Problematic Smartphone Use, Screen Time and Chronotype Correlations in University Students

Pavle Randjelovic a  Nenad Stojiljkovic a  Niko Radulovic b  Nikola Stojanovic a  Ivan Ilic c

a Department of Physiology, Faculty of Medicine, University of Nis, Niš, Serbia; b Department of Chemistry, Faculty of Science and Mathematics, University of Nis, Niš, Serbia; c Department of Pathology, Faculty of Medicine, University of Nis, Niš, Serbia

Keywords
Students · Chronotype · Screen time · Problematic smartphone use

Abstract
Background: Besides numerous advantages and commodities offered by smartphones, there are obvious unhealthy effects. The global trend of an increase in the frequency of usage of smartphones, that is, prolonged screen time, is closely related to problematic smartphone use. The aim of our study was to measure the level of problematic smartphone use in a student population through the assessment of the smartphone screen time and the determination of the student chronotype, as well as through the correlation between these variables. Methods: The participants were students of medicine of both sexes. Problematic smartphone use was measured by the short version of the Smartphone Addiction Scale. Smartphone screen time was assessed by the free Android application Quality Time. Chronotype was established by the Morningness-Eveningness Questionnaire. Results: Almost one quarter (22.7%) of students involved in our study could be classified as being “smartphone-addicted”. The students with problematic smartphone use more frequently (statistical significance) belonged to the evening chronotype. Those students spent significantly more time on their phones compared to the non-addicted ones. There was no statistically significant difference between the number of male and female students with problematic smartphone use. The best predictors of problematic smartphone use were longer daily smartphone screen time and evening chronotype personality. Conclusions: The results of our study showed that a significant number of students of medicine showed problematic smartphone use. There was a strong correlation between extensive screen time and the level of problematic smartphone use in the studied population.

Introduction
In 1997, the term smartphone was introduced by the manufacturer Ericsson to point out the advanced features of a new generation of mobile phones [1]. Ever since, the smartphones are becoming irreplaceable in an everyday life and are offering a wide spectrum of applications for news, entertainment, communications, and education. Smartphones have touchscreens, Internet connection, possibility to add new applications, and other interesting functions such as a digital camera, GPS navigation, and a
music player. Besides numerous advantages and commodities offered by smartphones, there are obvious unhealthy effects related to their usage. Some examples of such unwanted effects are neck pain syndrome [2] or traffic accidents [3]. Recent studies showed that increased screen time is connected to the sleep disturbances and depression [4]. Also, the global trend of the rise in the frequency of usage of smartphones, termed as “screen time”, is closely related to problematic smartphone use [5]. Lin et al. [6] showed that problematic smartphone use has similar aspects to substance addiction. The term “smartphone addiction” is not an official disorder and so it is recommended to use the term problematic smartphone use. The usage of the word addiction in the context of mobile phone overuse is also problematic due to stigmatization of users [7].

When we talk about mobile phones, the problematic smartphone use could start when usual behavior, such as owning a mobile phone for communication or security reasons, starts to produce negative consequences and the user becomes increasingly addicted [8]. Owning a mobile phone for primary purposes becomes secondary and the owner starts to use his phone for entertainment reasons solely. Over time, a smartphone user could develop progressively dangerous behavior, such as texting while driving a car, and in the end, the person reaches a point where he cannot control smartphone usage. The addiction process differentiates the need and desire. In other words, a smartphone user starts with the desire to use his phone and ends up feeling the need to use it. This overlapping point is showing the transition from safe behavior, being pleasant with minor unhealthy effects, to addictive behavior, where the urge (physical and/or mental) replaced the desire as a motivation factor. It is believed that this type of problematic smartphone use uses the same neural pathways involved in substance use disorder [9].

The constant use of mobile phone gives rise to the concept of Nomophobia (No-Mobile-Phobia), which is the fear of losing contact with a mobile phone [10]. Griffiths [10] suggests that everything that produces a feeling of excitement can cause an addiction. Having that in mind, the cause of problematic smartphone use could be the fact that the usage of smartphones brings a feeling of excitement. So if a certain type of behavior results in a sense of excitement or helps to reduce negative or unpleasant feelings, then such behavior is intensified and the person continues with it for pleasure or to reduce the unpleasant situation. Problematic smartphone use gives a sense of pleasure to consumers as a result of usage and relieves them from anxiety or stress [11]. Therefore, it could be assumed that this very scenario causes addiction-like processes.

Chronotype refers to the preference for sleep-wake timing: for example, morning types go to bed, get up, and experience peak alertness and performance earlier in the day than do evening types [12]. Individual circadian type can be clustered into 3 categories as “morning type”, “intermediate type”, and “evening type” with the normal distribution around the middle [13].

Aim of the Study
The aim of our study was to measure the level of problematic smartphone use in a student population and the screen time of smartphones and to determine the chronotype of the students. Also, the significance of the correlation between studied variables was assessed.

Material and Methods
The experimental proposal followed the principles suggested in the 2013 Declaration of Helsinki and was approved by the local Ethical Committee. The study was carried out at the Faculty of Medicine, University of Niš (Serbia) during March 2018. The participants were second-year students of medicine, 20–22 years of age, of both sexes. The study was based on simple random sampling. The involvement in the study was strictly on a voluntary basis and anonymous. Before the commencement of the study, all participants were informed about the study design. All enrolled students signed an informed consent document. The students could drop out of the study at any moment without any consequence to them. The inclusion criteria were having and using an Android-based mobile phone. The exclusion criteria were usage of sedative medications or psychoactive substances, the existence of recent stressful situations, and other sleep-interfering reasons. Primary outcomes of the study were the problematic smartphone use level, smartphone screen time, screen unlock number, and chronotype score.

Problematic smartphone use was measured by the short version of the Smartphone Addiction Scale (SAS-SV) [14]. This assessment tool was created in South Korea and published in the English language in 2013. It has 10 questions with answers on a scale from 1 (completely agree) to 6 (completely disagree). The total score could range from 10 to 60, with higher values indicating higher addiction from a smartphone. The questionnaire showed good validity and internal consistency (Cronbach’s alpha 0.91). The authors of SAS-SV proposed cutoff values for the prediction of problematic smartphone use as 31 for males and 33 for females.

Problematic smartphone use level, smartphone screen time, screen unlock number, and chronotype score.

Smartphone screen time and screen unlock number were assessed by the free Android application Quality Time [15]. The data were collected for 14 consecutive days, and the average for 14 days was calculated for each participant and those values were used for further analysis.

Chronotype was assessed by the Morningness-Eveningness Questionnaire (MEQ) [16], a self-rating questionnaire that consists of 19 items with a total score ranging from 16 to 86. Higher scores indicate greater morningness, while lower scores indicate more evening type.

The average grade was self-reported by study participants.
The body mass index (BMI) was calculated from body weight and height measured by standard equipment by one of the authors.

**Sample Size Calculation**

The sample size was calculated before the beginning of the study by the free software GPower 3.1 [17]. For predetermined values for a two-tailed test, medium effect size (correlation coefficient of 0.3), the statistical significance of 0.05, and the power of study of 0.8, the sample size needed was 82. To compensate for potential dropouts, we increased sample size by 10%, giving the total number of participants. Only the results for those participants who completed the study were analyzed. The number of participants who finished the study was 77. The achieved power of the study at the end was 0.78.

**Statistical Analysis**

Statistical analysis was done using the software GraphPad Prism version 6.00 for Windows, GraphPad Software, La Jolla, CA, USA, www.graphpad.com. Normal distribution of continuous data was tested with the D’Agostino-Pearson omnibus K2 test. For normally distributed data, the results were presented as the mean and SD. For nonnormally distributed data, the median was used. The correlation between outcomes was done by Pearson’s correlation coefficient for normally distributed data and by Spearman’s correlation coefficient for other data. The significance of differences between means of groups of participants with and without problematic smartphone use was determined by unpaired t test for normally distributed data, and by Welch’s t test for nonnormally distributed data. The multiple regression was performed by SPSS 21 software (IBM Corp.).

The level of statistical significance was set at 0.05. For interpretation of effect size, the recommendations by Cohen were used (0.1 small, 0.3 medium, and 0.5 large) [18].

**Results**

The average SAS-SV score in our study was 28.16 ± 1.69, ranging from 10 to 53 with a 95% CI from 25.12 to 31.12. We used the recommended cutoff values [13] for classifying students to those with and without problematic smartphone use, 31 points for males and 33 for females. According to SAS-SV test, 22.7% of students in our study population could be classified as subjects with problematic smartphone use.

We compared some parameters of the groups of students with and without problematic smartphone use that could potentially be used as predictors (Table 1). The results presented in Table 1 show differences in average BMI, grade, chronotype score, smartphone screen time, and screen locks between 2 groups of subjects. There was no statistically significant difference in BMI and average grade between students with and without problematic smartphone use. The effect size was very small 0.019 and 0.013, respectively. There was a statistically significant and medium (d = 0.51) difference in chronotype between the 2 groups. The students classified as with problematic smartphone use had significantly lower values for MEQ score, indicating a higher level of evening chronotype. There was statistically significant and large (d = 0.78) difference in smartphone screen time between the 2 groups. Students with problematic smartphone use spend significantly more time on their phones compared to the ones without problematic smartphone use. The students with problematic smartphone use unlocked their phones significantly more often compared to the other group. The observed difference was of high practical significance with a large effect size (d = 0.83).

There was no statistically significant difference between males and females in problematic smartphone use measured by SAS-SV in our study (Table 2). Even though differences were not significant, females showed a higher average problematic smartphone use score compared to males with a moderate effect size (d = 0.39).

| Table 1. Comparison of BMI, average grade, MEQ score, smartphone screen time, and screen locks between smartphone-addicted and non-addicted students |
|-----------------|-----------------|-----------|------|
|                  | Addicted        | Non-addicted | p value | d    |
| BMI              | 21.88±3.22      | 21.94±3.13  | 0.95   | 0.019|
| Average grade    | 8.65±0.88       | 8.64±0.62   | 0.97   | 0.013|
| MEQ score        | 44.05±6.15      | 48.41±10.29 | 0.042  | 0.514|
| Smartphone screen time, min | 301.5±103.4 | 208.7±133.6 | 0.011  | 0.777|
| Screen unlocks, n | 177.2±67.25     | 115.8±79.74 | 0.006  | 0.832|

Values are represented as mean ± SD.
BMI, body mass index; MEQ, Morningness-Eveningness Questionnaire.
The correlation between problematic smartphone use as measured by SAS-SV score and other variables (BMI, average grade, chronotype, smartphone screen time, and screen unlocks) is presented in Table 3. The correlation between problematic smartphone use and BMI was not statistically significant and was very weak (−0.05). Likewise, the correlation between SAS-SV score and the average grade was very weak (0.04) and was not statistically significant. There was a statistically significant (p < 0.05) and moderately negative (−0.35) correlation between SAS-SV and MEQ score. Lower MEQ scores (indicating an evening chronotype personality) were associated with higher SAS-SV scores. The correlation between problematic smartphone use and smartphone screen time was statistically significant (p < 0.05) and strongly positive (0.61). An increase in the time spent on the phone was associated with problematic smartphone use. Even though there was a moderately positive correlation (0.38) of screen unlocks with problematic smartphone use, it was not statistically significant (p = 0.08).

According to the unpaired t tests for differences between the subjects with and without problematic smartphone use, we tested the significantly different variables as potential predictors, in a model of multiple regression. The dependent variable was the SAS-SV score, whereas the independent variables were smartphone screen time and chronotype MEQ score. The multicollinearity of the independent variables was not violated because the variance inflation factors (VIF) were 1.001 and the Tolerance was 0.999. The regression model statistically significantly predicted 51.3% of the variance in problematic smartphone use (R² = 0.513, p < 0.001). The significant predictors of problematic smartphone use were the daily smartphone screen time (p < 0.001) and chronotype score (p = 0.038). Smartphone screen time was a more important predictive factor in this model with the highest beta value of 0.632. The results of this analysis are presented in Table 4.

Since at least 5 of 10 items of the SAS-SV are related to screen time, we analyzed how are these separate items related to smartphone usage. We performed multiple regressions with screen time as dependent variable and 10 items form SAS-SV as independent variables. The results are presented in Table 5. There was no multicollinearity between SAS-SV items because VIF were below 10 for all items and Tolerance was above 0.2 as well. There was no significant correlation between items from SAS-SV. All independent variables (SAS-SV items) were without statistical significance (p > 0.05). Even though

### Table 2. Smartphone addiction score in male and female students

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>p value</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAS-SV score</td>
<td>23.7±10.9</td>
<td>28.09±11.47</td>
<td>0.156</td>
<td>0.392</td>
</tr>
</tbody>
</table>

Values are represented as mean ± SD.

SAS-SV, short version of the Smartphone Addiction Scale.

### Table 3. Correlation between SAS-SV score and BMI, average grade, MEQ score, smartphone screen time, and screen unlocks

<table>
<thead>
<tr>
<th></th>
<th>r</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>−0.05</td>
<td>0.68</td>
</tr>
<tr>
<td>Average grade</td>
<td>0.04</td>
<td>0.76</td>
</tr>
<tr>
<td>MEQ score</td>
<td>−0.35</td>
<td>0.044</td>
</tr>
<tr>
<td>Smartphone screen time</td>
<td>0.61</td>
<td>0.024</td>
</tr>
<tr>
<td>Screen unlocks</td>
<td>0.38</td>
<td>0.08</td>
</tr>
</tbody>
</table>

SAS-SV, short version of the Smartphone Addiction Scale; BMI, body mass index; MEQ, Morningness-Eveningness Questionnaire.

### Table 4. Multiple regression of the predictive factors for smartphone addiction score

<table>
<thead>
<tr>
<th></th>
<th>Standardized β</th>
<th>t</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smartphone screen time, min</td>
<td>0.632</td>
<td>4.342</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Chronotype score</td>
<td>−0.32</td>
<td>−2.2</td>
<td>0.038</td>
</tr>
</tbody>
</table>

### Table 5. Multiple regression between individual SAS-SV items and screen time

<table>
<thead>
<tr>
<th>Item</th>
<th>p value</th>
<th>Tolerance</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1</td>
<td>0.129</td>
<td>0.276</td>
<td>3.62</td>
</tr>
<tr>
<td>Item 2</td>
<td>0.05</td>
<td>0.577</td>
<td>1.735</td>
</tr>
<tr>
<td>Item 3</td>
<td>0.089</td>
<td>0.397</td>
<td>2.516</td>
</tr>
<tr>
<td>Item 4</td>
<td>0.372</td>
<td>0.498</td>
<td>2.007</td>
</tr>
<tr>
<td>Item 5</td>
<td>0.638</td>
<td>0.379</td>
<td>2.64</td>
</tr>
<tr>
<td>Item 6</td>
<td>0.493</td>
<td>0.323</td>
<td>3.093</td>
</tr>
<tr>
<td>Item 7</td>
<td>0.721</td>
<td>0.212</td>
<td>4.709</td>
</tr>
<tr>
<td>Item 8</td>
<td>0.419</td>
<td>0.198</td>
<td>5.040</td>
</tr>
<tr>
<td>Item 9</td>
<td>0.687</td>
<td>0.274</td>
<td>3.653</td>
</tr>
<tr>
<td>Item 10</td>
<td>0.317</td>
<td>0.311</td>
<td>3.219</td>
</tr>
</tbody>
</table>

SAS-SV, short version of the Smartphone Addiction Scale; VIF, variance inflation factor.
the whole model had statistical significance in multiple regression ($p < 0.05$), each individual item did not have such significance.

Discussion

Up to the present day, a couple of studies dealt with the subject of problematic smartphone use worldwide; however, none of them was done in Serbia. This emerging topic was researched in Taiwan [6], Korea [19], India [20], and the USA [21]. Most of these studies were about the development and validation of the instrument for measuring problematic smartphone use. In our study, we arrived at a number of 22.7% of participants that could be classified as problematic smartphone users, based on cutoff values for the used instrument (SAS-SV). These numbers are in concordance with the results from other countries. For example, the percentage of students with problematic smartphone use in Spain was 12.8%, while in Belgium it was 21.5% [22]. The highest rate of students with problematic smartphone use, using the same instrument, was found in China, 29.8% [23]. One could question the validity of used cutoff values for classifying students into being “smartphone addicted”, since the percentage is relatively high (22.7%). The values are adopted from the authors of the SAS-SV instrument based on a Korean sample. Even though several studies used them so far for same purpose and got similar values, these cutoff values should be interpreted with caution. Even the term used by the authors “smartphone addiction” is problematic and it should be changed to “problematic smartphone usage”.

However, there is very little information about the predictors for problematic smartphone use. A Korean study [6] showed that the frequency of phone usage is more strongly correlated with problematic smartphone use than screen time. The same authors showed that screen time measured by a questionnaire and by a phone application was not the same. The subjects reported less time than they actually spend on their phones, where the greatest reporting error was with those having the highest screen time.

Problematic smartphone use could compromise academic performance in a student population. These young people often use their phones during classes or for cheating on exams which interfere with the study process. The negative impact of smartphone usage on academic achievement goes beyond studying and could influence work performance in the job setting. The overuse of smartphones could have an effect on interpersonal relationships between students themselves, between students and professors and parents, as well as between work colleagues. This phone-related problematic behavior could be an indicator of other problems in different spheres of personal functioning. Even though some studies showed a statistically significant small negative correlation between problematic smartphone use and academic performance [24], there was no statistically significant association in our sample. Higher screen time was not related with grades in our study. This result raise question to the practical relevance of the 22% of problematic smartphone users in our study.

There were reports on the phone screen time of around 9 h per day [25]. We found that the average smartphone screen time in our population was around 4 h daily, which is considerably less compared to the results from developed countries; however, it still a significant one. There is a trend in the world of a constant increase in smartphone screen time. We could assume that a similar trend is present in our country as well. The study from South Korea conducted in 2011 showed that the problematic smartphone use was present in 8.4% of the population and was higher than Internet addiction (7.7%) in the same population [26]. The same study showed that there was a higher level of anxiety in those persons with problematic smartphone use compared to those without.

The studies dealing with the relation between smartphone usage and addiction showed contradictory results. Some studies found that the frequency of smartphone use is strongly related to problematic smartphone use [19], while others showed that screen time is a better problematic smartphone use predictor [27]. Such opposite results could be a consequence of subjectivity in data collecting by questionnaires and a tendency to report lower numbers than real ones. In our study, we used an Android application for data collecting about smartphone usage and in this way eliminated possible self-report bias. Our results clearly showed that total screen time was a better and stronger indicator of problematic smartphone use compared to the simple frequency of usage. We should mention that problematic smartphone use has been associated with specific behavioral addictions like gambling. A recent study indicated that gambling apps on smartphone can cause perseverative gambling behavior [28]. However, in our study we did not collect data on the type of activity on smartphones, which is a limitation for inferring results.

At least 5 of 10 items on SAS-SV are related to duration of smartphone use. So the results of SAS-SV could be...
largely influenced by screen time. Therefore, it was not clear if problematic smartphone usage was a result of merely spending too much time using the device or some additional problems were present. To investigate this question, we performed multiple regression analysis between individual items from SAS-SV and screen time. The results showed that although there was strong and significant positive correlation between SAS-SV score and screen time, individual items did not significantly predict the model (Table 5). Because one of the pre-assumptions of multiple regression is no multicollinearity between independent variables, we showed this by calculation Collinearity statistics: Tolerance and VIF. Since all the items have Tolerance values > 0.2 and VIF < 10, we can state that there was no collinearity between individual items from SAS-SV. In other words, each item added value to overall regression model but without individual correlation. We can conclude that problematic overuse of smartphones in our sample was not only due to excessive screen time.

In our study, there was no significant difference in the frequency of problematic smartphone use occurrence between males and females. Up to now, published results related to gender differences in problematic smartphone use are not clear. There were studies where males were significantly more affected than females [29]. There were other studies showing the opposite results, with females being more affected [30]. And, finally, there were studies where results were in agreement with our data, with no statistical differences between the sexes [31]. However, the moderate effect size of the difference in favor of females in our study should be noted. The lack of statistical significance could be interpreted as coming from the small sample size.

Some studies indicate that the evening chronotype is tied to Internet addiction or problematic Internet use [32] and to computer game addiction [33]. Other findings indicate that the morning types are associated with the usage of traditional media, while the evening types showed a significantly stronger preference for and the use of new media [34]. Our results are in accordance with this trend. We found a moderate and statistically significant correlation between problematic smartphone use and the evening chronotype. Also, problematic smartphone users had significantly lower MEQ scores, which mean a greater tendency toward the evening chronotype. Similar results were found in the study of Japanese students, where also weak ($r = -0.16$) statistically significant correlation was found between problematic smartphone use and the evening chronotype [35]. However, it should be mentioned that problematic smartphone use was assessed by a different instrument (Mobile Phone Dependence Questionnaire) in that study. One can speculate about the relation between screen time and chronotype. Since chronotype has a genetic load [36], it is more likely that it will influence screen time and not the other way around. Our study was observational one giving only correlation data. So no causation could be drawn from it.

In our model of multiple regression, the best predictors for problematic smartphone use were shown to be the screen time and the evening chronotype score. Since these parameters are easily measured, one could be conscious about it to prevent and reduce problematic smartphone use. This is especially important for the evening chronotype since, more or less, it cannot be changed, leaving the person the only option to reduce screen time.

Strengths and Limitations of the Study

The main strength would be the objectivity coming from measuring smartphone screen time by a free and readily available Android application. The strength was also a predetermined sample size needed to achieve the desired power of the study. Our study has several limitations. The main one is the very design of the study, being a cross-sectional type. The next limitation is a correlation analysis that does not show causation, but only the strength of association. The following limitation is the usage of the questionnaire for measuring problematic smartphone use due to the nature and limitations of the instrument. Also, our results are not easily generalized because the population only included medical students. There is no information about the type of activities engaged on smartphone. We do not have information is gaming or gambling was present. Thus, it is not possible to infer how problematic in clinically relevant way the current results are. At the end, the relatively small sample size could be treated as a limitation, although it was precalculated and aimed to find a medium effect size.

Conclusion

The results of our study showed that among medical students there was a significant number of those with problematic smartphone use. There was a strong correlation between screen time and the level of problematic smartphone use in our population. The best predictors of problematic smartphone use in our study were screen time and evening chronotype. Having in mind that there is a trend of increase in smartphone screen
time and unhealthy consequences coming from that, more attention should be directed to this growing problem among students.

Acknowledgement
The authors want to thank all study participants for taking part in this study on volunteer basis.

Statement of Ethics
Subjects have given their written informed consent. The study protocol has been approved by the research institute’s committee on human research. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 2013 Helsinki declaration.

Disclosure Statement
The authors have no conflicts of interest to declare.

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