

## PEER REVIEW HISTORY

BMJ Open publishes all reviews undertaken for accepted manuscripts. Reviewers are asked to complete a checklist review form (<http://bmjopen.bmj.com/site/about/resources/checklist.pdf>) and are provided with free text boxes to elaborate on their assessment. These free text comments are reproduced below.

### ARTICLE DETAILS

<b>TITLE (PROVISIONAL)</b>	Leisure time computer use and adolescent bone health: Findings from the Tromsø Study, Fit Futures – a cross-sectional study.
<b>AUTHORS</b>	Winther, Anne; Ahmed, Luai; Furberg, Anne-Sofie; Grimnes, Guri; Jorde, Rolf; Nilsen, Ole; Dennison, E; Emaus, Nina

### VERSION 1 - REVIEW

<b>REVIEWER</b>	Germán Vicente-Rodríguez University of Zaragoza Spain
<b>REVIEW RETURNED</b>	24-Nov-2014

<b>GENERAL COMMENTS</b>	<p>General comment</p> <p>This paper represents an extension of the Tromsø study (already described by the same authors), focusing on the relationship between bone health and screen-based sedentary activities. It also adds data relative to a second evaluation, a follow-up carried out two years after the baseline study. However, it only included bone parameters and a second set of questionnaires aiming to assess the lifestyle of the participants is lacking. Therefore, results concerning the longitudinal perspective should be interpreted with caution. Overall, the article shows consistency from the introduction to the discussion and follows the scientific method. The sample analysed and the statistical tests applied are adequate and the redaction is correct; although some sentences may need rephrasing for the sake of clarity and a few spelling errors have been spotted. On this regard, an abbreviation of the terms “screen time during weekends” and “screen time during weekdays” may be helpful, since they are constantly repeated along the article, they might be easily mistaken, and are not always accompanied by the proper preposition. Tables should be relocated to the results sections, and a rearrangement should be considered, since they may be excessively long to serve their purpose of allowing the reader to quickly interpret data.</p> <p>Specific comments</p> <p>Abstract</p> <p>The first sentence states that obesity plays a negative role on bone health. This matter is barely discussed throughout the article and is currently under debate. The aim of the study should be defined more clearly. Also, a brief mention of the statistical methods used and an effort on explaining the gender differences presented would be appreciated.</p> <p>Introduction</p> <p>Again, the goal of the study should appear clearly stated. The theoretical framework included is adequate, and the bibliography</p>
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	<p>used is correct. However, additional citations on the first and second-to-last paragraphs may be required. The classification of “sitting down writing” as light physical activity may be discordant with cited studies such as Ainsworth, 2011.</p> <p>Page 3, line 33: devices</p> <p>Page 4, line 31: behaviours</p> <p>Page 4, line 38: extent</p> <p>Page 5, line 12: at both baseline and follow-up</p> <p>Methods</p> <p>As mentioned in the overall, comments, tables should be switched to the results section; only a brief description of the statistical tests applied is needed, with no specifications of results. This should help reducing the length of this section, which could also be shortened by discarding the explanations of the coefficient of variation of the densitometer or the estimation of the average daily screen time, which is never used afterwards.</p> <p>The explanation of certain abbreviations (BMI, WHO, PDS) is lacking, as well as a rationale for the cut-off points of the categorization of the physical activity, smoking and drinking variables. Finally, the tables should include footnotes explaining the abbreviations included, so that they are self-explanatory.</p> <p>➤ Table 2</p> <p>It does not provide info about BMD, as stated in the text. The physical activity categories are different than those reported previously. BMI is measured in kg/m<sup>2</sup> not kg/cm<sup>2</sup>.</p> <p>➤ Table 3</p> <p>A division or redistribution of this table should be considered, in order to reduce its excessive size. The R<sup>2</sup> shown for all the regressions is quite low, especially for the unadjusted model, yet this is not mentioned during the discussion.</p> <p>Page 5, line 21: MATERIAL</p> <p>Page 6, line 7: was</p> <p>Page 6, line 7: ...for bringing home to... (needs rephrasing)</p> <p>Page 6, line 10: schools'</p> <p>Page 7, line 17: value of</p> <p>Page 8, line 14: active hours per week</p> <p>Page 9, line 10 (table 1): characteristics of</p> <p>Page 9, line 36: who didn't</p> <p>Page 10, line 12 (table 2): number</p> <p>Page 10, line 39 (table 2): 51</p> <p>Page 12, line 23: ...missing likely not a source... (needs rephrasing)</p> <p>Table 3, several times: calcium</p> <p>Table 3, several times: sugar</p> <p>Page 16, line 30 (table 3): Smokers versus non-smokers</p> <p>Page 16, line 31 (table 3): No alcohol consumption versus sometimes</p> <p>Results</p> <p>This section in general is adequate in length and it describes the results precisely. Nevertheless, the paragraph which explains the regression results may seem difficult to follow by the reader.</p> <p>On page 19, line 7, the authors state that the group of 4 to 6 hours of daily screen time shows the best parameters of BMD in both genders, but table 3 says otherwise. Also, the relationship between carbonated drink consumption and screen time is not statistically significant, and this should be stated.</p> <p>The decrease in BMD alongside the screen time categories is only</p>
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	<p>significant for boys at baseline. However, if we check figure 2, it can be noted that this group shows the highest deviations of the regression lines, even though R<sup>2</sup> for the adjustments is not provided. This isn't discussed afterwards as well as the unexpected results regarding physical activity and sedentary behaviours.  Page 18, line 10: trend of in decreasing (needs rephrasing)  Page 19, line 17: statistically significant</p> <p>Discussion  The main results, establishing a relationship between screen time and bone mineral density are discussed properly, contrasting them with existing studies. Additional citations, however, may be needed (page 21, line 26).  Attention is paid to the possible bias induced by the questionnaire, but no analysis of other factors that are related to BMD and are actually evaluated in the study, such as physical activity or vitamin D serum levels, is carried out.  The limitations of working with questionnaires are acknowledged. However, no effort on trying to minimize these obstacles (i. e. under-reporting analysis) has been made.  On the conclusions, we are warned about cautiously interpret the contradictory results obtained for girls, due to the use of questionnaires. The same reasoning could be applied to the major conclusion of this study, regarding boys.  Page 19, line 17: Rodriquez Rodríguez  Page 21, line 26: make a precise  Page22, line 9: subjects. Which subjects, which  Page 6, line 10: ...improve high peak... (needs rephrasing)  Page 7, line 17: guidelines'</p>
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<b>REVIEWER</b>	Stuart Warden Indiana University, United States
<b>REVIEW RETURNED</b>	28-Jan-2015

<b>GENERAL COMMENTS</b>	<p><b>GENERAL COMMENTS:</b>  The current study explored the role of screen-based sedentary activities on the weekends on bone health in adolescent girls and boys. Data indicated that hip and whole-body BMD were negatively related to screen-based sedentary activities in boys and possibly positively related in girls (after correction for potential covariates). The data are relatively straightforward and adequately analyzed, albeit much of the data are presented in the statistical analysis section of the methods as opposed to in the results.</p> <p>The title of the paper indicates that the data were collected using a prospective cohort study design. However, this is an inaccurate descriptor. Prospective cohort studies follow cohorts who differ with respect to a certain factor (in this case, time spent doing screen-based sedentary activities) to determine how this factor affects the rate of a certain outcome. While many participants in the current study had their screen-based sedentary activities and BMD assessed at two separate time points, the effect of screen-based sedentary activities on the longitudinal rate of change of BMD was not explored. That is, no longitudinal data analyses were performed and instead data acquired at each time point were analyzed as being independent. Essentially, a cross-sectional cohort study was performed (i.e. FF1) and the data were confirmed by bringing back the same subjects and repeating the analyses (i.e. FF2).</p>
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	<p>The current analyses report on the association between bone health and screen-based sedentary activities performed only on weekends. Some rationale is provided for focusing on the weekend, but it is not clear why the weekday and total week data were not also analyzed. These data were collected and presented.</p> <p>Similarly, a weakness is the assessment of physical activity on a total week basis, as opposed to breaking it down to weekends and weekdays (as per the screen-based sedentary activities data). Screen-based sedentary activities may be greater on weekends, but is there a corresponding increase in physical activities due to more time availability.</p> <p><b>SPECIFIC COMMENTS:</b>  Page 2, line 12: provide the study design...cross-sectional cohort study.</p> <p>Page 2, line 12: provide the number of students that constituted 93% of the region's upper-secondary school students.</p> <p>Page 4, line 19: is there any distinction between traditional video games and motion-controlled gaming?</p> <p>Page 4, line 26: consider supporting your statement regarding the importance of physical activity when young with our recent data demonstrating the lifelong skeletal benefits of physical activity completed when young (Proc Natl Acad Sci U S A. 2014 Apr 8;111(14):5337-42).</p> <p>Page 4, line 33: consider also referring to the data of Gabel et al. (Med Sci Sports Exerc. 2015 Feb;47(2):363-72).</p> <p>Page 7, line 26: data was collected for screen-based sedentary activities on weekdays as well as weekends. Why was the weekday data not included in analyses?</p> <p>Page 8, line 7: was physical activity participation broken down into weekdays and weekends as well?</p> <p>Page 8, line 24: is there any rationale/evidence for defining cheese weekly or milk daily as 'high' calcium intake?</p> <p>Page 8, line 38: a separate statistics section is required where the statistical analysis approach is described in the absence of any data. The data tables in the current statistics section should be moved to the results section.</p> <p>Page 10, line 12: for the statistical comparisons in table 2, it would be informative to show the results of the ANOVA post-hoc analyses to demonstrate where the between group differences existed.</p> <p>Page 10, line 20: does screen time in table 2 refer weekend, weekday or total screen time?</p> <p>Page 18, line 17: 4 hours of screen time on the weekend (i.e. 2 days) and 4 hours of sports/hard training during the entire week (i.e. 7 weeks) is not balanced.</p> <p>Page 19, line 29: the current study did not present longitudinal</p>
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	<p>associations or analyses (i.e. effect of screen time on change in BMD).</p> <p>Page 22, line 15: consider including the sole use of DXA to assess bone health as a limitation. Bone mechanical properties are also impacted by bone size.</p>
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## VERSION 1 – AUTHOR RESPONSE

1. Reviewer Germán Vicente-Rodríguez  
Institution and Country University of Zaragoza, Spain

### General comment

This paper represents an extension of the Tromso study (already described by the same authors), focusing on the relationship between bone health and screen-based sedentary activities. It also adds data relative to a second evaluation, a follow-up carried out two years after the baseline study. However, it only included bone parameters and a second set of questionnaires aiming to assess the lifestyle of the participants is lacking. Therefore, results concerning the longitudinal perspective should be interpreted with caution.

We fully agree upon your concern and we have kept that in mind throughout the revised discussion.

Overall, the article shows consistency from the introduction to the discussion and follows the scientific method. The sample analysed and the statistical tests applied are adequate and the redaction is correct; although some sentences may need rephrasing for the sake of clarity and a few spelling errors have been spotted. On this regard, an abbreviation of the terms “screen time during weekends” and “screen time during weekdays” may be helpful, since they are constantly repeated along the article, they might be easily mistaken, and are not always accompanied by the proper preposition. According to the editor’s instruction, acronyms should be used sparingly. We have substituted “screen time during weekends” and “screen time during weekdays” with the abbreviations ScTWends and ScTWdays, respectively, to improve the readability. We hope that we may be allowed to use these abbreviations.

Rephrasing and corrections of spelling errors have been implemented to clarify the content.

Tables should be relocated to the results sections, and a rearrangement should be considered, since they may be excessively long to serve their purpose of allowing the reader to quickly interpret data. Due to a misunderstanding, the tables were placed where they were first sited. Now we have moved all tables to the result section, and made some rearrangements, please see the revised version.

### Specific comments

#### Abstract

The first sentence states that obesity plays a negative role on bone health. This matter is barely discussed throughout the article and is currently under debate. The aim of the study should be defined more clearly. Also, a brief mention of the statistical methods used and an effort on explaining the gender differences presented would be appreciated.

Thank you very much for this important clarification. In the revised version, we discuss obesity’s importance on bone in the last section.

#### Introduction

Again, the goal of the study should appear clearly stated. The theoretical framework included is adequate, and the bibliography used is correct. However, additional citations on the first and second-to-last paragraphs may be required. The classification of “sitting down writing” as light physical activity may be discordant with cited studies such as Ainsworth, 2011.

Thank you for making us aware of the latest version of the “Compendium of Physical Activities”, with

its changes. The phrase “sitting down writing” has been removed, as it now is classified as sedentary (MET < 1.5).

We have added more references, and with substantial rephrasing, tried to clarify the rationale and the aim of the study.

Page 3, line 33: devices

Page 4, line 31: behaviours

Page 4, line 38: extent

Page 5, line 12: at both baseline and follow-up

## Methods

As mentioned in the overall, comments, tables should be switched to the results section; only a brief description of the statistical tests applied is needed, with no specifications of results. This should help reducing the length of this section, which could also be shortened by discarding the explanations of the coefficient of variation of the densitometer or the estimation of the average daily screen time, which is never used afterwards.

The statistics part has been condensed, the explanation of the densitometers CV has been deleted, as well as the estimation of average daily screen time in text and Table 1.

The explanation of certain abbreviations (BMI, WHO, PDS) is lacking, as well as a rationale for the cut-off points of the categorization of the physical activity, smoking and drinking variables.

The abbreviations have been defined, and a more detailed description of the variables has been added.

Finally, the tables should include footnotes explaining the abbreviations included, so that they are self-explanatory.

Thank you very much, please see the revised tables.

## Table 2

It does not provide info about BMD, as stated in the text. The physical activity categories are different than those reported previously. BMI is measured in kg/m<sup>2</sup> not kg/cm<sup>2</sup>.

Thank you for reminding us of this BMD-error (reminiscence from a former draft), which has been corrected together with the BMI denomination and typing errors.

In Table 2 we have presented physical activity and screen time in categories in the same way they have been used in the regression analyses. By contrast, in Table 1 we described screen time and physical activity as continuous variables. To shorten the method section and reduce confusion, the continuous PA-variable has been deleted from text and Table 1.

Tables larger than 2 pages will only be published as online supplementary material, thus we have cut some of the numbers in Table 2 and only percentages are presented within each category.

## Table 3

A division or redistribution of this table should be considered, in order to reduce its excessive size.

The R<sup>2</sup> shown for all the regressions is quite low, especially for the unadjusted model, yet this is not mentioned during the discussion.

Table 3 has been rearranged to clarify the content and to meet Editor's requirement. In the revised discussion, we have raised low adjusted R<sup>2</sup> as an issue.

Page 5, line 21: MATERIAL

Page 6, line 7: was

Page 6, line 7: ...for bringing home to... (needs rephrasing)



Page 6, line 10: schools'  
 Page 7, line 17: value of  
 Page 8, line 14: active hours per week  
 Page 9, line 10 (table 1): characteristics of  
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 Page 12, line 23: ...missing likely not a source... (needs rephrasing)  
 Table 3, several times: calcium  
 Table 3, several times: sugar  
 Page 16, line 30 (table 3): Smokers versus non-smokers  
 Page 16, line 31 (table 3): No alcohol consumption versus sometimes

## Results

This section in general is adequate in length and it describes the results precisely. Nevertheless, the paragraph which explains the regression results may seem difficult to follow by the reader. Please see our changes, in Table 3 and in the result section.

On page 19, line 7, the authors state that the group of 4 to 6 hours of daily screen time shows the best parameters of BMD in both genders, but table 3 says otherwise. In boys we observed the lowest beta-levels in the 4-6 hours group, while in contrast among girls we observed the highest levels ( $p < 0.025$ ) in the corresponding group, compared to the reference. There is consistency in the findings, although not statistically significant in boys. In the text we have modified our conclusion at this point, and added a paragraph about this in the discussion section. Please see the revised version.

Also, the relationship between carbonated drink consumption and screen time is not statistically significant, and this should be stated. The relationships between screen time and sugared soft drinks are highly statistically significant, but non-significant for artificial sweetened soft drinks, which we now have stated in the revised text.

The decrease in BMD alongside the screen time categories is only significant for boys at baseline. However, if we check figure 2, it can be noted that this group shows the highest deviations of the regression lines, even though  $R^2$  for the adjustments is not provided. This isn't discussed afterwards as well as the unexpected results regarding physical activity and sedentary behaviours. In the revised discussion we have elaborated the possible reasons for the deviation of the regression lines caused by the observed BMD-levels in the 4-6 hours group. Please see the substantially revised section.

Page 18, line 10: trend of in decreasing (needs rephrasing)  
 Page 19, line 17: statistically significant

## Discussion

The main results, establishing a relationship between screen time and bone mineral density are discussed properly, contrasting them with existing studies. Additional citations, however, may be needed (page 21, line 26).

Any references of boys' dedication to their activities and girls multitasking have not been found, and the difference between girls and boys in self-reporting is our speculation, supported by the reliability and validity study of Gracia-Marco et al. We have supplied the text with an additional line about gender-variation in screen modality and multimedia use, which may interfere with the ability of self-reporting.

Attention is paid to the possible bias induced by the questionnaire, but no analysis of other factors that are related to BMD and are actually evaluated in the study, such as physical activity or vitamin D serum levels, is carried out.  
Please see the revised version.

The limitations of working with questionnaires are acknowledged. However, no effort on trying to minimize these obstacles (i. e. under-reporting analysis) has been made.  
Please see the added paragraph on measurement errors caused by under- and over-reporting exposure.

On the conclusions, we are warned about cautiously interpret the contradictory results obtained for girls, due to the use of questionnaires. The same reasoning could be applied to the major conclusion of this study, regarding boys.  
Following our revised discussion we have reformulated our conclusion, please see the revised version.

Page 19, line 17: Rodriquez Rodríguez  
Page 21, line 26: make a precise  
Page22, line 9: subjects. Which subjects, which  
Page 6, line 10: ...improve high peak... (needs rephrasing)  
Page 7, line 17: guidelines'

2. Reviewer Stuart Warden  
Institution and Country Indiana University, United States

#### GENERAL COMMENTS:

The current study explored the role of screen-based sedentary activities on the weekends on bone health in adolescent girls and boys. Data indicated that hip and whole-body BMD were negatively related to screen-based sedentary activities in boys and possibly positively related in girls (after correction for potential covariates). The data are relatively straightforward and adequately analyzed, albeit much of the data are presented in the statistical analysis section of the methods as opposed to in the results.

Due to a misunderstanding of the Author Instruction, the tables were placed where they were first sited. Now all tables have been moved to the result section. Please see the revised version.

The title of the paper indicates that the data were collected using a prospective cohort study design. However, this is an inaccurate descriptor. Prospective cohort studies follow cohorts who differ with respect to a certain factor (in this case, time spent doing screen-based sedentary activities) to determine how this factor affects the rate of a certain outcome. While many participants in the current study had their screen-based sedentary activities and BMD assessed at two separate time points, the effect of screen-based sedentary activities on the longitudinal rate of change of BMD was not explored. That is, no longitudinal data analyses were performed and instead data acquired at each time point were analyzed as being independent. Essentially, a cross-sectional cohort study was performed (i.e. FF1) and the data were confirmed by bringing back the same subjects and repeating the analyses (i.e. FF2).

We fully agree with you. The title has been changed, also when mentioned in the text.

The current analyses report on the association between bone health and screen-based sedentary activities performed only on weekends. Some rationale is provided for focusing on the weekend, but it is not clear why the weekday and total week data were not also analyzed. These data were collected and presented.



The students use their computers for homework to a great extent. As we didn't have information on how much time spent on homework, traditionally or by computers we thought this would bias the result. Therefore we focused on their preferred screen time, which is the modifiable part, supposed to be in the weekends. Corresponding analyses of the associations between screen time weekdays and BMD have been performed, but not presented, just to keep a better overview of the results.

Similarly, a weakness is the assessment of physical activity on a total week basis, as opposed to breaking it down to weekends and weekdays (as per the screen-based sedentary activities data). Screen-based sedentary activities may be greater on weekends, but is there a corresponding increase in physical activities due to more time availability. Assessment of physical activity broken down to weekends and weekdays would have been interesting. Unfortunately we don't have information on physical activities distribution during the week. In the Norwegian school system only 1,5 hours (on average) of PA is mandatory per week. So the reported PA outside school reflects their own preferences independent of weekdays or weekends. To shorten the method section and reduce confusion, the continuous PA-variable has been deleted from text and Table 1; please see the answer to the other reviewer.

#### SPECIFIC COMMENTS:

Page 2, line 12: provide the study design...cross-sectional cohort study.  
This has been changed.

Page 2, line 12: provide the number of students that constituted 93% of the region's upper-secondary school students.  
1,030 students participated, which has been included in the abstract.

Page 4, line 19: is there any distinction between traditional video games and motion-controlled gaming?  
According to Ainsworth et al. 2011, the MET value for traditional video games is estimated to 1, while more physical challenging video games vary in METs, and are not classified as sedentary behavior. Thank you for this clarification, which has been corrected.

Page 4, line 26: consider supporting your statement regarding the importance of physical activity when young with our recent data demonstrating the lifelong skeletal benefits of physical activity completed when young (Proc Natl Acad Sci U S A. 2014 Apr 8;111(14):5337-42).  
Thank you.

Page 4, line 33: consider also referring to the data of Gabel et al. (Med Sci Sports Exerc. 2015 Feb;47(2):363-72).  
Thank you.

Page 7, line 26: data was collected for screen-based sedentary activities on weekdays as well as weekends. Why was the weekday data not included in analyses?  
Please, see the explanation above

Page 8, line 7: was physical activity participation broken down into weekdays and weekends as well?  
Please, see the explanation above.

Page 8, line 24: is there any rationale/evidence for defining cheese weekly or milk daily as 'high' calcium intake?  
In general calcium intake is sufficient in Nordic populations, also the adoption to low calcium intake is very efficient in children and adolescents (Nordic Nutrition Recommendation 2012). As calcium is a necessary condition for developing healthy bones, we wanted to control our BMD-estimates for

potentially low calcium-levels. Therefore we separated the lowest calcium intake from more adequate intakes. Use of the term “High” is misleading, and has been substituted with the term “Sufficient” in the method section and in the tables.

Page 8, line 38: a separate statistics section is required where the statistical analysis approach is described in the absence of any data. The data tables in the current statistics section should be moved to the results section.

As mentioned above, all tables have been moved to the result section.

Page 10, line 12: for the statistical comparisons in table 2, it would be informative to show the results of the ANOVA post-hoc analyses to demonstrate where the between group differences existed.

Originally we used the ANOVA post-hoc test for the continuous variables and Pearson’s Chi-square test for continuous variables, and these p-values are displayed in Table 2.

We also used the ANOVA post-hoc test treating all variables as continuous, to see the difference between groups of screen time. This has now been incorporated in Table 2.

Page 10, line 20: does screen time in table 2 refer weekend, weekday or total screen time?

The table refers to screen time weekends, and the table caption has now been improved.

Page 18, line 17: 4 hours of screen time on the weekend (i.e. 2 days) and 4 hours of sports/hard training during the entire week (i.e. 7 weeks) is not balanced.

Thank you, this was in deed bad wording, and we have rephrased the revised result section.

Page 19, line 29: the current study did not present longitudinal associations or analyses (i.e. effect of screen time on change in BMD).

We agree upon your objection and have rephrased this period.

Page 22, line 15: consider including the sole use of DXA to assess bone health as a limitation. Bone mechanical properties are also impacted by bone size.

We are fully aware of the limitation of the DXA- measurements, but as the discussion is quite long, we have chosen not to elaborate this issue.