Author’s response to reviews

Title: A survey study of the association between mobile phone use and daytime sleepiness in California high school students

Authors:

Nila Nathan (nilandogz@gmail.com)
Jamie M Zeitzer (jzeitzer@stanford.edu)

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Author’s response to reviews: see over
Dr. Matthias Morgenstern  
BioMed Central  
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Dr. Morgenstern,

We thank the reviewers for their copious and excellent suggestions for the attached manuscript (1171542743845348). We appreciate the opportunity to improve and resubmit the manuscript for your consideration. We have made all corrections suggested, as detailed in a point-by-point fashion below. We believe that these edits have substantially improved the content and quality of the manuscript.

We look forward to working with you on this manuscript.

Sincerely,

Jamie Zeitzer, Ph.D.

Reviewer 1:  
The title is misleading. “Retrospective” gives the associations that the study deals with data that dates back in time. Both the dependent and the independent variables deal with the present including the past 30 days. The study is better described as cross-sectional. Furthermore, since it is cross-sectional, it is difficult to conclude anything about causal directions of associations and it is therefore advisable to avoid the term “its effects on”.

Major compulsory revisions 1. I suggest crossing out “retrospective” and “its effects on” in the title.

We have changed the title to: “A survey study of the association between mobile phone use and daytime sleepiness in California high school students”.

The abstract conveys what has been found, but the background statement about an equally rapid decline in teenage sleep is a bit too definite and should be modified. The Abstract results could put less emphasis on discussing possible moderating factors. The Abstract conclusions, as is discussed later, are a bit over-confident.

Major compulsory revisions 2. Abstract conclusions: Avoid generalizing the conclusions too far from the study, perhaps by changing the tempus, i.e., from is to was.
We have changed the removed reference to moderation and softened the conclusion.

Minor essential revisions 3. The references are rather outdated. When studying a rapidly increased phenomenon such as mobile phone use it seems relevant to report fresh statistics on e.g. number of users (or perhaps statistics from the same year the study was performed, which is not defined). Also, the reference for the 3.3 billion subscribers in 2008 seems to be missing.
We have changed the verbiage and added the reference for this. We have specified the estimated numbers of US teens in 2012.
Minor essential revisions 4. Some editing is needed concerning tempus when reporting the earlier research. We have made several edits to the Introduction and Abstract that, hopefully, address this concern.

In the abstract, the aim of the study is defined as “to see if there was a correlation between mobile phone use at night and the lack of sleep in teenagers”. The aim is not defined in the main manuscript (“...it seemed worthwhile to attempt a cross-sectional study of sleep and mobile phone utilization in a US high school”). Isn’t it sleepiness rather than lack of sleep that is studied? We have changed the abstract to indicate that the purpose is to examine sleepiness rather than sleep.

Major compulsory revision 5. Define the aim in the main manuscript. Besides making sure that it corresponds with the abstract aim, it could also be expanded to include research questions. Moreover, an a priori hypothesis is mentioned in the Discussion, which should be stated here.

We have now made the a priori hypothesis explicit in the abstract.

Discretionary revision 6. I suggest that the statistical term “correlation” is changed to “associations” in the aim. This has been done.

Are the methods appropriate and well described? The survey is included as an additional file, which is good. The ESS is well described and referenced in the manuscript. The mobile phone questions are attributed to Thomée et al (2011) which is correct with the exception of one item; staying up late to use the mobile phone. This was probably designed by the authors? Also, the phone calls and texts items in Thomée et al had category response sets, but were open-ended in the present study (an adaptation).

We have now made explicit that we have adapted Thomée's questions for the purpose of this study.

Minor revisions 7. Update referencing of mobile phone questions as mentioned above. This has been done.

Minor revisions 8. When describing how data was collected, I miss a mentioning on how the survey was sent to the students, e.g. by email?

We have now included this information (surveymonkey.com).

Minor revisions 9. What year was the data collected?
We have now included this information (April 5-23, 2012).

Minor revisions 10. There were more than twice as many girls than boys that responded to the survey. What was the gender distribution at the school?
48% of the students are female.

Major compulsory revision 11. The authors are encouraged to consult a statistician to ensure that correct statistical methods are used and that results are reported appropriately. The use of t-tests and multivariate regression analysis is based on the assumption that data is normally distributed. There are no comments about the distributions of data in the study. The summary data is presented as means +/- 1SD in Table 1. It is clear that the calls and text data must be skewed, i.e. not normally distributed, and it would thus be more appropriate to present medians (and perhaps upper and lower quartiles). And because the data most likely isn’t normally distributed, t-testing of the variable “texts” is inappropriate. What about the main independent variable; the ESS scores? Is it normally distributed? If the ESS isn’t normally distributed the choice of parametric statistics should at least be motivated. Moreover, r=0.02 is presented as a linear relationship. This must be a typing error?

We thank the reviewer for correcting our oversight here. While the ESS is normally distributed (Kolmogorov Smirnov p=0.16), the number of texts is not (p's<0.001 for texts, calls, and texts+calls). In the Table, we have changed the reporting of texts and calls to median (range). Post hoc analysis of the relationship between non-normally distributed data and ESS is now done with the Spearman correlation. These changes are included in the Methods and Results.

Minor essential revisions 12. The use of X2 (chi square)-tests are not mentioned in the analysis section.
We now explicitly mention the chi-square test in the Methods.
Minor essential revisions 13. Results section could be more clearly structured (please see also point 19.). Only some data is presented in Table 1, not well referenced in the text. (Is Demographics the correct heading for the table?) The descriptive data of the predictor variables would be easier to overview in a separate table. The column heading in Table 1: “tried to stop using phone” should be “tried to reduce using phone”?
We have rearranged and added a table. There are now two tables: Descriptive statistics - continuous variables and Descriptive statistics - categorical variables. We have also changed the column heading as requested.

Minor essential revisions 14. The use of the term “significance” can be misunderstood – better to write (in last paragraph of Results): “…had a numerically though not statistically significant higher texting rate...”.
This change has been made.

Discretionary revisions 15. I am not familiar with the term iterative multivariate regression analysis but assume that this means some kind of stepwise regression model?
We have changed this to stepwise regression.

Discretionary revisions 16. Given that gender was a major predictor variable, it would have been nice if gender specific analysis (the n permitting) had been performed.
We have increased the amount of information and gender-based statistical analysis that we present (Tables 1 and 2). Given this suggestion, we also explored our multivariate modeling in the males and females as separate groups. In the females, accessibility was the only predictor of ESS (having tried to cut down was no longer part of the model) and in males, there was no significant prediction of ESS (though accessibility was the last part of the stepwise regression that was removed). Given the lower numbers in the separate groups, we have not included this sex-specific modeling.

Major compulsory revision 17. The discussion lacks mentioning of limitations (!); such as dropout, cross-sectional design, possible common causal factors (confounders) not adjusted for etc., which of course is essential in scientific reporting!
We have now included a discussion of limitations.

Major compulsory revision 18. Due to the limitations of a cross-sectional study in a specific population and with a high dropout etc, generalized conclusions should not be drawn. Tempus of conclusions could be changed (i.e. “...likely contributed to daytime sleepiness”) so that it is clear that the conclusions concern the present study (and not a general truth). Also, check that conclusions respond to the aim.
We have changed the tempus of the conclusions to reflect the preliminary nature of the data.

Minor essential revisions 19. Make sure that the results discussed are actual results (such as the linearity of texts and sleepiness?).
We hope that the changes that we have made in response to your, and the other reviewers, comments have addressed this issue.

Minor essential revisions 20. Some emphasis is put in discussing likely moderators. Weren’t these tested in the regression analyses? Furthermore, some of the discussion takes place already under Results. Please check the structure of reporting results and discussing the results.
We hope that the changes that we have made in response to your, and the other reviewers, comments have addressed this issue.
Reviewer 2:

**Major Compulsory Revisions** 1. The second paragraph of the results is confusing. It gives EES results, then describes the variables in the "iterative multivariate regression analyses", but follows this with ANOVA results. Multivariate regression results are not given. It appears the word “regression” may need removing or regression results provided. This needs to be clarified.
We have now included a table with the regression results (Table 3).

**Minor Essential Revisions** 1. The title of the paper refers to a retrospective survey study. It is a cross-sectional survey (as it says in the background).
**Minor Essential Revisions** 2. The title does not reflect the findings
We have now changed the title to: “A survey study of the association between mobile phone use and daytime sleepiness in California high school students”.

**Minor Essential Revisions** 3. There is no statement on which body provided the ethics consent.
We have now added this to the manuscript.

**Minor Essential Revisions** 4. I have some queries about the questionnaire that need addressing or commenting on. (There are others in the discretionary revisions section.)
- Q 4 & 5 read ‘...how many ... have you made OR received per day’. The word OR is unclear and may elicit responses referring to sending, receiving or both
We intended to have the respondent indicate the total number of texts/call that were made + received.
- Q 14 & 18 could refer to being either a passenger or the driver. The way this is interpreted may well affect the response
Question 14 mistakenly omitted "as a passenger," which has now been included. Question 18 refers to either situation.
- Q3 excludes those who borrow a phone. Did any non-owners report using a phone in Q 4 & 5?
We excluded from all analyses those individuals who did not own a cell phone. Given the title of the research project, there may have been a bias for individual who did not own a cell phone not to participate.

**Minor Essential Revisions** 5. The following need to have information or some comment provided:
- the very low participation rate (about 10%) and the possible impact of this
We have mentioned possible response bias as a limitation in the Discussion.
- when the survey was undertaken
We have now included the dates of the survey in the Methods.
- the age range of the students at the school (only the age range of participants is given),
The age range of the students in the school matches the participants.
- what percentage of respondents answered all the questions in the model and were such values imputed or were those respondents excluded?
For the regression model, only students with complete answer sets were included (191 of 202). This information is now included in the Results.
- Were the variables in the model tested for collinearity?
We examined the variables in the model for collinearity using the VIF statistic and found that there was low likelihood of collinearity (VIF's<3.9).

**Minor Essential Revisions** 6. What were the determinants for choosing the best model?
We used step-wise modeling in which the least significant components were iteratively excluded.

**Minor Essential Revisions** 7. Why were non-phone owners excluded (they may have borrowed)?
We decided to limit our analysis to those who owned phones as we hypothesized that there may have been significant heterogeneity in the accessibility of the cellular phone (especially at night) in individuals who borrowed the phone.

**Minor Essential Revisions** 8. The last paragraph of the Background does not provide a logical reason for undertaking the research.
We have changed the last line of the Background to read: "As there has been limited examination of how mobile phone usage affects the behavior of young children and adolescents, none of which have addressed the effects of such usage on daytime sleepiness in U.S. teens, it seemed worthwhile to attempt a cross-sectional study of sleep and mobile phone utilization in a U.S. high school."

**Minor Essential Revisions** 9. The means and SD of the reported amount of texting and phone calling indicate a heavy positive skew which is typical of cellphone studies. This means that the median and range are more suitable for reporting than the mean and SD.
We agree and have changed these data to median (range).

**Minor Essential Revisions** 10. Proof reading, bold print is the correct version:
- 1st line of abstract methods: “containing an Epworth...”
- Results, para 1, line 13 “7.5% reported that they needed to be accessible...”
- Results, para 2, line 11 “relationship between the number of estimated texts...”
- Results, para 2, line 17 “those who felt they needed to be accessible...”
- Results, para 2, line 19 would read better as: “reporting having tried, but failed, to reduce...” (Remove the first “to” which is after the word ‘tried’)
These changes have been made.

**Discretionary Revisions** 1. Questions 12-18 in the questionnaire don’t provide a ‘not applicable’ choice. This is unlikely to have been needed for most questions, but Q15 could do with some comment.
The ESS is an independently validated scale and widely used in the sleep field. It shows good correlation with objective measures of sleepiness (e.g., Maintenance of Wakefulness Test, electroencephalographic correlates, sustained vigilance testing). Participants are asked to respond to the best of their ability. In cases in which data are missing, missing values are replaced with population means.

**Discretionary Revisions** 2. The last sentence of the background is strangely worded. How about “There has been limited examination of how mobile phone usage affects the behavior of young children and adolescents”?
We have changed the last line to read: "As there has been limited examination of how mobile phone usage affects the behavior of young children and adolescents, none of which have addressed the effects of such usage on daytime sleepiness in U.S. teens, it seemed worthwhile to attempt a cross-sectional study of sleep and mobile phone utilization in a U.S. high school."

**Discretionary Revisions** 3. The last but one line of the paper suggests limiting phone use during prescribed sleeping hours. It seems that eliminating phone use during sleeping hours is likely to be far more effective at “alleviating some degree of daytime sleepiness”.
While we agree that eliminating phone use during sleeping hours is the ideal, a reduction would be a first step.

**Discretionary Revisions** 4. The first citation is quite an old one. More up-to-date information is readily available.
We have changed the first citation, as well as made it more specific to the individuals being studied (US teens).

**Discretionary Revisions** 5. A table of ANOVA results would be helpful
We have now provided a table reflecting our final model.
Reviewer 3:
My main comment is that the authors did not define their research question well, which made it difficult for me to assess whether this was answered sufficiently and/or appropriately. In particular, I felt the discussion was - for the most part - a missed opportunity to place the findings in context, discuss the strengths and limitations of the study design, and explore the implications for practice.

We have made several revisions in response to this and the other reviewers to better define the research question in the Introduction. We have also expanded the discussion to reflect the limitations of the study design and point to future research directions. Given the limitations of our analysis, we didn’t want to make too strong a recommendation about phone use.

Major compulsory revisions 1. Title. I think the title is misleading as it implies causality: “....mobile phone use and its effects on daytime sleepiness”. Causality cannot be inferred from your cross-sectional design, so please consider changing this. For example “A retrospective survey study of the association between mobile phone use and daytime sleepiness in California high school students”.

We have changed the title to: “A survey study of the association between mobile phone use and daytime sleepiness in California high school students”.

Major compulsory revisions 2. Abstract. In your abstract, the stated aim of the study is to examine “mobile phone use at night and the lack of sleep in teenagers”. For two reasons, I think this misrepresents what you actually did. Firstly, of the eight questions asked about mobile phone use, only two referred specifically to mobile phone use at night. The rest asked about total daily volume of mobile use, and perceptions of mobile phone use. Secondly, your scale assessed subjective sleepiness – I don’t know if this is exactly the same thing as “lack of sleep”.

We have edited the Abstract to more explicitly state our a priori hypothesis about nocturnal phone use and its association with daytime sleepiness.

Major compulsory revisions 3. Background. Para 2. Here, it seems you are making the point that sleepiness is a normal part of going through puberty, due to changes in circadian rhythms not accommodated by the school schedule. This may then be compounded by mobile phone use. However, in the abstract you make the point that sleep time is declining in teenagers. This seems to represent two slightly different points – that sleep time is low in teenagers, and that sleep time is declining over time in teenagers. Can the authors provide some clarity?

We have edited the Abstract to clarify the point that it is the amount of sleep obtained, not needed, that is declining.

Major compulsory revisions 4. Background. I did not get a good sense of why sleepiness is an important measured a range of variables on mobile phone use (total daily volume, perceptions etc), did you have a hypothesis about anything else other than mobile phone use at night?

Given the limited amount of published data on this topic, we wanted to be broader rather than narrower in our assessment of mobile phone use and not to approach the question with too many a priori hypotheses. We limited ourselves to the questions designed by Thomée to allow a degree of comparability with an already published work in the area.

Major compulsory revisions 13. Discussion. Para 1. “It may be that adolescent females score higher on the ESS without being objectively sleepier, though this remains to be tested”. I wasn’t sure about the value of this discussion point. It suggests that the ESS has inherent flaws in its construct validity, in which case I would question the validity of the entire study. I’m also not sure how you would measure sleepiness objectively.

The ESS measures subjective sleepiness. Objective sleepiness can be measured in a variety of ways that include both behavioral performance testing (e.g., Psychomotor Vigilance Test), electroencephalographic measures (e.g., slow wave power), and other physiologic measures (e.g., percent of time with eye lid closure). Dichotomies between subjective and objective measures of both sleep and sleepiness have been reported in a variety of circumstances. There is no specific data to indicate that this is one such circumstance, but we felt that it was important to raise the point.
**Discretionary revisions** 1. Background. Para 1. Given that you conducted the study in the US, do you have any mobile phone ownership statistics for adolescents, similar to what you presented for the UK? We have changed this part of the Background to reflect statistics for the US.

**Discretionary revisions** 2. Methods. Para 1. The ESS question “in a car for an hour without a break” – I was not clear whether this referred to driving the car, or travelling as a passenger. This was a mistaken omission on our part. The correct text has been added (“as a passenger in a car…”)

**Discretionary revisions** 3. Results. Para 1. “The number of mobile phone calls sent or received per day”. Suggest changing to “the number of mobile phone calls made or received per day”. This has been changed.