**Relationship of Smartphone Use at Night to Sleep Quality and psychological Well-Being among Healthy Students: A Pilot Study**

**Abstract**

*Objective*: To examine the differences between objective and subjective measures of smartphones use at night, as predictors of sleep quality and three indicators of psychological well-being: anxiety, depression and Fear of Missing Out (FoMO).

*Methods*: We monitored the smartphone use of 40 college students for four nights. On the fifth morning, they also completed these online questionnaires: FoMOs, STAI-T, PSQI, BDI-II.

 *Results*: Objective measurements show that 40% of the student sample actually woke up during the night and checked their smartphone. However, the subjective measurements showed that they overestimated this behavior. Greater checking of a smartphone during the night is associated with lower sleep quality and higher anxiety, and FoMO.

*Conclusions*: This study demonstrated differences between objective and subjective measures of smartphone use at night. It also showed that an objective measurement of smartphone use could identify subjects at high risk in terms of psychological well-being and sleep quality.

Keywords: Smartphone use, Fear of Missing Out (FoMO), Trait anxiety, Sleep quality

 Introduction

The use of smartphones all day long is a feature of modern life 1 because of their availability and ease of use. Smartphones’ numerous applications have made them an integral part of individuals’ daily functioning (and sometime even during the night), to the point of creating a merger between the individual and the device2.

Research on the effects of smartphone use has reported direct associations between extent of use and sleep disturbance and daytime dysfunction 3, as well as changes in sleep onset latency and bedtimes 4. These changes have been shown to be related to different emotional states such as anxiety5, depression3, and FoMO (Fear of Missing Out;4 6). All are indicators of psychological well-being 4 7.

To the best of our knowledge, most researchers examined the use of smartphones during the daytime, before sleep onset, and during sleep latency8 9 , but not during night sleep after sleep onset. In addition, their findings were based on subjective reports of smartphone use and thus may be inaccurate10.

Given the lack of studies, the current pilot study addresses these gaps through an objective measurement of smartphone use at night among students, a comparison of objective and subjective measures of that use, and an analysis of the relationship between high smartphone use sleep quality and psychology well-being measured by anxiety, depression and FoMO.

2. Methods

2.1. Participants

Forty female college students from Israel (aged 19–30 years; M = 23, SD = 2.4) were recruited through social networks and on campus to participate. The exclusion criterion was the type of smartphone device they own. Only students with an Android smartphone device participated in the study.

The study was approved by the college’s Committee of Ethics. All participants were fully informed about the nature of the study and signed an informed consent form.

2.2. Procedures

The participants downloaded a free application for Android to their private smartphone that monitored their use of the device during four nights and filled out a sleep diary each morning. On the fifth morning they completed several online questionnaires.

2.3. Tools

2.3.1 Objective and Subjective Smartphone Use

*Objective smartphone use during the night (QualityTime app by Mobidays, Inc):* Subjects downloaded a free application that monitors smartphone activity and converts the results into an Excel spreadsheet regarding the type of application used, the time spent checking it, and the time of night. Subjects were divided into two groups based on whether they checked the device during the night after sleep onset (Check / check NOT). In order to check the reliability of the data from the application, pilot tests were performed.

 *Subjective smartphone use during the night:* This was measured by the question: "How often do you check your smartphone during the night"? We scored the answer on a scale from 1 (never) to 5 (always) and divided the subjects into two groups based on whether they turned on the device after sleep onset (Check, check NOT).

2.3.2 Subjective Sleep Measures

 *The Pittsburgh Sleep Quality Index* (PSQI; 11) assessed self-reported sleep quality (e.g., sleep duration, onset latency) over the past month. The global score served as the outcome of interest, with higher scores indicating poorer sleep quality.

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

2.3.3 Emotional Measures

The *Fear of Missing Out Scale* (FoMO;12 ) 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 = 0.85).

The *State-Trait Anxiety Inventory* (STAI; 13) contains 20 items, each scored from 1–4, with potential scores ranging from 20–80 (Cronbach’s alpha = 0.93).

The *Beck Depression Inventory* (BDI-II: 14) contains 21 items. Participants were asked to select among groups of four statements regarding the intensity of various depression symptoms in the last two weeks. The total score ranges from 0–63, with higher scores suggesting greater symptomatology (Cronbach’s alpha = 0.90).

2.4. Statistical Analyses

We analyzed the relationship between objective and subjective measures of smartphone use during the night using the χ² test, Pearson’s correlations between study dependent variables, and differences in sleep quality and emotional measures using a two-way MANOVA with objective and subjective measures of smartphone use during the night as independent measures. We followed the MANOVA with ANOVAs to further assess impact on the dependent variables.

3. Results

3.1. Differences between Objective and Subjective Use of Night-Time Smartphone Use:

According to the application, 40% (16 participants) checked their smartphone during the night at least one time over the four nights, and 60% (24 participants) did not check it at all. In contrast, subjectively, 70% (28) reported checking the smartphone during the night, and 30% (12) reported not checking it.

We did an χ² test to analyze the relationship between objective and subjective measures of smartphone use at night and found a significant association (*rp*=0.53) between variables [χ² (1)=11.42, *p*<0.01]. All the subjects who checked their smartphone during the night also reported doing so. However, of those who did not check it at night, 50% (12) reported that they did so.

3.2. Differences between the Impact of Objective and Subjective Smartphone Night-Time on Sleep Quality and Psychological Well-Being:

Pearson's correlations between the dependent variables presented significant positive correlations. A two-way MANOVA was conducted with objective and subjective measures of smartphone use during the night (Check/ check NOT) as independent variables and subjective sleep quality (global score PSQI) and psychological measures (Trait Anxiety, Depression and FoMO; see Table 1) as dependent variables. We found a significant multivariate effect for objective measure of smartphone use during the night on the four dependent variables [Wilk's lambda = .69, *F* (4, 34) = 3.66, *p* < .05; *η2p* = .30]. Each dependent variable was then subjected to an ANOVA. The difference between "Check" and "check NOT" was significant for sleep quality: PSQI: *F* (1, 37) = 8.71, *p* < .01; *η2p* = .19; trait anxiety: *F* (1, 37) = 6.96, *p* < .05; *η2p* = .15]; and higher global score of FoMO: *F* (1, 37) = 5.72, *p* < .05; *η2p* = .13]. However, the difference for depression failed to reach statistical significance: *F* (1, 37) = 2.37, *p* > N.S. Thus, the "Check" group was characterized by poor sleep quality, higher trait anxiety, and FoMO.

There was no multivariate effect for the 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 measures of smartphone use during the night was not significant [Wilk’s lambda = .98, *F* (4, 34) =.00, *p* > .N.S].

Table 1. about here

4. Discussion

This pilot study found that, among healthy students, 40% woke up during the night to check their smartphone. However, 70% of respondents reported that they did so, but only 50% of them actually check. This finding is consistent with the literature showing a difference between an objective measurement (actigraphy) and a subjective measurement (a sleep questionnaire) in measuring sleep quality. In the subjective measurement, participants report poorer sleep quality than actually measured in the objective measurement15. This discrepancy related to findings from the field of social psychology that show a discrepancy between subjective attitudes and actual behavior. These studies show that subjective attitudes are a weak and invalid predictor of behavior16.

This difference is important because we found that the check/ check NOT groups, according to the objective measurement of smartphone use, differed significantly in sleep quality and two indices of psychological well-being: anxiety and FoMO. In contrast, the two groups, divided according to their reported use of smartphones, showed no difference in those indices of well-being.

These differences can be an explanation for the weak association between smartphone use and outcome measures3 4 7 5. The current results showed that the subjective report of smartphone use, contains those participants who actually do this (and with whom the outcome variables are significantly associated) and those who check NOT. The objective measurement allows better monitoring of those at risk in terms of outcome measures.

These preliminary findings may have important implications. Measurement of smartphone use during the night is possible through a widely available, simple, and free application that enables the identification of those healthy individuals who are at risk for poor sleep quality and lower psychological well-being. Thus, the smartphone is not only the problem for wake-up during the night, however it might be the solution for identifying those who need help17 18.

These findings must be considered along with the study’s limitations. The sample was small and confined to one population. The sample was small and confined to homogeneous population (women, college students, with global PSQI score above 7). In addition, it did not assess sleep quality using an objective measurement (actigraphy). These objective data may enrich our understanding of the impact of smartphone use on sleep quality during the night.

5. Conclusion

This pilot study demonstrated differences between objective and subjective measures of smartphone use at night. The results presented that "actual use", not the subjective reported, that affects sleep quality and emotional measures in healthy students. This objective behavioral measurement made it possible to identify subjects at high risk in terms of sleep quality and psychology well-being.

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