Author's response to reviews

Title: Development and testing of a past year measure of sedentary behavior: the SIT-Q

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Rita Aguirre
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Dear Ms Aguirre

MS: 2077252317110726 "Development and testing of a past year measure of sedentary behavior: the SIT-Q"

Thank you for the opportunity to revise and resubmit our manuscript. My co-authors and I are grateful for the suggestions provided by the reviewers, and we have been able to make important improvements to the manuscript based on their feedback.

We hope that we have answered reviewer questions and addressed any concerns to your satisfaction. Please see our responses to each reviewer’s comments, below.

Yours sincerely

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Response to Reviewer 1

First, based on reading the text, the study design is not at all clear. Add a Study Design paragraph and reference the Figure provided (in the text) to help clarify. Currently, much of the study design information is interspersed in the Methods section in various places. It’s hard to follow/understand the study design.

As suggested by Reviewer 1, we have added a brief paragraph about the study design, and directed readers to an amended version of Figure 1 (that now includes a flow-chart description of the SIT-Q development phase as well as the measurement properties study):

p5: “This study was comprised of two distinct components: the development of the SIT-Q through a three staged approach of expert review, cognitive interviewing and pilot testing; and establishing the measurement properties of the SIT-Q (see Figure 1). The Alberta Cancer Research Ethics Committee of Alberta Health Services approved the procedures for all elements of this study.”

Second, please increase the description of the SIT-Q in the Methods section. How many domains were initially targeted and why? How many questions/items were included in each domain? Since the major changes were made in response to the Cognitive Interviews (vs. the “experts”), perhaps the initial description of the SIT-Q that entered Cognitive and psychometric testing could be included in the SIT-Q Description part of the Methods. What is the time-frame for the SIT-Q (not clear from reading the Methods)?

We have expanded our description of the initial version of the SIT-Q, noting the time-frame for the measure.

p6: “The first version of the SIT-Q comprised 18 items across six different domains (sleeping and napping; transportation; employment and volunteer activities; meals; leisure time; household chores and do-it-yourself tasks). Common sitting or reclining tasks were identified from the Compendium of Physical Activities,[24] the American Time Use Survey,[25] and from a self-report measure of activity energy expenditure (the Sedentary Time and Activity Reporting Questionnaire; STAR-Q) developed by one of our study team.[26] We also created items pertaining to whether or not more prolonged sedentary behaviors were interrupted by standing or walking breaks, as patterns of sedentary behavioral accumulation have been shown to affect health outcomes.[27, 28] The SIT-Q recall period was past 12 months, and participants were instructed to estimate their usual activity pattern.”

We have not provided this detail for the version that underwent psychometric testing, as we have provided this version of the questionnaire as an additional file (this is referred to in the text on p. 8: “see Additional File 1”).

Third, the 7-day Diary.
A. Describe the 7-day Diary completely in its own stand-alone section/paragraph.
Currently, salient details about your only criterion measure to estimate validity of the SIT-Q are scattered all around the paper (e.g., definitions of sedentary time via the diary, use of two administrations to estimate validity, consideration of week- and weekend days, etc).

We have reformatted the section relating to the SIT-Q measurement property study, so that we provide an overall description of the protocol (with reference to our revised Figure 1), then we have separate subheading sections describing the 7-Day Activity Diary and the SIT-Q.

p. 8: “Participants of the MAREE Study (n=106) were invited to participate in the SIT-Q measurement property study. The primary aim of the MAREE Study was to validate a self-report measure of activity energy expenditure (STAR-Q) against doubly-labeled water. As part of the MAREE Study protocol, participants completed a 7-Day Activity Diary two weeks after their recruitment (see Figure 1). The SIT-Q measurement property study entailed a second administration of the 7-Day Activity Diary, followed by two administrations of the SIT-Q, one month apart (Figure 1). The two administrations of the 7-Day Activity Diary allowed us to generate mean estimates of sedentary behaviors from diaries completed at different times of the year, but within the same reference period that was assessed by the SIT-Q.

7-Day Activity Diary
The 7-Day Activity Diary involved recording the following details for each daily task: time task started; brief description of the task; position (recline, sit, stand, walk, in motion); activity group (self-care, household, occupation, walking for pleasure, care giving, transportation, yard work, exercise and conditioning, light leisure activity, sleeping, other); and physical effort (mainly sitting, mainly standing/no increase in heart rate, slight increase in heart rate, substantial increase in heart rate). The 7-day activity diary was adapted from Conway et al.[31] and was designed to ascertain sleep time as well as all activities (10 minutes or longer, or activities that caused a noticeable change in physical effort) and posture while awake. Participants were instructed to detail their activities in the 7-Day Activity Diary throughout the course of each day, rather than completing the diary each evening or at the end of the week.

Time spent in sedentary behaviors was estimated by two methods. The first estimated sedentary time from all tasks performed in a reclining or sitting position (postural definition). The second method assigned a metabolic equivalent (MET) level from the Compendium of Physical Activities [24] based on the brief description of the task and physical effort indicated, and was operationalized as behaviors ≤ 1.5 METs (MET definition). Sedentary behaviors were summarized into domains that matched those of the SIT-Q: meals; transportation; work, study and volunteering; childcare and eldercare; and, leisure time. Several of the activity group categories of the 7-Day Activity Diary were directly comparable to SIT-Q domains (transportation, occupation, care giving, and light leisure activity). We were not able to determine television viewing and computer use time separately from the 7-Day Activity Diary data (these were often jointly reported and hence amalgamated into leisure time sedentary behaviour). The self-care activity grouping corresponded with the
meals domain (although self-care also included a minimal amount of time spent sitting during personal grooming activities), and a small amount of sitting time recorded within the household activity group was re-allocated to light leisure activity. There were no sedentary behaviors recorded within the walking for pleasure, yardwork or exercise and conditioning activity groups, and sleeping was excluded from our analyses as this is not considered a sedentary behavior.

SIT-Q
Participants were sent a copy of the SIT-Q one month after the 7-Day Activity Diary, and a second copy of the SIT-Q one month after the first (see Figure 1 for data collection overview; see Additional File 1 for SIT-Q). All questionnaires were returned by mail, and participants received up to three telephone calls to follow-up unreturned questionnaires. Importantly, all measures were completed within a 12-month period, commensurate with the 12-month recall period of the SIT-Q.

Data were manually entered into a database and any outlying responses were checked against the original questionnaires. Sedentary behaviors were assessed separately for weekdays and weekends within each domain except work, study and volunteering. Sedentary behavior during work, study and volunteering was reported based on weeks per year, days per week and hours per day. Given that most individuals did not work on a daily basis, the descriptive statistics for each type of “job” (work, study or volunteering) were summarized as hours or minutes of sedentary behavior in this domain per week. To facilitate estimation of total sedentary time, average minutes per day were calculated for each sedentary behavior.”

B. The sitting data from the criterion measure is vital to understand the utility and comprehensiveness of the SIT-Q, yet it is very hard to understand what the sitting time values from the criterion measure looks in this population. Table 3 is close (I think) but it’s not that clear in the end. Please add a descriptive Table 1 for your study participants and include the mean sitting time data from the Diary in this table, for overall sitting, and the summary measures that match the SIT-Q categories. Table 3 appears to be the result of an analysis of Diary data that was matched (by item/questionnaire content), which is appropriate for the validity analysis. Was the ALL of the sitting reported on the Diaries, or just the sitting that matched the SIT-Q items? Please report in Table 1 all of the sitting reported on the diaries (if you have not already done so). This could shed light on how comprehensive your survey may be (vs. capture of open ended sitting information via the Diaries).

Table 3 includes all of the sitting data collected by the 7-Day Activity Diaries. We have clarified the process by which the 7-Day Activity Diary data was summarized and how this was comparable to the SIT-Q domains in the second paragraph of the 7-Day Activity Diary section beginning on page 8 (see revised text in previous section).

Additionally, we have added the following sentence to the paragraph describing the convergent validity analyses (Statistical analyses, p. 12): “All sedentary behaviors were
incorporated into these domains, and each domain was considered overall and separately for weekdays and weekend days.”

C. Two definitions of sedentary behavior were operationalized using the diary. Which one is closest to that used for selecting items for the SIT-Q? What MET value did you use to define sedentary time (or maybe I missed it)? Why didn’t you utilize the conventional definition that uses a combination of posture and the energy cost of the activity? Clearly it will not make too much of a difference. You might add a sentence in your discussion or methods to indicate why you didn’t use the combination definition.

We have clarified our criterion for the MET based definition of sedentary behavior (≤ 1.5 METs) in the second paragraph of the 7-Day Activity Diary section beginning on page 8. These two methods were employed to see whether or not there was much variability in the correlation, depending on the method employed. As Reviewer 1 has noted, there was negligible difference between the methods.

Fourth, Page 13, first paragraph. Much of this reads like the Methods section for Cognitive testing. Please revise and try to describe your methods in one place and results in another. Currently they are scrambled together and it makes for tough reading, and there is not a specific place the reader can go back to to get information about the methods employed.

We have removed the methodological elements of this paragraph, and some of this text is now present in the methods section. The first paragraph of the cognitive interviewing results now reads:

   p. 14: “Eleven cognitive interviews were conducted, each one lasting between one and a half and two hours. Three males (mean age = 51.0 years, SD = 13.9 years) and eight females (mean age = 44.9 years, SD = 7.5 years) participated. Further details on the characteristics of participants in the cognitive interviews and pilot testing can be found in Additional File 2. Three rounds of testing were conducted until, during the final round, five successive interviews did not identify any new sources of misunderstanding.”

Fifth, a weighted Kappa appears to have been used (vs. conventional/unweighted Kappa), but this isn’t that clear in the Statistical section. Further, please indicate how the kappa was weighted for partial credit for a close re-test (if it was).

We confirm that we employed a weighted Kappa to examine the breaks in sitting time items. The default weights matrix in Stata 12.0 was used for this analysis (specifies weights $1 - |\text{i} - \text{j}| / (k - 1)$, where i and j index the rows and columns of the ratings at the two timepoints, and k is the maximum number of possible ratings). This is now clarified on p. 11: “Finally, the consistency with which participants rated how frequently they interrupted their prolonged
sitting was assessed by absolute agreement (%) and a weighted kappa statistic (wκ)[34] with the default weights matrix in Stata 12.0.”

*Sixth, Table 3. Present (in the text) the mean differences reported in Table 3 and comment on these results in your Discussion. Currently, only the correlations are considered. Why are the mean differences consistently negative for meals, transport and work, but positive for leisure-time sitting? Do these differences jibe with your cognitive testing results? Does this mean that non-leisure was underestimated by ~2 hrs/d and leisure sitting was overestimated by about 2 hrs/d, since total sitting time between SIT-Q and the Diary was about the same?

We have now noted the mean differences between the two administrations of the SIT-Q, and the 7-Day Activity Diary and the SIT-Q, in the Results:

p. 16: “Overall, there was a mean difference of 52 minutes between the first and second administrations of the SIT-Q. There was little mean difference noted across the meals, transportation or childcare and eldercare domains, however the second administration saw an overall decrease of approximately half an hour for the work, study and volunteering, and leisure time domains.”

and p. 17: “There were 69 participants with mean diary and first SIT-Q data. Overall, there was less than ten minutes difference between the SIT-Q and 7-Day Activity Diary estimates of total daily sedentary behavior. Compared with the 7-Day Activity Diary, the SIT-Q estimated over half an hour less within the meals and transportation domains. There was relatively little difference between the different methods of sedentary behavior assessment for the work, study and volunteering or childcare and eldercare domains. A substantial difference was noted within the leisure time domain; the SIT-Q estimated nearly two hours per day more leisure time sedentary behavior.”

We have also added an additional paragraph in the Discussion section to consider the differences in the mean differences between the 7-Day Activity Diary and SIT-Q estimates of sedentary behaviour:

p. 19: “The second administration of the SIT-Q generated an estimate of total sedentary behavior that was 52 less than derived by the first administration. Whilst the difference between total sedentary behavior estimates from the first administration of the SIT-Q and the 7-Day Activity Diary were small, we noted substantial differences between methods in relation to leisure-time sedentary behavior. The first administration of the SIT-Q appears likely to have over-estimated leisure time sitting, possibly due to concurrent computer and television use. These two behaviors could not be disentangled from the diary data, as many participants reported these as occurring at the same time. We note that leisure-time sedentary behavior was over 40 minutes less in the second administration of the SIT-Q; perhaps familiarity with methods of recalling and reporting sitting time resulted in less of the ‘double counting’ that had been identified as an issue in the cognitive interviewing process.”
**Minor Essential Revisions**

**Page 14, last paragraph, second sentence. It’s not clear if these values are for the SIT-Q or the Diary.**

The characteristics of the measurement study participants were assessed during the parent MAREE Study. We have added the following footnote to Additional File 3 (that describes the sociodemographic characteristics of the sample): “Sociodemographic characteristics assessed during initial MAREE Study testing.”

**Page 15 and 16. The citations for Tables 2 and 3 seem to be reversed.**

This error has been corrected.

**Page 16. For Bland-Altman plot, indicate which instrument is being evaluated and how far apart the measures were taken.**

We have amended the description to read: “The Bland-Altman plot for total sitting time (h/day) is shown in Figure 2. This plot also shows wide confidence intervals but little systematic variability in reporting.”

**Page 17, Discussion, line 9-10 (of Discussion). Specify the main issues that were addressed in the “wording” in the SIT-Q.**

Each of the issues relating to participant comprehension of the SIT-Q (the ‘wording’) is outlined in detail in Table 1. There are no distinct themes that can be summarised to give an overview of the types of changes made to the wording. In this instance, we do not think we can address this request from Reviewer 1 without simply reiterating the text contained within Table 1.

**Page 20, Strengths. Add that you used the mean of two 7-day Diary measures as a criterion measures (which should reduce intra-individual variation in your criterion measure). Also, note that your choice to use a Diary (vs. accelerometer) allowed you to estimate the validity of domain/type-specific sitting items.**

We thank Reviewer 1 for these helpful suggestions. We have added these to the appropriate section of the Discussion:

p. 21: “A major strength of the SIT-Q is the rigorous methodological approach used to develop the instrument. The three-stage process of expert review, cognitive interviewing and pilot testing was critical for minimizing future participant reporting errors by ensuring that items and instructions were worded in a manner appropriate for the target population. However, it is important that the SIT-Q is used within the context for which it was designed. The SIT-Q was developed for use in epidemiological studies where habitual patterns of sedentary behavior are of interest in relation to chronic disease development and progression;
it may not be a sensitive measure of change in sedentary behavior. Using the 7-Day Activity Diary as our criterion measure enabled us to estimate the validity of domain-specific estimates of sedentary behavior. Further, incorporating two administrations of the diaries and using the mean of these estimates likely reduced intra-individual variation in the criterion measure.”

**Page 20, Strengths.** Why does estimating changes in the context of an intervention enter the discussion here? That’s an objective that is more broad than you outlined in your Introduction.

We have removed our reference to this, as per the revised paragraph in the previous suggestion.

**Page 20. Conclusion.** “acceptable measurement properties”. Can you be more specific about which properties and for which goal (epidemiologic studies need to do what with their exposure data)?

We have revised our conclusion to read:

p. 22: “The SIT-Q was developed to fill a need for a rigorously tested, comprehensive measure of habitual adult sedentary behavior. It is the first sedentary behavior questionnaire to be developed and refined using expert review, cognitive interviewing and pilot-testing. Overall, the SIT-Q demonstrated fair to good test-retest reliability and moderate validity. Items pertaining to behaviors that occur in more structured contexts, such as television viewing or occupational sitting, displayed the strongest psychometric properties.[39] These findings, coupled with the high acceptability of the questionnaire from respondents in the pilot study, suggest that our aim to develop a feasible measure of usual sedentary behavior for use in population cohort studies has been achieved. Given the emerging evidence suggesting that sedentary behavior is a modifiable lifestyle risk factor for numerous chronic diseases, the SIT-Q should be a useful addition to available methods of sedentary behavior assessment.”

**Response to Reviewer 2**

**ABSTRACT**

*Line 10: “Following a number of iterations during development”. I think that this sentence should be excluded from the abstract. It does not provide key information for the reader.*

This suggested edit has been made.

**INTRODUCTION**

*Line 1: “Sedentary behavior (time spent sitting)”: Add …or in a reclined position.*

This section now reads: “time spent sitting or reclining”.
• Last line of second paragraph: “Hence, self-reported methods of data collection are likely…”. I suggest finishing this sentence as “… in case of limited economic resources”.

We have amended this sentence to read: “Hence, self-report methods of data collection are likely to remain the primary methods whereby activity will be quantified in epidemiological studies, especially for studies with limited economic resources.[15, 16]”

• Page 5, first line: “Currently, few questionnaires…” (INCLUDE REFERENCES)

This has been done.

• The next line:
“Such measures … rigorously”. I disagree with the term rigorously. Objective methods (i.e. PAL) are more accurate tools than questionnaires. Rephrase this sentence.

This sentence now read: “Such measures are necessary in order to determine whether the behavioral context is important in the associations between sedentary behavior and chronic disease.[11, 24]”

METHODS
• Development of the SIT-Q:
In my view, authors are included excessive information (2 pages) in this section. Write a maximum of 1 page.

We have revised this section significantly, in response to Reviewer 1’s suggestions. We are thus not able to significantly reduce the description of the development of the measure, as suggested by Reviewer 2.

• Measurement property study (page 7):
Include basic information of the study participant in this part.

We provide a description of our participants within the Results section of the manuscript (see p. x).

• Statistical analyses
Authors say that absolute agreement was used. Rename the technique as “percent agreement”.

This change has been made.

RESULTS
Development of the SITQ (page 11-15)
Again, reduce the information to no more than 2 pages (Authors can include
We respectfully disagree with Reviewer 2’s suggestion that this section should be shortened. The development of the SIT-Q through the three-staged approach – including, very importantly, cognitive interviewing – ensures that the measure has good construct and content validity.

**CONCLUSION (page 20)**

*Delete the three first lines. Authors need to be more direct in this section.*

Again, we feel that the strength of the SIT-Q testing is that it has employed mixed methods in the testing of the measure across all stages of its development. The expert review, cognitive interviewing and pilot testing components are just as important as the traditional reliability/validity assessment to ensuring that the SIT-Q is a sound measure.