

PEER REVIEW HISTORY

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ARTICLE DETAILS

TITLE (PROVISIONAL)	Sleep and Use of Electronic Devices in Adolescence: Results from a Large Population-Based Study
AUTHORS	Hysing, Mari; Pallesen, Staale; Stormark, Kjell Morten; Jakobsen, Reidar; Lundervold, Astri; Sivertsen, Børge

VERSION 1 - REVIEW

REVIEWER	Steven J. Linton CHAMP, Örebro University Sweden
REVIEW RETURNED	07-Nov-2014

GENERAL COMMENTS	<p>This paper reports the results from a substantial cross-sectional survey of 17 year olds concerning their habit with various digital/screen apparatus and their sleep. Given the dramatic development of digital devises, and earlier reports on the effects of certain devices like television, this paper is quite timely and relevant. The findings are also consistent with those hypothesized as well as with dose-response relationships. Moreover, the findings have relevance for prevention since they suggest a route for intervening. Nevertheless, there are also some issues of concern.</p> <p>First, I found the description of the method and procedure to be lacking in clarity and important details. The design, for example, should be stated clearly; as is, the design cross-sectional nature of the design is first addressed in the discussion. The items used to assess both the independent and dependent variables was not clear stated. To illustrate, the reader does not know what the question(s) was/were for assessing the use of devises, nor does the reader know what the time frame for the ratings were. This is important since it could be for a shorter or longer period ranging from a day or two to several weeks or months. Further, we do not know how the ratings distinguished between "daytime use" (which also seems to be during evenings since the only restriction (p5 line6-8) seems to be outside of school hours) and "at bedtime". Wouldn't the daytime item overlap with the evening one? Further, no reason is given for not including school hours. If the idea is that total screen time is important, even use during school would be of interest? It is assumed that ratings are made electronically, but again this is not clearly spelled-out. Finally, the time point and method for rating sleep is not provided but is of interest.</p> <p>Second, I believe the introduction would be strengthened by including a short section that would make the inherent assumptions about the direction and mechanisms more transparent. While some pathways are mentioned in the discussion, no model or framework is provided for why one might suspect that these devises impact on</p>
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	<p>sleep.</p> <p>Third, this study utilizes a cross-sectional design that innately limits conclusions, especially concerning causality. I believe the paper would be strengthened if this were addressed up-front. I find the paper to have value since it is a new research area where establishing the cross-sectional relationship is vital in order to guide longitudinal research. It would be refreshing to read this early on.</p> <p>Fourth, I wonder why results are not calculated for total screen time/device use? The figures illustrate nicely the relationships described. However, the actual number of hours is only reported in the figures. Adding these together would give an interesting sum of the time spent using such devices. Further, calculating the effects on sleep, using total time would be of interest since the exact device used varies and new forms are continually being marketed. This would add to the value of the study.</p> <p>Finally, the total sleep time and the total time using devices raises a methodological question of importance; namely, how youngsters make the ratings. Is it really so that youngsters use devices for more than 6 hours outside of school hours and not including the hour before bed (as figure 2 would suggest)? Or, could it be that they multitask and “use” them while doing other things? Do they “monitor” devices like telephones, but are engaging in other activities at the same time. Also, is it realistic to believe that these youngsters sleep so little as 6:30 (figure 4, no screen use)? This is much less than in other reports.</p> <p>Taken together, this is an interesting study that shows clear results that are of theoretical and clinical significance. It also raises important issues for future research.</p>
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REVIEWER	Sarah Blunden Central Queensland University, Australia
REVIEW RETURNED	10-Nov-2014

GENERAL COMMENTS	<p>Large sample size, cross sectional , comprehensive.</p> <p>LIMITATIONS self report, particularly sleep need calculation. On what was this based? Do the authors think that the participants were well informed in relation to how much sleep they needed?</p> <p>SPECIFIC COMMENTS 1. Page 4 line 40 : Sleep variables were checked for validity of answers based on preliminary data analysis, How was this done? 2. Page 4 Instruments. There is no explanation of how this survey was developed or accessed. Need more information here. For those people who did not access it online, what happened? 3. Page 5 Was there consideration of the amount of time participants spent online for their homework? 4. Page 5 Line 32: Was sleep need asked for each individual or were they</p>
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	<p>asked how much sleep adolescents should get? This is unclear....</p> <p>5. Page 6 What is the difference between Figure 1 and 3 ...what exactly was the question asked? Are they both necessary?</p> <p>DISCUSSION</p> <p>1. More conversation around the 8-9 hours baseline used as a reference category .given that these Students were at a low baseline [to start with. More conversation</p> <p>2. Given the scope of the public health issue identified by the authors...what do the authors suggest might be done? Technology is not going to go away. What ideas do they have apart from using technology as an educator? .</p>
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VERSION 1 – AUTHOR RESPONSE

Reviewer #1

This paper reports the results from a substantial cross-sectional survey of 17 year olds concerning their habit with various digital/screen apparatus and their sleep. Given the dramatic development of digital devices, and earlier reports on the effects of certain devices like television, this paper is quite timely and relevant. The findings are also consistent with those hypothesized as well as with dose-response relationships. Moreover, the findings have relevance for prevention since they suggest a route for intervening. Nevertheless, there are also some issues of concern.

1. First, I found the description of the method and procedure to be lacking in clarity and important details. The design, for example, should be stated clearly; as is, the design cross-sectional nature of the design is first addressed in the discussion.

Response: The study's cross-sectional nature is now stated both in the abstract, introduction, as well as in the methods.

2. The items used to assess both the independent and dependent variables was not clear stated. To illustrate, the reader does not know what the question(s) was/were for assessing the use of devises, nor does the reader know what the time frame for the ratings were. This is important since it could be for a shorter or longer period ranging from a day or two to several weeks or months.

Response: We agree that this information was lacking, and we have therefore added the following sentences to this section:

"The phrasing of the question was: "How many of the listed electronic devices do you use in your bedroom the last hour before going to bed?"

... and...

"No time-frame was available for the ratings."

3. Further, we do not know how the ratings distinguished between "daytime use" (which also seems to be during evenings since the only restriction (p5 line6-8) seems to be outside of school hours) and "at bedtime". Wouldn't the daytime item overlap with the evening one? Further, no reason is given for not including school hours. If the idea is that total screen time is important, even use during school would be of interest? It is assumed that ratings are made electronically, but again this is not clearly spelled-out. Finally, the time point and method for rating sleep is not provided but is of interest.

Response: We agree that the phrasing of the items assessing daytime and bedtime does not rule out

the possibility of some overlap. We have now acknowledged this in the Discussion by adding the following sentence:

“Second, the phrasing of the questions assessing daytime and bedtime use of electronic devices does not rule out some overlap between the two items. For example, when adolescents report a total screen time use of 6+ hours, it is not unlikely that some adolescents include the last hour before going to bed.”

We have now made it more clearly in the Methods sections that the questionnaire was web-based, and we have also added information concerning the time-frame of the sleep variables, and that it was their “typical” bedtime, rise time etc. that we assessed.

4. Second, I believe the introduction would be strengthened by including a short section that would make the inherent assumptions about the direction and mechanisms more transparent. While some pathways are mentioned in the discussion, no model or framework is provided for why one might suspect that these devices impact on sleep.

Response: We agree with this comment, and have now added the following paragraphs on potential mechanisms in the sleep-media use association.

“The mechanisms behind the relationships between use of electronic media devices and sleep problems are not well established, but a theoretical model of the relationship has been proposed [12], suggesting several possible mechanisms. According to this model, media use may directly affect sleep by replacing it due to its time consuming nature, or it may interfere with sleep through increased psychophysiological arousal caused by the stimulating content of the material, or alternatively through bright light exposure inherent in most electronic media devices [12]. Bright light may impact sleep in two ways; by delaying the circadian rhythm when exposure takes place in the evening [14] and also by causing an immediate activation in itself [11, 15]. According to the aforementioned model sleep may also be negatively impacted by electromagnetic radiation [12]. Another proposed mechanism by which electronic media may impair sleep relates to physical discomfort, such as muscular pain and headache which can be caused by prolonged media use (e.g., computer games) [16]. Furthermore, repeated use of electronic media in the bed or in the bedroom can reduce the sleep inducing properties of the two latter, as the bed and bedroom become associated with electronic media use [17].”

5. Third, this study utilizes a cross-sectional design that innately limits conclusions, especially concerning causality. I believe the paper would be strengthened if this were addressed up-front. I find the paper to have value since it is a new research area where establishing the cross-sectional relationship is vital in order to guide longitudinal research. It would be refreshing to read this early on.

Response: We agree with this comment, and we now state more clearly that the study was cross-sectional, both in the abstract, introduction as well as methods section.

6. Fourth, I wonder why results are not calculated for total screen time/device use? The figures illustrate nicely the relationships described. However, the actual number of hours is only reported in the figures. Adding these together would give an interesting sum of the time spent using such devices. Further, calculating the effects on sleep, using total time would be of interest since the exact device used varies and new forms are continually being marketed. This would add to the value of the study.

Response: We agree with this suggestion, and we have now added the total number of hours of screen use across all devices. This is now illustrated in the updated Figure 2. The effects on sleep, using total screen time is presented in Table 2 and Table 3.

7. Finally, the total sleep time and the total time using devices raise a methodological question of importance; namely, how youngsters make the ratings. Is it really so that youngsters use devices for more than 6 hours outside of school hours and not including the hour before bed (as figure 2 would suggest)? Or, could it be that they multitask and “use” them while doing other things? Do they “monitor” devices like telephones, but are engaging in other activities at the same time. Also, is it realistic to believe that these youngsters sleep so little as 6:30 (figure 4, no screen use)? This is much less than in other reports.

Response: We agree with this comment, and as mentioned above, we now acknowledged this issue in the Discussion, adding the sentence:

“Second, the phrasing of the questions assessing daytime and bedtime use of electronic devices does not rule out some overlap between the two items. For example, when adolescents report a total screen time use of 6+ hours, it is not unlikely that some of them include the last hour before going to bed. In addition it cannot be ruled out that some adolescents multitask and use electronic media in parallel with other activities.”

In relation to the average sleep duration of 6.5 hours, we agree that this is less than what has previously been reported, but we still consider our data to be quite accurate, as most comparable studies finding longer sleep durations in this age cohort have employed more crude measures, and not included well-defined operationalizations of e.g. SOL and WASO. Also, there is data suggesting a negative trend in terms of adolescent sleep (see Pallesen, Hetland, Sivertsen, Samdal, Torsheim & Nordhus. Time trends in sleep-onset difficulties among Norwegian adolescents 1983-2005. *Scand J Public Health* 2008; 36:889-895).

Taken together, this is an interesting study that shows clear results that are of theoretical and clinical significance. It also raises important issues for future research.

Response: We appreciate this comment!

Reviewer #2

Limitations

- Self report, particularly sleep need calculation. On what was this based? Do the authors think that the participants were well informed in relation to how much sleep they needed?

Response: Our assessment of “subjective sleep need” is now described in more details, emphasizing that it was each individual’s own perceived sleep need we were interested in, not adolescents in general. In now reads:

“Subjective sleep need (each individual’s own perceived sleep need) was reported in hours and minutes on a scroll down menu with five minutes intervals, and the phrasing of the question was “How much sleep do you need to feel rested?”

It can be argued that not all know their exact sleep need, however personalizing sleep need as done in the present study seems like a far better approach than using norms or habitual sleep time (see Carskadon. Measuring sleep need. *Sleep Med Rev* 2014; 18:369-370) when estimating sleep need.

Specific comments:

1. Page 4 line 40: Sleep variables were checked for validity of answers based on preliminary data analysis, how was this done?

Response: We have now added some more information on how this was done:

“Sleep variables were checked for validity of answers, resulting in data from 374 subjects being excluded due to obvious invalid responses. For example, when calculating sleep duration and sleep efficiency, individuals with negative values on these computed variables were excluded from further the analyses.”

2. Page 4: Instruments. There is no explanation of how this survey was developed or accessed. Need more information here. For those people who did not access it online, what happened?

Response: We agree that this section was somewhat briefly covered, and the following paragraph has been added to better describe how the study was carried out:

“The questionnaire was web-based, and a teacher was present to organize the data collection and to ensure confidentiality. Survey staff was available on a phone number for both the adolescents and school personnel for answering queries. Those not in school received information and the questionnaire package by postal mail to their home addresses, and were also provided with a prepaid envelope for returning of the questionnaires.”

3. Page 5: Was there consideration of the amount of time participants spent online for their homework?

Response: Unfortunately, we had no information on the purpose of the screen time use, and as such we were not able to look at homework versus other use. This limitation has now been added to the Discussion:

“Along the same lines, we had no information on the purpose of the screen time use, and as such we were not able to single out school-related work”

4. Page 5: Line 32: Was sleep need asked for each individual or were they asked how much sleep adolescents should get? This is unclear....

Response: As also mentioned above, each adolescent were asked how much he/she needed, not how much adolescents in general need. This has been clarified in the Methods section by adding the following sentence:

“Subjective sleep need (each individual’s own perceived sleep need) was reported in hours and minutes on a scroll down menu with five minutes intervals, and the phrasing of the question was ‘How much sleep do you need to feel rested?’”

5. Page 6: What is the difference between Figure 1 and 3 ...what exactly was the question asked? Are they both necessary?

Response: We agree that Figure 1 and Figure 3 were quite similar, and we have therefore decided to remove Figure 3, as it did not convey very different information than already shown in Figure 1.

Discussion

1. More conversation around the 8-9 hours baseline used as a reference category given that these students were at a low baseline to start with.

Response: The following paragraph has been added to the Discussion to address this issue:
“In the current study, a sleep duration of 8-9 hours was chosen as the reference category for all regression analyses, as this was the average sleep need reported by the adolescents [4], and also because this corresponds well with experts’ recommended sleep need in this age group [25]”

2. Given the scope of the public health issue identified by the authors...what do the authors suggest might be done? Technology is not going to go away. What ideas do they have apart from using technology as an educator?

Response: We have now expanded the final section of the paper, in which clinical implications and public health issues are discussed. This section now reads:
“Parallel with the rapid change in technology, the recommendations for healthy media use given to parents and adolescence also need updating, and age-specific guidelines regarding the quantity and timing of electronic media use should be developed and made known to the public [12]. The current recommendation is not to have a TV in the bedroom, in accordance with the research status. It seems, however, that there may be other electronic devices exerting the same negative influence on sleep, such as PCs and mobile phones. The results confirm recommendations for restricting media use in general. The combination of secular trends to impaired sleep (see[3] and the established relationship to health and school achievement [35] underscore the importance of prevention. The scope of the problem suggests that this is a public health issue and that primary prevention may be needed. Parent-set bedtimes have been shown to be related to good sleep hygiene in adolescents [36] and an increased parental involvement in technology use could be a recommendation based on the findings, but this needs further evidence. While technology use may be a source of sleep deficiency, this may also serve as a medium of intervention, as internet-based interventions have proven to be effective and cost-efficient modes of treating sleep problems [37].