Author’s response to reviews

Title: Do country-level environmental factors explain cross-national variation in adolescent physical activity? A multilevel study in 29 European countries

Authors:

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Author’s response to reviews:

[Please see "National Environment Adolescent PA. BMC PH Rebuttal Letter.docx" for a formatted version of this letter]

14 January 2019,

Dear Editor and Reviewers,

Thank you for your constructive, insightful and supportive comments on our manuscript, “Do country-level environmental factors explain cross-national variation in adolescent physical activity? A multilevel study in 29 European countries”. We are grateful for the opportunity to revise and resubmit our paper. The suggestions for revisions have helped to improve the manuscript, so we look forward to hearing from BMC Public Health about the publishing potential of this version.

We include below the comments of each reviewer, and subsequently explain point by point our responses in boxes below each comment. We have also submitted a manuscript with revisions marked as tracked changes and an unmarked version of the revised manuscript.

Kind regards,

Dom Weinberg on behalf of the co-authors
Reviewer #1

The [paper] is worth studying, but there were several concerns after reviewing this article as belowing: 1. To investigate the association, you may adjust family (or their parents) income/or education status and so on, which affect their physical activity. If you cannot, you should discuss about that.

Response 1 to Reviewer #1

We thank the reviewer for suggesting that family socioeconomic status (SES) should be included in the analyses. In the previous version of our manuscript, we included family affluence as a measure of family SES in our sensitivity analyses, However, because it made no substantial differences to the results, we chose to exclude this variable from the main analyses, and report this result as a sensitivity analysis. We have amended this sentence in the results section to make it clear that the inclusion of a measure of family SES made no substantial difference to the results.

Results (revision – page 13, lines 304-306 in version with tracked changes)

“The inclusion of an individual-level measure of family socioeconomic status – the Family Affluence Scale (FAS, which was available for all countries except Lithuania and Spain) did not substantially affect the models.”

Reviewer #2

1. The use of multilevel models with three levels of individuals clustered within schools within countries is the right approach. However, it is unclear what the rationale is for having 4 separate models for the country-level environmental factors before testing them together simultaneously in one model (model 6). It would be different if there were more variables within each category (physical environment, socio-cultural environment, etc.), and that the question was whether these broad categories of variables as a whole impacted physical activity. However, the research question focusses only on which of the 8 variables do impact physical activity, and so the approach should simply be to add them all in one model, removing the non-significant variables, and then running a final model.

If the authors wanted to use a step-wise approach, then why not 8 separate models for each of the variables? It seems arbitrary for temperature to be grouped with urbanisation when in this dataset they are not correlated with each other but actually with national income and income equality respectively. The rationale of the less stringent criterion of alpha=0.25 also seems weak - although there might not have been previous published models analysing these variables together, the variables were selected by the authors because there is existing literature supporting their impact on physical activity. So if the authors do want to first demonstrate significance of
these variables in this cohort of countries individually before consideration into the full model, then they should be tested individually.

Additionally, there should be a final model after model 6 (the model with multiple variables), which removes the non-significant variables after testing for them as a group. This way, only significant variables are included, and accounts for the collinearity that exists between variables.

Response 1 to Reviewer #2

We thank the reviewer for these helpful suggestions on our modelling approach, and agree that an alternative strategy better answers the research question. As suggested by the reviewer we first tested all predictors in one model (Model 2), and then removed the non-significant predictors to get our final model (Model 3). We have amended the methods, results and discussion section accordingly (see below). In addition to the significant results in the original manuscript, two further effects were found. Firstly, education policy was a significant predictor of MVPA, and secondly, adult physical activity was a significant predictor of VPA.

Abstract (revision – page 2, lines 42-48)

“Results: The environmental variables explained 38% of country-level variance in MVPA and 81% of country-level variance in VPA. Lower annual average national temperature, higher community safety, lower average national household income and a weaker physical education policy were significantly associated with more MVPA. Greater urbanisation, lower annual average national temperature, higher adult physical activity and higher average national household income were significantly associated with more VPA.”

Methods (revision – page 10, lines 244-256)

“Model 2 included individual-level variables and all country-level variables. We included only significant variables in the final model, Model 3. Due to large number of predictors and the possibility of correlations between them and suppression effects, we adopted a less conservative \( \alpha \)-level of .1 as a screening criterion for entry into the final model, Model 3, to ensure that all potentially relevant variables were considered in the final model [58-59]. For testing the significance of variables in the final model, \( \alpha \) was .05.”

[All references to other modelling strategies were removed.]

Results (revisions)

[Based on the reviewers suggestion to run analyses differently, we have substantially altered the results section, removing most of the results relating to previous model. However, the substance of the results remains similar, apart from the two additional significant predictors noted above.]
“Model 2 included all country-level variables, and national temperature, safety, national income, and physical education policy met the criterion (α-level of .1) for inclusion in the final model. Model 3 shows that when these variables were included in a regression together, lower national temperature, higher safety, lower national income, and a weaker physical education policy were significantly associated (at an α-level of .05) with more MVPA. The country-level variables in Model 3 explained 38% of the total country-level variance.”

“Model 2 included all country-level variables, and national temperature, urbanisation, adult physical activity, safety and national income met the criterion for inclusion in the final model. In a model with these five variables, safety was no longer significant (b = 0.007, p = .073). Model 3 shows that when the remaining four variables were included in a regression together, lower national temperature, greater urbanisation, more adult physical activity, and higher national income were significantly associated with more VPA. 81% of the total country-level variance was explained by these four variables.”

Discussion (revision/addition – pages 13-14, lines 316-328)

“Overall findings”

“This study shows that national differences in the physical, socio-cultural, economic and policy environment were associated with individual differences in adolescent physical activity. Characteristics of the national environment explained a large amount of the international variation: 81% of country-level variance in VPA and 38% of country-level variance in MVPA. Adolescents did more MVPA in countries with lower annual average national temperatures, higher perceptions of community safety, lower average national income and weaker physical education policies. More adolescent VPA took place where there was a lower annual average national temperature, a higher percentage of urban areas, more adult physical activity and a higher national income. The findings show that combinations of characteristics from different environment types best explained both MVPA (physical, socio-cultural, economic and policy) and VPA (physical, socio-cultural and economic), and as such indicate the usefulness of the ANGELO framework.”

Discussion (revision/addition – page 15, lines 350-355)

[Income inequality]

“Income inequality was not associated with MVPA or VPA. Our findings suggest that previous evidence of links between income inequality and physical activity could be due to the correlations between income inequality and national temperature and safety (MVPA) and urbanisation (VPA) [38].”
Discussion (revision/addition – page 15, lines 359-361)

[Safety]

“Concerning the socio-cultural environment, there was more adolescent MVPA and VPA in countries perceived to be safer, although the association between VPA and safety was no longer significant in the final model.”

Discussion (revision/addition – pages 15-16, lines 367-373)

[Adult physical activity]

“The national level of adult physical activity was significantly associated with VPA but not with MVPA. Adolescents may benefit from a culture of active adults which encourages young people to be involved in sport and exercise [31,32]. The lack of findings for MVPA accords with the evidence found in reviews of physical activity correlates which show inconsistent evidence of older family members’ influence on individual physical activity [20,27].”

Discussion (revision/addition/removal – page 16, lines 374-393)

[Policy]

“Countries with strong physical education policies (i.e., a greater required minimum annual taught time for physical education) were unexpectedly likely to have lower adolescent MVPA. Strong policies may be a legislative response to low levels of physical activity and may be in the process of implementation. Alternatively, implementation of policies may be suboptimal, with actual practice deviating from official policy [7]. The lack of an effect of physical education policy on VPA may be due to the measure of VPA, which measures exercise outside school hours. The impact of transport policy may not be effectively evaluated using a measure of single policy item. A combination of physical activity-enhancing policies in urban planning, transport, infrastructure and education domains may be necessary to create an environment for more physical activity [7]. Even in just one domain an accumulation of policies and facilities can have a greater effect on physical activity than policy alone [65]. Measures that capture the broader policy agenda, such as a ‘global matrix’ of internationally comparable indicators of the physical activity environment in adolescence, may be useful for further analyses [12]. Transport policies at the national level may be quite independent from those at the regional or even school level, which may be more influential [65].”

Discussion (revision – page 18, lines 436-439)

[Conclusion]

“The findings that physical, socio-cultural, economic and political environment factors are all related to physical activity provide support for ecological theory and emphasise the importance of taking different environmental factors into account simultaneously.”
### Tables 3 and 4 (revision – pages 36-37)

#### [MVPA]

<table>
<thead>
<tr>
<th>Fixed effects</th>
<th>Intercept</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b (SE)</td>
<td>p</td>
<td>b (SE)</td>
<td>p</td>
</tr>
<tr>
<td>Gender a</td>
<td>6.096 (0.196)</td>
<td>&lt; .001</td>
<td>5.649 (1.505)</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Age</td>
<td>0.619 (0.037)</td>
<td>&lt; .001</td>
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<td>&lt; .001</td>
</tr>
<tr>
<td>Age</td>
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<td>&lt; .001</td>
</tr>
</tbody>
</table>

#### Fixed effects (country-level)

<table>
<thead>
<tr>
<th>Fixed effects</th>
<th>Ntl. temperature</th>
<th>Urbanisation</th>
<th>Adult PA</th>
<th>Safety</th>
<th>Ntl. income</th>
<th>Income inequality</th>
<th>PE policy</th>
<th>Transport policy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.001 (0.015)</td>
<td>.923 (0.017)</td>
<td>0.001 (0.007)</td>
<td>0.016 (0.007)</td>
<td>−0.029 (0.016)</td>
<td>0.006 (0.019)</td>
<td>−0.003 (0.002)</td>
<td>−0.039 (0.138)</td>
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<td></td>
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#### Variance components

<table>
<thead>
<tr>
<th>Variance components</th>
<th>Individual-level</th>
<th>School-level</th>
<th>Country-level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b (SE)</td>
<td>p</td>
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</tr>
<tr>
<td></td>
<td>3.776 (0.057)</td>
<td>&lt; .001</td>
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<td></td>
<td>(0.137)</td>
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<td></td>
<td>0.106 (0.026)</td>
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<td>0.066 (0.014)</td>
</tr>
</tbody>
</table>

Note. Ntl.= National. PA = Physical Activity. PE = Physical Education. National income divided by 1,000 for interpretability of b values.

- **a** Female is reference group.
- **b** Explained country-level variance = (106-.066)/.106 = .38

#### [VPA]

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</tr>
<tr>
<td>---------------</td>
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</tr>
<tr>
<td>(individual-level)</td>
<td>1.709 &lt; 2.745</td>
<td>0.738 &lt; 0.738</td>
<td>0.039</td>
</tr>
<tr>
<td></td>
<td>(0.218)</td>
<td>(0.049)</td>
<td>(0.014)</td>
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<td>(1.654)</td>
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<tr>
<td></td>
<td>.011 (0.650)</td>
<td>&lt; 0.001 (0.049)</td>
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</tr>
</tbody>
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Note. Ntl.= National. PA = Physical Activity. PE = Physical Education. National income divided by 1,000 for interpretability of b values.

a Female is reference group.

b Explained country-level variance = (.248-.046)/.248 = .81

2. Another important point to note is the naming and framing of the temperature variable. The variable being analysed in this study is yearly average national temperature, and needs to be termed as such (like average national household income). Unlike most of the other 8 variables which are common national metrics, temperature is not commonly used at a national level but more at a city level or regional level. Temperature values fluctuate within day, from day to day, and from season to season, as well as from region to region within a country. As pointed out in the text, the literature suggests an inverted U-shaped curve of temperature's relationship with
physical activity. The term temperature, in the context of such research, is at a cross-sectional level, with temperatures used from a limited time-frame of a season, months or maybe even days, with less fluctuations. It is more reflective of levels of heat in immediate surrounding for the day and more in line with what is commonly understood. The yearly average national temperature, however, is taking the average of temperatures through its fluctuations across seasons, which might somehow reflect more of a country's latitude and altitude than the immediate sensation of heat.

Even though the sensitivity analysis did not indicate any difference using the World Bank country-level temperature or Weatherbase's average of major cities, a better justification is needed than that it was also used by Lang et al.

Response 2 to Reviewer #2

We thank the reviewer for their helpful comments regarding the temperature variable, and have addressed these comments in several steps. Firstly, as advised by the reviewer, we changed the name of the variable throughout; we now refer to “annual average national temperature” in the methods and subsequently to “national temperature”. Unfortunately, we do not have adolescent location data that would enable us to include a regional-level measure of temperature. We agree that seasonal fluctuation adds an additional limitations to the measure of temperature and have amended the relevant section of the discussion.

Manuscript (addition – throughout the manuscript)

“national temperature”

Method (revision – page 8, lines 188-189)

“Annual average national temperature data were obtained from Weatherbase for 2017”

Discussion, Limitations (revision – page 17, lines 414-419)

“Future studies should consider including explanatory variables at the region- or school-level (including temperature, assessments of community safety and policy measures), because national indicators may underestimate the effect of local environmental influences. Measures of annual average temperature also do not capture whether there are substantial or small seasonal effects that cause temperatures to fluctuate throughout the year, which may affect adolescent physical activity [28].”

3. The manuscript should also present details of the exact months from which the HBSC data was collected. As the question on physical activity asks for recall of behaviour in the past seven days to approximate for yearly or general behaviour of that group, any confounders due to systematic data collection biases would need to be accounted for. For example, if data for
schools in Finland was collected in late Spring when it was warm, but data for schools in France was collected in dead of winter, near a national examinations period, then the timing of the data collection would have majorly impacted the results seen. If it is not possible to get this data, but that the understanding is that there is a large variation of when the data was collected between or within countries, then this potential confounder should at least be acknowledged in the limitations.

Response 3 to Reviewer #2

We agree with the reviewer that including details of the data collection date strengthens the manuscript, and may have been important for our analyses. Therefore, we have added information about the data collection date to the method section; data was collected between January and June 2014 in 22 out of 29 countries. We recognise that the collection date could have introduced slightly more error into the physical activity measure, but as we sought to model overall international variation, not to compare countries, we do not expect our results to be affected. We have added a sentence to the limitations to indicate the possibility that the data collection may have been affected by seasonal effects.

Method (addition – page 7, lines 158-160)

“Data collection took place between September 2013 and January 2015, with the majority of countries (22 out of 29) conducting fieldwork between January and June 2014 (p. 239, [16]).”

Discussion (addition – page 17, lines 419-421)

“The data in this study were collected at different times of the year in different countries and therefore may be subject to some seasonal effects.”

4. Table 1 should also include the number of schools since each unique school is a cluster in the second level of the models. Table 2 should not be in-text but be on a separate page at the end like the other three tables.

I think the work done thus far with this wealth of data is very exciting, and I hope my comments and suggestions can help make this an even stronger paper.

Response 4 to Reviewer #2

We thank the reviewer for their suggestions to improve the tables and have made the suggested revision to Table 1 and moved Table 2.

Table 1 (addition – page 34)

[n schools column added]

Table 2 (moved – page 35)