**Objective and subjective measures of smartphones use at night, in sleep quality and emotional measures among healthy students: A pilot study**

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**Abstract**

*Objective*: To examine the differences between objective and subjective measures of smartphones use at night as predictors of mental well-being measured by sleep quality, anxiety, depression and fomo.

*Methods*: 40 college students downloaded a free application to their private smartphone that monitors their use of the device during 4 nights, and feel sleep diary every morning. After four nights, they completed online questionnaires: Fear of Missing Out Scale (FoMOs), Trait Anxiety Inventory (STAI-T), Pittsburgh Sleep Quality Index (PSQI), Beck Depression Inventory (BDI-II) demographic questionnaire.

 *Results*: The findings from the objective measurement show that among healthy students, 40% actually wake up during the night and check the smartphone. However, subjective measurement shows that this behavior is overestimated (70% claimed to wake up at night to check the smartphone). In addition, an objective measurement of the smartphone check during the night is a tool to identify those who are characterized by low mental well-being measured by: sleep quality, anxiety and Fomo.

*Conclusions*: this pilot study demonstrated differences between objective and subjective measures of smartphones use at night in sleep quality and emotional measures in healthy students. This objective behavioral measurement made it possible to identify subjects at high risk in terms of mental well-being.

Keywords: Smartphone use, fear of missing out (FOMO), trait anxiety, sleep quality

1. Introduction

The use of smartphones all day long has become dominant in individual life (Samaha & Hawi, 2016), because of its availability and mobility anywhere and at any time, it enables the use of various applications that require different levels of activity. These features made the smartphone an integral part of the individual's daily functioning, to the point of creating a merger between the individual and the device (Lepp, Li, Barkley, & Salehi-Esfahani, 2015).

Research on the effects of using a smartphone on sleep reported differentiate between high / low smartphone users in sleep disturbance and daytime dysfunction (Demirci et al., 2015) and in sleep onset latency and bedtime (Scott & Woods, 2018). It is also found that these distinctions related to different emotional states such as anxiety (Rosen, Carrier, Miller, Rokkum, Ruiz, 2015), depression (Demirci et al., 2015) and fomo (Scott & Woods, 2018; Vorderer, Krömer, & Schneider, 2016). All are indicators of mental well-being.

These researches examined the use of smartphones during the daytime, before sleep onset and during sleep latency, but did not examine the use of smartphones during night sleep after sleep onset. In addition, these findings were based on subjective reports of the extent to which a smartphone was used. This subjective report may be inaccurate for various reasons.

The current pilot study addresses this difficulty by an objective examination of the smartphones use at night among students, and an examination the differences between objective and subjective measures of smartphones use at night as predictors of mental well-being measured by: sleep quality, anxiety, depression and Fomo.

2. Methods

2.1. Participants and procedures

 Forty college students from Israel (aged 19-30 years; Mage = 23, SDage = 2.4) participated in the study, participants recruited through social networks and on campus. Participants downloaded a free application to their private smartphone that monitors their use of the device during 4 nights, and feel sleep diary every morning. After four nights they completed online questionnaires.

The study was approved by the Academic college's Committee of Ethics. All subjects agreed to participate in the study after they were fully informed about the nature of the study, and signed on informed consent form.

2.2. Tools

2.2.1 Subjective Sleep measures:

*The Pittsburgh Sleep Quality Index (PSQI*; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) assessed self-reported sleep quality (eg, sleep duration, onset latency) over the past month. The global score served as the outcome of interest, with higher scores indicating poorer sleep quality.

2.2.2 Emotional measures:

*The Fear of Missing Out Scale* (FoMOs; Przybylski et al., 2013) comprises 10 items presented on a 5-point Likert-type scale, ranging from 1 (*not at all true of me*) to 5 (*extremely true of me*). Item scores were averaged to give an overall score of 1–5 (Cronbach’s alpha = .85).

*The State-Trait Anxiety Inventory* (STAI; Spielberger, 1983): contains 20item. Each item is scored from 1 to 4 points, with potential scores for the STAI-T ranging from 20 to 80 (Cronbach’s alpha = .93).

*The Beck Depression Inventory* (BDI-II: Beck & Steer, 1987) contains 21 items. Participants asked to select among groups of four statements regarding the intensity of various depression symptoms in the last 2 weeks. The total score ranges from 0 to 63 with higher scores suggesting greater symptomology (Cronbach’s alpha = .90).

2.2.3 Objective and Subjective Smartphone use:

*Objective smartphone use during the night:* Subjects downloaded a free application that monitors the activity on the smartphone and converts the results into an Excel spreadsheet. The information included: the type of application used, the time spent in the application and the time of the day. In order to obtain reliable information, data collected for four nights and examined whether during night sleep the participant entered one of the various applications (WhatsApp, Facebook, Instagram, YouTube, News and Sports sites). Subjects divided into two groups: Check/check NOT the device during the night after sleep onset.

 *Subjective smartphone use during the night: measured by the question*: How often do you check your smartphone during the night? Scored from 1 (Never) to 5 (Always). Subjects divided into two groups: Check/check NOT the device during the night.

 *Sleep diary*: Each subject kept a log of bedtimes, wake-up times and special events during the day.

2.3. Statistical analyses:

The relationship between the objective and the subjective measures of smartphone use during the night examined using χ² test. Differences in sleep quality and emotional measures were examined using Two-way MANOVA with objective (Check, check NOT) and subjective (Check, check NOT) measure of smartphone use during the night as independent measures. When appropriate, MANOVA was followed by ANOVA on specific factors of differentiation of the dependent variable.

3. Results

Measuring the objective use of a smartphone showed that 40% (16) checked the smartphone during the night at list one time over four nights, and 60% (24) did not check at all. Measuring the subjective use of a smartphone showed 70% (28) reported checking the smartphone during the night, and 30% (12) reported not checking.

To examine the relationship between the objective and the subjective measures of smartphone use during the night, a χ² test was performed. A significant association (rp=0.53) was found between variables [χ² (1)=11.42, p<0.01]. All the subjects found "checking the smartphone during the night" in objective measurement also reported, "checking the smartphone during the night" in the subjective measurement. However, among those found "not checking the smartphone during the night" in objective measurement, 50% (12) reported that they "check the smartphone during the night" in the subjective measurement.

3.1. The differences between objective and subjective check / check not smartphones use at night in sleep quality and emotional measures.

Table 1. Means (SD) for smartphone use during the night on sleep quality and emotional measures (Trait Anxiety, Depression and Fomo), comparison between groups.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | *Objective* |  |  | *subjective* |  |
|  | *Check (N=16)* | *check NOT (N=24)* | *F* | *Check (N=28)* | *check NOT (N=12)* | *F* |
| Sleep Quality |  |  |  |  |  |  |
| PSQI | 8.06 (1.58) | 6.58 (1.58) | 8.71*\*\** | 7.17 (2.33) | 7.25 (1.28) | 2.94 |
| Emotional measures |  |  |  |  |  |  |
| Trait Anxiety  | 45.68 (8.35) | 36.50 (11.47) | 6.96\*\* | 41.17 (10.53) | 37.83 (12.76) | 0.39 |
| Depression | 11.75 (8.15) | 6.83 (6.39) |  2.37 | 9.92 (7.86) | 6.16 (5.89) | 0.26 |
| Fomo | 3.01 (0.89) | 2.24 (0.64) | 5.72\*\* | 2.72 (0.89) | 2.16 (0.52) | 0.20 |

*\*\* p < .05*

Two-way MANOVA was conducted with objective measure of smartphone use during the night (Check/ check NOT) and subjective Check/ check NOT as independent variables on the subjective sleep quality (PSQI) and emotional measures (Trait Anxiety, Depression and Fomo). A significant multivariate effect for objective measure of smartphone use during the night on the four dependent variables was found [Wilk's lambda = .69, *F* (4, 34) = 3.66, *p* < .05; *η2p* = .30]. Each dependent variable was subjected to a further ANOVA. The difference between "Check" and "check NOT" for Sleep Quality (PSQI) was significant [*F* (1, 37) = 8.71, *p* < .01; *η2p* = .19], for Trait Anxiety was significant [*F* (1, 37) = 6.96, *p* < .05; *η2p* = .15], for Fomo was significant [*F* (1, 37) = 5.72, *p* < .05; *η2p* = .13]. However, Depression failed to reach statistical significance [*F* (1, 37) = 2.37, *p* > .N.S]. The differences between the "Check" / "check NOT" in all the dependent variables showed the same pattern. The "Check" group was characterized by poor sleep quality and higher trait anxiety and Fomo (see Table 1).

There was no multivariate effect for subjective measure of smartphone use during the night [Wilk's lambda = .82, F (4, 34) =1.87, p > .N.S]. Furthermore, the interaction between objective and subjective measure of smartphone use during the night was **not** significant [Wilk's lambda = .98, *F* (4, 34) =.00, p > .N.S].

4. Discussion

Findings from this preliminary study show that among healthy student, 40% wake up during the night to check their smartphone. However, a subjective measurement of this behavior shows a more severe outcome, with 70% of respondents reporting that they wake up at night to check their smartphone.

This finding is consistent with the research literature showing a difference between an objective measurement (actigraphy) and a subjective measurement (sleep questionnaires) in measuring sleep quality (Cohen et al., 2018).

This difference between objective and subjective measurement is important because the comparison between the "check" / "check NOT" groups in objective measurement showed a difference between the groups in the indices of mental well-being: sleep quality, anxiety and Fomo. Whereas the comparison between the "check" and the "check NOT" group in subjective measurement showed no difference in the indices of mental well-being.

The preliminary findings may have important implications. An objective measurement of the smartphone checks during the night is a simple and available measurement (free application) that enables the identification those who are at risk, as measured by sleep quality and emotional measures among a healthy student. Thus, the smartphone is not necessarily the problem but also the solution for identifying those who need help (Cornet & Holden, 2018; Min et al., 2014).

These findings must considered along with the limitations of the study. The first limitation is related to the size of the sample. The objective behavior of checking the smartphone during the night should be examined on a larger number of subjects and among different groups, such as adolescents.

In addition, sleep quality data should also be collected in an objective measurement (actigraphy). These objective sleep data may enrich the understanding of the behavior of using the smartphone during the night.

5. Conclusions

To conclude, this pilot study demonstrated differences between objective and subjective measures of smartphones use at night in sleep quality and emotional measures in healthy students. This objective behavioral measurement made it possible to identify subjects at high risk in terms of mental well-being.

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