Author’s response to reviews

Title: Physical exercise and body-mass index in young adults a national survey of Norwegian university students

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Author’s response to reviews:

Dear Editor.

Thank you for the constructive and positive comments from the three reviewers, and our chance to revise and improve our manuscript. As outlined below, we have responded to each of the comments and we have described the changes we have made in the manuscript. We hope you agree that the manuscript has improved through this process, and we are pleased to submit our revised manuscript for your consideration.

On behalf of the authors,
Børge Sivertsen
Corresponding author

Reviewer 1
This study uses questionnaire data from three data collections among Norwegian university students. There is a reasonable sample size, but attendance rates are low. This should probably be expected since web-based questionnaires usually have low participation rates.
It is not clear to me what recommendations are used to evaluate how many who fulfill the recommendations. Haskel et al, Circulation 2007 wrote: adults aged 18 to 65 yr need moderate-intensity aerobic (endurance) physical activity for a minimum of 30 min on five days each week or vigorous-intensity aerobic physical activity for a minimum of 20 min on three days each week. [I (A)] Combinations of moderate- and vigorous-intensity activity can be performed to meet this recommendation. In their definition it can be 150 min MVPA or it can be replaced with a lower duration of higher intensity. WHO has a slightly different definition, and when authors calculate how many fulfilled recommendations of both amount, intensity and frequency, they should write exactly what it means.

• Response: This is an important point, and we agree that these paragraphs in Instruments section could have been more accurately described. We now provide more details in the instruments section when specifying how we operationalized the two recommendation variables:
Based on WHO’s recommendation (4) that adults (≥18 years) should get at least 30 minutes (or preferable 60 minutes for increased health benefits) of MVPA 5 days or more per week (=150 [or preferable 300] minutes per week) (4), two dichotomous recommendation variables were created based on the students’ responses on all three exercise items: 1) MVPA: 150 mins/week: students answering both “Almost every day” on the frequency item, “I push myself so hard that I lose my breath and break into a sweat” on the intensity item, and “30 minutes or more” or “More than 1 hour” on the duration item. 2) MVPA: 300 mins/week: students answering both “Almost every day” on the frequency item, “I push myself so hard that I lose my breath and break into a sweat” on the intensity item, and “More than 1 hour” on the duration item.”

We also agree with the reviewer that other combinations of moderate- and vigorous-intensity activity are possible to achieve these recommendations, and we now acknowledge this in the Discussion under study limitations:

“Finally, there may be other combinations of MVPA that can be performed to meet the recommended levels of physical activity. For example, 150 minutes of MVPA can be replaced with a lower duration of higher intensity, which are not accounted for in the current study.”

Authors conclude that the percentage of students fulfilling guidelines are much lower than in a recent lancet paper including 168 countries. However, there is no judgement of the comparability between assessment methods used in the present study and the WHO study, and I cannot see if the same criteria for fulfilling guidelines have been used. The authors argue that it is unlikely methodological differences could explain the differences, but I disagree. It is very likely. The percentage of students in the present study exercising more than twice a week is actually high, and does not indicate an inactive population.

• Response: We agree with the reviewer on this point, and we have now changed the paragraph comparing our findings in the Discussion to those reported in the Lancet paper to:

“However, we cannot disregard the possibility that some of these differences may be due to methodological issues, including slightly different operationalizations of both frequency, intensity and duration of physical exercise.”

Specific comments:

Abstracts

Authors write that the association between exercise and BMI is strong, but they do not provide a r-value. My knowledge about this type of data tells me that the association probably is very weak.

• Response: We agree that this section was not entirely accurately described. While it is unlikely that a monotonic inverse relationship between exercise frequency and continuous BMI will very strong, the aim of this study was rather to assess the link between exercise and overweight and obesity, a relationship we found to be quite strong. We have now changed this sentence in the abstract to:

“As expected, the associations between exercise and overweight/obesity were in a dose-response manner, and strong across all three waves.”

P6: authors also claim that the association between questionnaire assessed PA and measured max oxygen uptake is strong. I guarantee this is not the case. I have not looked up the reference, but usually
we don't find more than 4% explained variance between these measures. They should report how strong the association was in the validation study.

• Response: We have now added this information to the section detailing the strength of associations between the exercise questionnaire items and VO2max, which now reads:
  “Previous validation studies (12, 13) have demonstrated moderate correlations between the questionnaire responses and direct measurement of VO2max during maximal work on a treadmill (r=0.43 [frequency], r=0.40 [intensity] and r=0.31 [duration]), […]

Authors also analyse trends in BMI from self-reported height and weight. They only report BMI and not weight and height. However, I would like to see if body height has changed. The change in BMI is small and because weight increase with the third power of height and BMI only include the second power of height, BMI would increase proportionally to a change in height if body dimensions were the same.

• Response: This is an interesting point, and we have now examined if there have been any changes in body height from 2010 to 2018. In short, we found no evidence of any significant changes in neither male nor female students. We have added the following sentence to the results section to reflect this: “Of note, there were no significant changes in body height in neither male students (182.2 cm [2010]; 181.9 cm [2014] and 182.2 cm [2018]) nor females students (168.0 cm [2010], 167.8 cm [2014] and 167.9 cm [2018]).”

P11: authors claim that physical activity decreases over the decade of observation, but this is not supported by data. PA increases from 2010-2014 and decreases from 2014-2018 to the level of 2010. If anything, I would say from Figure 2 that the percentage exercising twice a week increases from 2010-2018. Therefore, it seems unlikely that the increase in BMI can be explained by a change in PA. The statement is followed by a long discussion of how PA should be integrated into university life. I don't mind this is discussed, but it should not be based on a change, which is not existing.

• Response: We fully agree with the reviewer on this issue. While we have been careful to be point out that the students exercised less in 2018 compared to 2014, the exercise level was comparable to the levels in 2010, this specific sentence in the Discussion was not accurate. We have therefore removed this sentence from the section on public health implications in the Discussion.

The authors claim to assess intensity, but this is not true. They assess perceived intensity, which is different. Low fit subjects will feel exhausted by an intensity that a fit person felt comfortable.

• Response: This is a fair point, and we have now added this as a study limitation: “However, as a final limitation related to the physical activity measure, it is more accurate to say that we assessed perceived intensity, as less fit individuals will feel exhausted by an intensity that a fit person will feel comfortable.”

Figure 3: I would like to see a figure of those exceeding BMI 30. Well trained subjects can easily have a BMI above 25 because of muscle mass, but a BMI above 30 is rarely caused by muscle mass, so this cut-point would be better to evaluate a trend in health.
• Response: We have now updated Figure 3 to also include the prevalence of obesity (BMI > 30) from 2010 to 2018. The results have also been updated accordingly with the following text:
“As also can be seen in Figure 3 the prevalence of obesity (BMI > 30; displayed in shaded bars), increased in a similar pattern over time, with the strongest increase from 2014 to 2018.”

Reviewer 2:

The sample used in this paper is shown as a weak point of the study. The PA levels of the university students population has presented huge differences depending on the field of knowledge of studies (there are a remarkable research studies about that, mostly done in Spanish spoken countries), so the distribution of the sample in this kind of studies is crucial. In the paper is shown three different criteria or distribution requirement in three different moment during the last decade. At this way, it's impossible to reach an explanation about the results. The first recommendation for this paper is to use a sample similar in the criteria and always stratified by study institutions, faculties, and departments. If the authors have this kind of information in the survey, could be select subjects randomly respecting the strata.

• Response: We appreciate these comments, but unfortunately, we do not have any detailed information regarding faculty or departments of all participants. However, as the three surveys/waves included somewhat different welfare associations and institutions, sensitivity analyses were performed only including the institutions included in all three surveys. The samples included in these analyses were n=24 298 (49.2%) in 2018, n=6 681 (48.9%) in 2014 and n=4 369 (72.2%) in 2010. In short, these sensitivity analyses gave near-identical findings, suggesting that different composition of the three samples could not explain the trend findings.

The proposal of the study is confused. By one side it tries to explain the evolution of the physical activity levels related to BMI, and by other side, it tries to describe the features of the physical activity that students do. Maybe both parts could be in different research. My recommendation is to focus in exploring the trend.

• Response: While we agree that it is usually a good idea to focus on specific hypothesis, not trying to cover too much information, we would like to keep the current structure and study aims, taking advantage of both the rich data on physical activity in the 2018-dataset, as well as the investigating the trend data from 2010 to 2018.

Review the structure that must content what it's known about the topic, what isn't, why it's important to know that, and the objectives of the paper. In this case, the part of why it's important to know that is too weak.

• Response: We appreciate this comment, and we have now added the following the paragraph to the introduction addressing this issue:
“Expanding our knowledge on these issues in college populations may be especially important, as sedentary behaviour in this age may represent a continued snowballing risk for the development of poor health.”
While is talked about the recommendation, the WHO recommendation are omitted. Although these are very similar to showed, it's important to include them too.

• Response: We agree, and we have now changed this section in the Introduction to:
“Public health efforts regarding exercise have included establishing guidelines on the level of physical activity, and provided recommendations and guidance on both the frequency, duration, and intensity of physical activity. For example, the US Centers for Disease Control and Prevention recommend that adults (aged 18-64 years) should get at least 30 minutes (or preferable 60 minutes for increased health benefits) of moderate to vigorous physical activity (MVPA) at least 5 days per week (4). The World Health Organization (WHO) have published very similar recommendation, and have aimed to reduce the prevalence of insufficient physical activity by 10% by 2025 (5).”

While is talked about the reasons that make university students sedentary, the authors talked about the good health of the students. Consider to include some information about the motives toward PA of this kind of population. It would add more accurate information about that.

• Response: While we agree with the reviewer that the student population is quite important to study, given that they are both highly sedentary and highly active, we are not entirely sure what the reviewer here is requesting. The SHOT study ooes do not contain any information regarding the motives towards PA.

As it's said in the general comments, regarding to explore the trend it's irrelevant to add new questions in the third wave. Use just items that were included in the three waves.

• Response: We do not share the reviewer’s opinion that the additional items assessing exercise intensity and duration are irrelevant, as these are needed to assess the proportion of students meeting the PA recommendations set by e.g. WHO. As such, we are reluctant to remove these parts/data of the article and solely focus on the trend data, as we consider the additional information provided by the more detailed SHOT2018-data provide important data for the paper.

The option to answer the question "How long does each session last?" doesn't seem good enough. The option for the more extended PA level is just "More than 1 hour" while a lot of people could do just one or more much longer sessions per week, so it includes a lot of kind of people.

• Response: We agree that there are limitations when using these short self-reported instruments, both in terms of assessing physical activity, as well as in general. However, this specific questionnaire has shown good psychometric properties, and has also been validated against objective measures of e.g. VO2max. We have now updated the instruments section with more details on this issue, which now reads::
“Previous validation studies (12, 13) have demonstrated moderate correlations between the questionnaire responses and direct measurement of VO2max during maximal work on a treadmill (r=0.43 [frequency], r=0.40 [intensity] and r=0.31 [duration]), with ActiReg (14, 15), an instrument that measures PA and energy expenditure (EE), and with the International Physical Activity Questionnaire (16).”

Although the use of ORs is original, consider the authors to use other parametric tests to reinforce the significance of the results about the relation between BMI and PA levels.
• Response: As the main objective of this study, and table 1 in particular, was to assess whether PA was associated with overweight and obesity, using the pre-defined BMI-cutoffs of 25 and 30, we are not sure if adding additional parametric statistical testing of the associated between BMI and PA in general will be beneficial to the paper. As also mentioned in our response to reviewer #1, it is likely the case that a monotonic inverse relationship between exercise frequency and continuous BMI is not likely to be very strong. Rather, the author group considers it more appropriate to focus on providing accurate effect-size estimates (using ORs) on the strength of association between exercise and overweight and obesity. However, we have added asterisks to Table to indicate the significance levels of the obtained ORs.

Information about the significance in the graphics should be shown, at least, with asterisk or similar.

• Response: The potential benefits of adding asterisks or p-values in the figures is something we have considered carefully also in the author group. However, given the very high number of asterisks or p-values needed to provide the required details of statistical results for all tests conducted, we have decided to rather use 95% confidence intervals as an indication of result being statistically significant. For example, when 95% confidence intervals for the proportions or means of two independent populations don't overlap, there will indeed be a statistically significant difference between the proportions or means at the 0.05 level of significance (although the opposite is not necessarily true).

Many information is not cited and referenced.

• Response: We have done our best to add relevant references to all instances where this was required.

The respond rates are not a limitation at all. In fact, the rates showed are very good, considering that a 10% of response is usual in surveys offered by Internet.

• Response: We appreciate this comment, and we have now toned down this specific sentence in the Discussion, which now reads:
"A limitation of the current study is the moderate response rates for the SHoT2010 (23%), SHoT2014 (29%) and SHoT2018 (31%)."

Regarding university population, the sample size could be huge but not good enough if it's not properly stratified.

• Response: As also mentioned in a previous response, unfortunately we do not have any detailed information regarding faculty or departments of all participants, making stratification difficult.

The conclusion must be related to the objectives propose in the introduction. Read the paper, it's impossible to conclude that "the large majority of young adults fail to meet international recommendations on exercise". That wasn't an objective of this paper.

• Response: We appreciate this suggestion, and we have now modified out first study aim in the introduction, which now reads:
“1) to investigate the current level of physical exercise among male and female college and university students in terms of how many meet the international recommendations of frequency, intensity and duration of exercise; (...)”

Reviewer 3
Thank you for the opportunity to review this paper describing the level of physical exercise and BMI in college and university students, as well as examining potential changes from 2010 to 2018. Topic of great interest to readers. Clear and concise writing of all sections of the manuscript. Discussion is clear and nicely places study findings in context with other studies. Nevertheless, I have some points below for authors to consider.

Page 6 line 21 - Given that the sample is composed of participants ≥ 18 years-old, it is not necessary to include the international recommendations of physical activity for participants < 18 years-old.

• Response: We agree, and we have now removed this reference to adolescents from the paper. However, we have kept the 300 min/week recommendation, as this also applies for adults for increased health benefits. This section now reads: “For example, the US Centers for Disease Control and Prevention recommend that adults (aged 18-64 years) should get at least 30 minutes (or preferable 60 minutes for increased health benefits) of moderate to vigorous physical activity (MVPA) at least 5 days per week (4).”

Page 6 line 17 - The authors stated ".. measure of physical inactivity..." I recommend that the authors change the sentence to "measure of physical activity" for a more comprehensive structure.

• Response: We agree, and this has now been fixed.

Page 6 line 32 and Figure 4 - The authors presented 2 physical activity recommendations, i.e., 150 min/week and 300 min/week. Please clarify this option, since the sample only includes participants ≥ 18 years-old.

• Response: We no longer use the reference to the recommendations for adolescents (aged <18 yrs). However, as also the recommendations for adults include both 150 mins/week and 300 mins/week for increased health benefits, we believe that presenting both these recommendations add important information to the paper.

Page 6 line 43 - A reference ismissing to support the BMI categories.

• Response: We have now added appropriate reference to the use of BMI: two older original references (Keys et al. 1972 and Garrow et al 1985) regarding BMI in general, and one WHO expert committee report from 1993 regarding the use of the commonly used cut-offs (18.5, 25 and 30).
Figures

I suggest that "male" and "female" be used in the figures 1, 2 and 3 to describe the gender of the individuals rather than "men" and "women" for manuscript consistency. The p-value is missing.

• Response: We now use “male” and “female” in all figures, as suggested. Regarding adding p-values to all figures, this is something we have considered carefully also in the author group. However, given the very high number of p-values needed to provide the required details of statistical results for all tests conducted, we have decided to rather use 95% confidence intervals as an indication of result being statistically significant. As mentioned in a previous response, when 95% confidence intervals for the proportions or means of two independent populations don't overlap, there will indeed be a statistically significant difference between the proportions or means at the 0.05 level of significance (although the opposite is not necessarily true).