Author's response to reviews

Title: Examining the influence of a text message-based sleep and physical activity intervention among young adult smokers in the United States: a randomized controlled trial

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Author's response to reviews: see over
Dear Ms. Pafitis,

Thank you very much for the opportunity to address the reviewers’ comments and resubmit our manuscript “Examining the influence of a text message-based sleep and physical activity intervention among young adult smokers in the United States: a randomized controlled trial” (MS: 5003597416506212) to *BMC Public Health*. We have a number of revisions based on suggestions from the reviewers, which we hope will make this paper suitable for publication.

We appreciate your continued interest in this manuscript and look forward to hearing from you.

Sincerely,

A. Jordan Filion, M.Sc.
Thank you to the reviewers for their very thorough and helpful reviews. Below please find our detailed responses to each comment.

Response to Referee 1 (reviewers’ comments are in bold):

Major Compulsory Revisions

Abstract:

1. In the background, it is somewhat unclear what you are examining in this paper, with the first read through. Perhaps it would be helpful to allude to the link between sleep and physical activity with smoking cessation. Then you can go on to clarify that text message-based interventions have been used to promote smoking cessation and physical activity, however they have not been used to improve sleep. This would more adequately set the stage for your sentence where you note that this intervention was used as an active control in a smoking cessation study. Then you can stress that the purpose of this paper is to examine the sleep and physical activity results in the active control group.

Thank you to the reviewer for this suggestion. We have rewritten the Background section of the abstract to include this information, along with the suggestion from the other reviewer to state that the target population was recruited for a smoking cessation intervention who did not express any plans/interest in changing sleep or physical activity behaviour: “Sleep and physical activity are two health behaviors associated with improved smoking cessation outcomes. Text message-based interventions have previously been used to promote physical activity and smoking cessation; however, this type of intervention has not targeted sleep habits. This study examined the effectiveness of a text message-based active control intervention in improving sleep and physical activity habits among a U.S. national sample of young adult smokers participating in a smoking cessation intervention, who had not expressed an interest in changing sleep or activity behavior”.

2. In methods, noting that this is a secondary data analysis of the SMS USA randomized controlled trial would be helpful.

Based on this suggestion, we have updated the Methods section of the abstract to include this information.

3. In the conclusion, it might provide clarity to frame this from the perspective of the young adult smoker, bringing the reader back around to the overarching purpose of the larger study that these results were from.

Thank you to the reviewer for this suggestion. We have rewritten the Conclusion section of the abstract to frame things from a young adult smoker’s perspective: “This study provides preliminary evidence that a text message-based intervention may be a promising approach for improving sleep quantity among young adult smokers who are short sleepers and interested in quitting smoking. Similar programs should be further explored as a novel approach for improving sleep habits among individuals with insufficient sleep”.

**Background:**

1. This is an interesting paper. However it needs to be clear from the beginning that what is being presented is part of a larger study that examined a smoking cessation text message program. I understand that these results have already been presented, but this is still a secondary data analysis – so needs to be presented as such and clear from the beginning. This is no way diminishes the importance of these findings, but provides a proper context in which to understand them.

Based on this suggestion, we have edited the final paragraph of our Background section to clarify that this is a secondary analysis, using data from the Stop My Smoking (SMS) USA randomized controlled trial.

2. If in the beginning paragraph – instead of talking about emerging adulthood, which is distracting, it would be helpful if the authors could do some minor reorganization of their background. Perhaps if they start right off with discussing the importance of promoting specific healthy behaviors in young adults it would flow better. For example they could begin their introduction with the importance of 1) Promoting smoking cessation programs in young adults, 2) Improved sleep behaviors in this population (which they already provide a useful introduction for), and 3) Improved physical behavior in this population (which they already provide a useful introduction of this literature).

Thank you to the reviewer for this suggestion. We have rewritten the first paragraph of our Background section to briefly provide a foundation for why young adulthood is a critical time to intervene on poor health behaviours, including smoking, inactivity, and insufficient sleep: “Health behavior patterns established during one’s young adult years have the potential to become life-long habits that can dictate one’s health status and risk for chronic disease [1,2]. During this transitional period, individuals are more sensitive to environmental influences which, in addition to having the potential to motivate the adoption of positive health behaviors, can influence the adoption of poor health behaviors [3,4]. Therefore, young adulthood can be viewed as a critical period for intervening on poor health behaviors, including smoking, inactivity, and insufficient sleep, before such behaviors become entrenched”. Then, as suggested, this section segues into a discussion about the importance of improving sleep and physical activity behaviours in this population.

3. Then I think it would be helpful to discuss how sleep and physical activity impact and are impacted by smoking and smoking cessation. In the paper that they reference [16], the paragraph on the control group notes that “Message content was aimed at improving one’s sleep and exercise habits within the context of how it would help the participant quit smoking”. However as the background is currently written, it is difficult to quickly understand that foundational context. Brief additional information here, would strengthen the rationale for the design of this study and presentation of these particular findings.

Based on this suggestion, we have added a paragraph to our Background section that describes the negative effects of cigarette smoking on sleep and physical activity: “Cigarette smoking has been shown to negatively impact both sleep and physical activity [12-14]. It has been well-documented that smokers have lower subjectively measured sleep quality and experience more insomnia-like symptoms, compared
with non-smokers [15-17]. One recent study examining both subjectively and objectively measured sleep among adult smokers found that, in addition to having lower subjectively measured sleep quality, adults who smoked had shorter sleep period time, longer sleep latency (i.e., took longer to fall asleep), higher rapid eye movement sleep density (indicating less restful sleep), and more sleep apneas and leg movements in sleep than non-smokers, all of which were objectively measured using polysomnography [13]. In addition, it has been established in the physical activity literature that cigarette smoking compromises cardiopulmonary function in the short-term, which could lead to reduced levels of physical activity [12,14].

We have also added a paragraph to the Background section that emphasizes how improving sleep and physical activity can assist with smoking cessation: “Improving sleep and physical activity habits are two of many recommended strategies to assist with smoking cessation [18]. Physical activity has been associated with improved weight control among those trying to quit smoking, and can also alleviate stress and assist with managing food and nicotine cravings and withdrawal symptoms experienced during the quitting process [18,19]. Furthermore, physical activity can lead to improved sleep [20]. This, in turn, can provide individuals trying to quit smoking with the energy to cope with nicotine cravings and avoid the negative feelings that typically emerge as a result of being tired [21].”

4. If the authors could rewrite the next section to provide a discussion on what is known about text messaging with each of these areas, with a brief section on smoking text messages – since that is what is being compared to in this group, sleep promotion (and granted, the sleep text messaging background would be very limited, hence the importance of this study), and then physical activity text messages (which they already discuss), that would be helpful.

Based on this suggestion, we have added three paragraphs into our Background section that outline the literature on previous text message-based interventions:

“Using a text message-based intervention platform offers several other advantages compared with interventions involving face-to-face contact with participants, including great reach [22], cost-effectiveness [22], unobtrusiveness [22], the ability to collect data in real-time [22], and the ability to intervene anywhere, anytime [23]. Capitalizing on these advantages, text message-based behavior change interventions have recently been applied to a range of health behaviors, including smoking [24-28], diet [29-32], screen time [32] and physical activity [29-35], with varying success. Text message-based smoking cessation interventions, in particular, have yielded promising results, with participation in the majority of such interventions being associated with increases in abstinence from cigarette smoking [24, 26-28].

To date, a text message-based intervention platform has not yet been used to improve sleep habits. In addition, all of the in-person interventions that have aimed to change sleep habits among young adults have been conducted exclusively among higher education students, so it remains unknown whether results from these interventions can be generalized to young adults outside of a tertiary education setting, particularly those who are engaging in, but interested in ceasing, health risk behaviors. Given the remarkable amount of time that young adults spend on mobile devices [36], implementing a text message-based sleep intervention may be a promising approach for improving young adults’ sleep habits.
Examining results from text message-based interventions targeting physical activity behavior, one intervention was associated with significant increases in physical activity [35], while another demonstrated no significant effect [34]. Prestwich and colleagues found that university students randomized to receive a 4-week intervention comprised of both creating a personalized exercise plan and receiving tailored text messages reminding them of that plan significantly increased their physical activity as compared to either approach alone and the control conditions [35]. Newton and colleagues found that adolescents with type 1 diabetes who were randomized to receive motivational text messages for 12 weeks while wearing a pedometer actually decreased their physical activity over the study period [34]. Studies examining the impact of physical activity interventions among groups engaging in other types of health risk behaviors, such as smoking, are lacking. Furthermore, no text message-based physical activity interventions designed exclusively for young adults who are trying to quit smoking exist in the literature.

5. After the text messaging discussion, they could provide a paragraph about why active controls or attention control groups in text messaging studies are so important. Organizing it in this way would lead nicely to the gap in the literature that they point out.

Thank you to the reviewer for this suggestion. We have added the following text at the end of the second last paragraph of our Background section, in order to justify why active/attention-matched controls are important in mobile health research: “This attention-matched control design is an efficient way to test the effect of interventions on multiple outcomes and allows the researcher to ascertain that any observed intervention effects are not a result of more attention being given to intervention group participants”.

Methods:

1. Overall – I found the Methods section to be relatively clear. The sentence on why follow-up rate differs from previous reports – was helpful – thank you for providing that. However often missing in text messaging papers are how the text message database was developed, the total number of text messages in the database, and how it was determined when text messages would be sent out, as well as which text messages were chosen to be used. If you could elaborate on each of these issues, it would make the paper much richer from a text message research perspective.

Based on this suggestion, we have elaborated on these issues in the Interventions section of our methods. We also provided some example text messages in our description of the intervention. For readers who are interested in additional detail regarding the development of the smoking cessation text messages, we also provided the citation that describes the development of the database for the smoking cessation group.

2. Measures - Please provide psychometrics for both the sleep and physical activity measures.

Cronbach’s alpha for the sleep quality scale used in this study was 0.77 at baseline and 0.73 at 3-month follow-up. This information has been added to the Measures section of our manuscript. No psychometrics are available for number of hours participants slept/were physically active on a daily or weekly basis.
**Results:**

1. Overall I found the Results section to be relatively clear. It is an interesting finding in baseline results – that the sleep/activity group had significantly less sleep quantity than did the smoking cessation group, although their sleep quality score difference was insignificant.

Thank you to the reviewer for this comment. We found that particular finding to be interesting as well.

**Discussion:**

1. In the first sentence, keep to the order you have established - with 1) sleep, and 2) physical activity (in the first sentence you state activity and then sleep hygiene). However overall, I found the Discussion section to be well thought out, discussing the important points and plausible explanations of the findings.

Thank you to the reviewer for spoting this. We have edited the first sentence of our Discussion section to keep with the order we previously established.

2. In the limitations section – important limitations were pointed out. In addition, speaking briefly to the modest sample size would be helpful, as well as the use of Craigslist recruitment.

Thank you to the reviewer for this recommendation. We have added the suggested limitations to the Limitations section of our discussion.

**Response to Referee 2:**

**Major Compulsory Revisions**

**Abstract Background:**

1. It would be more transparent to alert the reader to the fact that the target population was recruited for a smoking cessation intervention and did not express any plans/interest in changing sleep or physical activity behavior. The last sentence of the background alludes to this but is not explicit.

Based on this suggestion, we have reworded the last sentence in the Background section of our abstract to more clearly portray that the target population was recruited for a smoking cessation intervention and had not expressed any interest in changing sleep or physical activity behaviour: “This study examined the effectiveness of a text message-based active control intervention in improving sleep and physical activity habits among a U.S. national sample of young adult smokers participating in a smoking cessation intervention who had not expressed an interest in changing sleep or activity behavior”.

Background:

2. Is there any rationale for targeting 2 behaviors for the control group? While both may be important behaviors to target for this population, it sets up the study from the start to be biased toward the null as the authors a) target two very different behaviors and b) attempt to intervene on behaviors that were not identified as being targets for change by the subject population.

Ybarra and colleagues chose to target two behaviours for two key reasons. First, these are synergistic behaviours. In the literature, the positive association between physical activity and sleep quality has been well-documented (e.g., Youngstedt & Kline, 2006). Although they found the strength of this association to be only modest in their review of the literature, Youngstedt & Kline (2006) contend that physical activity is the most consistent predictor of better sleep, when compared with other predictors such as depression and stress. Second, Ybarra and colleagues thought that, given the length of the intervention period (i.e., 6 weeks), the text messages would get too redundant if just one of these behaviours was addressed. Therefore, the rationale for this decision was based on empirical research as well as practical efforts to enhance user experience and prevent participants from getting annoyed with repetitive text messages.


Discussion:

3. (Last sentence of paragraph 1): This sentence summarizes my primary concern with the study. Is there any literature that supports the alternative? (i.e., targeting people for behavior change who may not have any interest or motivation to change?). I appreciate the innovative design of study with a control group that also receives an intervention, but question the premise of expecting change on two behaviors not cited by participants as targets for change.

We thought that this would be a valuable addition to the literature on behaviour change interventions, in that we could examine what happens when we encourage change on behaviours that were not identified as behaviours of interest by participants (i.e., sleep and physical activity) when the change is framed around the behaviour change they are interested in (i.e., quitting smoking). We believe this can have important implications for interventions in other areas that are attempting to do the same thing (e.g., improving fitness among individuals who are trying to change their diet, for example).

In General:

4. The Hurling reference is not the best comparison study. Not only is the target population very different (adults, mean age 40) but the intervention had text messages as 1 component among many (internet content, email, and self-monitoring with an accelerometer) which is substantially different than a text message intervention in isolation. Also, the Hurling study was conducted before the widespread adoption of Smartphones so we can’t assume the study participant received the email and internet information on the phone, similar to a text message. It might be worth looking at the Prestwich, Perugini, Hurling study of text messaging for physical activity in college students (2009). Otherwise, a better comparison would be a study that evaluated the efficacy of
text messaging alone or at least as the primary component (even if you can’t use the same comparison population).

Thank you very much to the reviewer for suggesting the Prestwich, Perugini & Hurling (2009) study. Based on this suggestion, we have replaced the Hurling & colleagues study with the Prestwich & colleagues study in the Background and Discussion sections of our manuscript to serve as a comparison to our intervention study.

5. Since the study is presented as an intervention to itself, the authors should justify why the control/sleep/physical activity group received text messages at the same rate as the smoking cessation group and in particular any justification for up to 9 messages/day re: sleep and/or physical activity.

The control/sleep/activity group received text messages at the same rate as the intervention/smoking cessation group in order to match the level of attention that the intervention group was receiving. Based on this suggestion, we have clarified this in our Methods section.

6. It would also be helpful to include examples of the text messages used and more details about the messages: Were they sent at the same time each day, did everyone receive the same messages, did they receive messages about sleep and physical activity on the same day, etc.

Based on this suggestion, we have provided example text messages in the Interventions section of our methods. Regarding the timing of text message delivery, both smoking cessation and sleep/activity group participants were allowed to define their “window” for receiving daily text messages. Those participants who had the same window (e.g., 5 hours) would have received the text messages around the same time each day. All participants in the sleep/activity group received the same text messages (there was no pathing), and both sleep- and activity-related messages were delivered on the same day. We have added these details into the Interventions section of our methods.

Minor Essential Revisions

1. Table 2 and Table 3. The superscript notation is confusing. It appears the superscript “a” indicates how the model was adjusted (for baseline sleep only) but it’s not clear what exactly was adjusted (and the corresponding #) for superscript “b”.

Thank you very much to the reviewer for spotting this error. Superscript “a” belongs in the ‘unadjusted difference’ column, and superscript “b” belongs in the ‘adjusted difference’ column, as we controlled for a number of covariates listed below the table beside superscript “b”. Superscript “c” (which we had forgot to include in the table) belongs beside the ‘sleep quality score’ heading in the table. Tables 2 and 3 have been edited to correct these errors.

2. Table 4. There is a “b” superscript but no reference “b” in the actual table. Looking only at the table (and not the main text) it is difficult to ascertain if the “Adjusted difference” in the 2nd to last column on the left is adjusted for baseline PA only or baseline PA change in average sleep quantity etc.
Thank you again to the reviewer for spotting this error. Similar to the previous recommendation, superscript “a” belongs in the ‘unadjusted difference’ column, and superscript “b” belongs in the ‘adjusted difference’ column. Table 4 has been edited to correct these errors.