughly responded to the reviewers' comments. However I have two minor comments which relate to my previous comments on the previous version of the manuscript.

The authors now report 'validity' of the physical activity question in the manuscript (top of page 8) however, it would be preferable to present some numeric values to support 'acceptable validation'.

Authors:
As suggested, we have included in the text the numeric value of the validation: This question, when compared with PA assessed by accelerometers in Spanish adolescents, has shown an acceptable validation (Spearman correlation=0.43).25

Similarly, the reporting of comparisons between missing and included data at the top of page 9 could benefit from some p values (or similar) for the comparisons.

Authors:
We have added that the difference between the two samples was no statistically significant: The sample excluding missing values was similar to the original (there was no statistically significant difference), comparing the main socioeconomic variables, health status, and the frequency of undertaking MVPA.

We attach below, the 95% Confidence Intervals and p-values for the comparison of each category between the original sample and sample excluding missing data.

Gender: Original sample size

Number of obs = 21811

	Linearized			
	Proportion	Std. Err.	[95% Conf.	Interval]
Gender				
Male	.4692203	.0093204	.4508932	.4875474
Female	.5307797	.0093204	.5124526	.5491068

Gender: Sample size excluding missing data

Number of obs = 17467

	Linearized			
	Proportion	Std. Err.	[95% Conf.	Interval]

Gender |
Male | .4560236 .0098674 .4366208 .4754263
Female | .5439764 .0098674 .5245737 .5633792

P-values: no statistically significant

Age: Original sample size

Number of obs = 21811

| Linearized
| Mean Std. Err. [95% Conf. Interval]
---+---
Age | 14.47145 .1519659 14.17263 14.77027

Age: Sample size excluding missing data

Number of obs = 17467

| Linearized
| Mean Std. Err. [95% Conf. Interval]
---+---
edad_aÑos | 14.61931 .1545347 14.31545 14.92318

P-values: no statistically significant

Socioeconomic status: Original sample size

Number of obs = 21537

| Linearized
| Proportion Std. Err. [95% Conf. Interval]
---+---
Socioeconomic
Status|
Low | .1579951 .0072041 .1438293 .1721609

Average | .4647503 .0079537 .4491107 .48039
High | .3772545 .0126104 .352458 .402051

Socioeconomic status: Sample size excluding missing data

Number of obs = 17467

| Linearized
| Proportion Std. Err. [95% Conf. Interval]
---+---
Socioeconomic
Status|
Low | .1503122 .0072175 .1361202 .1645043
Average | .465247 .0080808 .4493575 .4811366
High | .3844407 .012937 .3590022 .4098793

P-values: no statistically significant

Optimal self-rated health: Original sample size

Number of obs = 21633

| Linearized
| Proportion Std. Err. [95% Conf. Interval]
---+---
|
No optimal | .0910135 .0041122 .0829274 .0990995
optimal | .9089865 .0041122 .9009005 .9170726

Optimal self-rated health: Sample size excluding missing data

Number of obs = 17467

| Linearized
| Proportion Std. Err. [95% Conf. Interval]
---+---
|
No optimal | .0889121 .004322 .0804135 .0974107
optimal | .9110879 .004322 .9025893 .9195865

P-values: no statistically significant

Frequency of undertaking physical activity (MVPA): Original sample size

Number of obs = 21034

	Linearized		
	Proportion	Std. Err.	[95% Conf. Interval]
Frequency			
Never	.0598736	.0030626	.0538515 .0658956
1-2 days	.2507102	.0054253	.2400421 .2613783
3-4 days	.3190528	.00488	.3094571 .3286486
5-6 days	.1793832	.0041762	.1711714 .187595
7 days	.1909802	.0058509	.1794753 .2024851

Frequency of undertaking physical activity (MVPA): Sample size excluding missing data

Number of obs = 17467

	Linearized		
	Proportion	Std. Err.	[95% Conf. Interval]
Frequency			
Never	.0587022	.0033718	.052072 .0653324
1-2 days	.2499415	.0060667	.2380122 .2618708
3-4 days	.3192562	.0054461	.3085472 .3299651
5-6 days	.1821689	.0043098	.1736944 .1906434
7 days	.1899313	.0060428	.178049 .2018135

P-values: no statistically significant