Effects of smartphone overuse on headache, sleep and quality of life in migraine patients

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ABSTRACT

Objectives: To investigate the effects of smartphone overuse on headache, sleep quality, daytime sleepiness and quality of life in migraine patients.

Methods: This study is a single-center, cross sectional comparative study. This study was conducted between July and September 2017 in the Neurology Clinic of a private hospital. Migraine disability assessment (MIDAS) questionnaire was used to evaluate the disability status, and Mobile Phone Problematic Use Scale (MPPUS) was used to evaluate smartphone use frequency. The Visual Analogue Scale (VAS), 24-h Migraine Quality of Life Questionnaire (24-h MQoLQ), Pittsburgh Sleep Quality Index (PSQI) and Epworth Sleepiness Scale (ESS) were used to evaluate the pain intensity, quality of life, sleep quality and daytime sleepiness, respectively.

Results: The study included a total of 123 patients. There was a significant difference between the groups in terms of pain intensity, frequency and duration as well as VAS, PSQI, 24-h MQoLQ and ESS (p<0.05) scores. There was a negative correlation between MPPUS and PSQI (r=−0.367, p<0.05); a strong positive correlation between MPPUS and ESS (r=0.675, p<0.05) and a negative correlation between MPPUS and 24-h MQoLQ (r=−0.508, p<0.05).

Conclusion: Smartphone use has been observed to increase headache duration and frequency in migraine patients. Its overuse in migraine patients is related to poor sleep quality and daytime sleepiness; furthermore, as the smartphone use increases, sleep quality decreases, daytime sleepiness increases and quality of life decreases.
The use of smartphones in daily life has increased because it is an easily accessible communication tool that people can keep with them at all times and places. Increased use of smartphones, one of the new media technologies, has increased their effect on the daily lives of people.1 Today, smartphones have become an important part of the daily lives of people because many activities such as connecting to other people, calling family and friends and connecting to the Internet are carried out via smartphones.2 With this increasing interest, it has become important to study the effects of smartphones on human health.

Some users experience issues such as headache, sleep disorders, forgetfulness, dizziness, and burning sensation in the head and ear during or after mobile phone use.3,4 It has been stated that the main cause of these issues is mobile phone usage.5 The clinical characteristics of headache related to smartphone overuse have been reported in the literature.6,7 Additionally, smartphone overuse can cause physical, mental and behavioural health problems such as addiction, forgetfulness, blurred vision and pain in the hands and neck.8

Migraine is a type of chronic headache, and the frequency of migraine episodes gradually decreases with age.9 According to Global Burden of Disease Study 2015, migraine is one of the 8 chronic diseases and injury that affecting more than 10% of the world’s population in 2015.10 From the perspective of health, it is important to know the effects that smartphones have on the quality of life, pain and sleep quality of people with migraine. Researches on the effects of smartphone overuse do not provide adequate information on the quality of life, sleep quality and pain in migraine patients. The present study, therefore, aimed at investigating the effects of smartphone overuse on pain, quality of life and sleep quality in migraine patients.

Methods. Study design. This study is a single-center, cross sectional comparative study. This study was conducted between July 2017 and September 2017. 

Participants. We recruited a total of 156 smartphone users who volunteered to be monitored in the Neurology Clinic of a private hospital or who were diagnosed with migraine after presenting to a neurologist for first-time headache.

Inclusion criteria. Volunteers aged >18 years and <65 years, who use smartphones, who do not have any neurological disorders other than migraine and who consented to participate in the study were included.

Exclusion criteria. Patients with neurological, psychiatric or vascular disorders; those with hypertension and coronary artery disease; those receiving prophylactic therapy for migraine; those who are illiterate and those who use mobile phones for <30 min per day were excluded from the study. Finally, 123 migraine patients were included in the study. Flow chart of the study is shown in Figure 1.

Ethics Committee Approval. Our study was approved by the Atılım University Human Research Ethics Committee, with a decree number of 59394181-604.01.01-1941 and dated 22.06.2017. The study participants were informed about the study, and informed consent was obtained. The study was perform according to principles of Helsinki Declaration.

Evaluation procedure. Migraine was diagnosed by a neurologist according to the diagnostic criteria of International Classification of Headache Disorders-II and clinical evaluation.11 Demographic data of the patients were recorded. Pain history and factors triggering migraine were recorded. Pain intensity was evaluated with Visual Analogue Scale (VAS).12 The Migraine Disability Assessment Scale (MIDAS)13 was used to evaluate the extent to which migraine disturbs the daily life of a person; the 24-h Migraine Quality of Life Questionnaire (24 h MQoLQ)14 was used to evaluate the quality of life; Pittsburgh Sleep Quality Index (PSQI)15,16 was used to evaluate sleep quality and Epworth Sleepiness Scale (ESS)17 was used to evaluate sleepiness level. The Mobile Phone Problematic Use Scale (MPPUS)18 was used to evaluate smartphone use frequency. In order to prevent measurement bias in the study, the evaluator was blinded to smartphone use frequency. Assessments other than MPPUS were evaluated with a different evaluator. The mean MPPUS
Table 1 - General characteristic of the sample of the study.

| General Characteristic | Low smartphone use group (MPPUS<32) n=62 | High smartphone use group (MPPUS≥32) n=61 | P-value |
|------------------------|-------------------------------------------|--------------------------------------------|---------|
| Age (year) (M±SD)      | 43.77±11.21                               | 38.17±10.46                                | 0.204   |
| Gender (%)             |                                            |                                            | 0.000*  |
| Female                 | 74.2 (46)                                 | 13.1 (8)                                   |         |
| Male                   | 25.8 (16)                                 | 86.9 (53)                                  |         |
| Migraine history in the family (%) |                                    |                                            | 0.366   |
| Present                | 61.3 (38)                                 | 63.9 (39)                                  |         |
| Absent                 | 38.7 (24)                                 | 36.1 (22)                                  |         |
| Sports habit (%)       |                                            |                                            | 0.050   |
| Present                | 43.5 (27)                                 | 60.7 (37)                                  |         |
| Absent                 | 56.5 (35)                                 | 39.3 (24)                                  |         |
| Sports (%)             |                                            |                                            | 0.134   |
| Jogging                | 67.7 (42)                                 | 64.3 (38)                                  |         |
| Soccer-volleyball      | 8.1 (5)                                   | 9.8 (5)                                    |         |
| Pilates                | 6.5 (4)                                   | 9.8 (5)                                    |         |
| Fitness                | 9.7 (6)                                   | 16.4 (8)                                   |         |
| Other                  | 8.1 (5)                                   | 9.8 (5)                                    |         |
| Sports frequency       |                                            |                                            | 0.781   |
| 1 day a week           | 61.3 (38)                                 | 73.8 (45)                                  |         |
| 1-3 days a week        | 30.6 (19)                                 | 19.7 (12)                                  |         |
| Everyday               | 8.1 (5)                                   | 6.6 (4)                                    |         |

M±SD - Mean and standard deviation, MPPUS - Mobile Phone Problematic Use Scale, *p<0.005

Table 2 - Comparison of proportional results between groups.

| Description measurements | Low smartphone use group n=62 | High smartphone use group n=61 | P-value |
|--------------------------|--------------------------------|--------------------------------|---------|
| MIDAS Levels n (%)       |                                |                                | 0.993   |
| Little or no disability  | 14.5 (9)                      | 11.5 (7)                       |         |
| Mild disability          | 9.8 (6)                       | 8.2 (5)                        |         |
| Moderate disability      | 23.0 (14)                     | 24.6 (15)                      |         |
| Severe disability        | 52.5 (33)                     | 55.7 (34)                      |         |
| Pain frequency n (%)     |                                |                                | 0.03*   |
| 1 per week               | 53.2 (33)                     | 21.3 (13)                      |         |
| 3 per week               | 37.1 (23)                     | 60.7 (37)                      |         |
| 5 per week               | 3.2 (2)                      | 9.8 (6)                        |         |
| Everyday                 | 6.5 (4)                      | 8.2 (5)                        |         |
| Pain duration n (%)      |                                |                                | 0.007*  |
| 0-15 minute              | 4.8 (3)                      | 1.6 (1)                        |         |
| 15-60 minute             | 33.9 (21)                     | 13.1 (8)                       |         |
| 1-3 hour                 | 38.7 (24)                     | 37.7 (23)                      |         |
| More than 3 hours        | 22.6 (14)                     | 47.5 (29)                      |         |
| Factors associated with pain n (%) |                  |                                | 0.481   |
| Vomiting and nausea      | 6.4 (4)                      | 6.6 (4)                        |         |
| Light sensitivity        | 4.8 (3)                      | 3.3 (2)                        |         |
| Sound sensitivity        | 17.7 (11)                    | 18.0 (11)                      |         |
| Light and sound          | 66.1 (41)                    | 65.5 (41)                      |         |
| PSQI n (%)               |                                |                                | 0.115   |
| PSQI<5 Good sleep quality | 8.1 (5)                      | 4.9 (3)                        |         |
| PSQI>6 Patological sleep | 91.9 (57)                    | 95.1 (58)                      |         |
| ESS n (%)                |                                |                                | <0.001* |
| ESS ≤10 Normal sleepness | 75.8 (47)                    | 39.5 (24)                      |         |
| ESS >10 Patological sleep| 26.2 (15)                    | 59.5 (37)                      |         |

Chi-square test, p<0.05, MIDAS - Migraine Disability Assessment Scale, PSQI - Pittsburgh Sleep Quality Index, ESS - Epworth Sleepness Scale

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scores of the patients were determined. The patients were divided into 2 groups as the high smartphone use (HSPU) group with mean MPPUS score above average and low smartphone use (LSPU) group with MPPUS score below average, and the final results were compared.

Evaluation Methods. Pain assessment. The VAS is a tool used to determine pain intensity. The patient marks pain intensity on a 10-cm ruler between the ‘no pain’ and ‘worst possible pain’ anchor. It is stated that VAS is more sensitive and reliable in pain intensity measurement than other one-dimensional scales.12

Disability assessment. The MIDAS evaluates the extent to which headache in patients diagnosed with migraine affected their lives in the last 3 months. According to these questions, patients indicate the number of days they were unable to go to school/work, do housework and had decreased efficiency. It is graded as ‘no disability’ due to migraine if the total score is 0–5, ‘low-level disability’ for 6–10 score, ‘medium-level disability’ for 11–21 score and ‘severe disability’ for >21 score.13

Quality of life. 24-h Migraine Quality of Life Questionnaire consisting of 15 items was developed in 1995 and is composed of 3 parts. In the first part, the
symptoms accompanying migraine are inquired. In the second part, the limitations on the person’s life caused by these symptoms are evaluated. In the final part, how these symptoms affect the person psychologically and socially is evaluated. An increase in the total score indicates an increase in the quality of life. The cultural validity and reliability of the questionnaire were evaluated by İltsu et al.\textsuperscript{14} in 2007.

Sleep quality. The PSQI was developed by Buysse et al.\textsuperscript{15} evaluates total sleep time, sleep quality and sleep disorders over a 1-month period. It comprises 7 components: subjective sleep quality, sleep latency, sleep duration, sleep activity, sleep disorders, medication use and daytime functions. Each component is rated on a scale of 0–3 points. The total PSQI score is calculated as the sum of all component scores. An increase in the total PSQI score indicated a decrease in the sleep quality. The validity and reliability of the Turkish scale were evaluated by Ağargün et al.\textsuperscript{16}

Assessment of daytime sleepiness level. The ESS evaluates general daytime sleepiness of the person. It determines the possibility of falling asleep or dozing off in 8 different daily-life situations. The ESS is a 4-point Likert-type scale. It is scored from 0 to 3, and a high score indicates sleepiness. The ESS is a valid and reliable tool for the evaluation of general sleepiness level and that can be used in Turkish studies regarding sleep and sleep disorders.\textsuperscript{17}

Smartphone use frequency. The MPPUS was developed by Bianchi and Philips, and the validity and reliability of the Turkish version were evaluated in 2012. The effects of mobile phone use frequency and overuse on social relationships are determined using this scale.\textsuperscript{18} The MPPUS has also been used in smartphone users in the literature.\textsuperscript{19} The scale consists of 3 parts: 9 questions for addiction, 7 questions for social relationships and 10 questions for the consequences. Each item is rated on a scale of 0–4. In the first 2 parts, 0=disagree, 4=strongly agree; in the final part, 0=not at all and 4=very frequently. The total score ranges from 0 to 104 and indicates the degree of smartphone overuse of a person.\textsuperscript{18}

Statistical analysis. Statistical analysis of the data was performed using Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) for Windows 18.0 software package. Kolmogorov–Smirnov/Shapiro–Wilk test was used to analyze normally distributed continuous variables. The descriptive statistics were given as mean±standard deviation or median (minimum–maximum) for continuous variables and as number and percentage (%) for categorical variables. The aim was to determine the sample size required for the study, and the G *Power (G*Power Ver. 3.0.10, Franz Faul, Kiel University, Germany) software package was used.\textsuperscript{20} It was calculated that a sample size of 128 patients (64 patients in each group) would achieve 80% power (d=0.50 effect width, α=0.05 type I error, β=0.20 type II error). Because of patients who were excluded, 123 patients were included in the analysis, yielding a power of 79%. The differences between 2 measures were evaluated with independent sample t-test and chi-square test. The relation between measurement findings was evaluated using Pearson’s correlation coefficient.\textsuperscript{21} A correlation coefficient (r) of ≥0.75 is considered good to excellent; 0.50–0.75 as moderate to good; 0.25–0.50 as fair and 0.00–0.25 as little to no relationship. A p-value of <0.05 was considered statistically significant.\textsuperscript{22}

Results. Of the participants, 99 were females (80.5%) and 24 were males (19.5%). Descriptive findings are presented in Table 1. The disability level was severe in 54% and moderate in 23.8% of the patients, according to MIDAS, and

Table 3 - Comparison between high smartphone use group and low smartphone use group.

| Outcome measures | Low smartphone use group (MPPUS ≤32) n=62 | High smartphone use group (MPPUS ≥32) n=61 | P-value |
|------------------|-----------------------------------------|-----------------------------------------|---------|
| MPPUS            | 21.26±4.74                              | 42.46±10.25                             | <0.000* |
| MIDAS            | 10.17±10.10                             | 11.57±17.73                             | 0.559   |
| PSQI             | 16.08±4.6                               | 14.26±5.6                               | 0.049*  |
| 24 h MQoLQ       | 43.88±14.22                             | 30.65±12.52                             | 0.000*  |
| ESS              | 10.40±4.39                              | 12.31±5.6                               | <0.000* |
| VAS              | 4.09±1.89                               | 7.11±1.73                               | <0.000* |

Independent T test, *p<0.05, SD - Standard Deviation, MPPUS - Mobile Phone Problematic Use Scale, MIDAS - Migraine Disability Assessment, PSQI - Pittsburgh Sleep Quality Index, ESS - Epworth Sleepiness scale, 24 h MQoLQ - 24-hour Migraine-Specific Quality of Life Questionnaire, VAS - Visual Analog Scale.

Table 4 - The correlations between the score of MPPUS and other scale scores.

| MPPUS (n=123) | X±SD | r     | P-value |
|---------------|------|-------|---------|
| VAS           | 6.99±1.66 | 0.715 | 0.00*   |
| MIDAS         | 10.88±4.41 | 0.029 | 0.75    |
| 24 h MQoLQ    | 36.12±14.68 | -0.508 | 0.00*   |
| ESS           | 9.42±5.87  | 0.675 | 0.00*   |
| PSQI          | 15.18±5.21 | -0.367 | 0.00*   |
| Pain frequency| 0.158 | 0.157 |         |
| Pain duration | 0.308 | 0.01* |         |

Pearson correlation *p<0.05, MPPUS - Mobile Phone Problematic Use Scale, MIDAS - Migraine Disability Assessment, PSQI - Pittsburgh Sleep Quality Index, ESS - Epworth Sleepness scale, 24 h MQoLQ - 24-hour Migraine-Specific Quality of Life Questionnaire, VAS - Visual Analog Scale.
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there was no difference between the groups in terms of disability \( (p=0.993) \). However, when evaluated in terms of pain frequency and duration, there was a significant difference between the groups \( (p<0.05) \). The pain duration and frequency in the HSPU group was higher than those in the LSPU group. Comparison of proportional results between groups are shown in Table 2.

The mean MPPUS score of the patients was 32.00. The patients were divided into 2 groups as HSPU group with a mean MPPUS score of above average \( (\text{MPPUS} \geq 32.00) \) and LSPU group with a mean MPPUS score of below average \( (\text{MPPUS}<32.00) \). According to the LSPU group, the quality of life and sleep quality were lower and daytime sleepiness was higher in the HSPU group. There was a significant difference between the groups \( (p<0.05) \). The severity of pain, as evaluated by VAS, was higher in the HMPU group than in the LPMU group, and there was a significant difference between the groups \( (p<0.05) \). Comparisons of measurements between the HSPU and LSPU groups are shown in Table 3.

There was a negative correlation \( (r=-0.367, p<0.05) \) between the MPPUS score and sleep quality in migraine patients, whereas there was a strong positive correlation \( (r=0.675, p<0.05) \) between the MPPUS score and daytime sleepiness. In addition, there was a negative correlation \( (r=-0.508, p<0.05) \) between the MPPUS score and 24-h MQoLQ score. Correlations between the MPPUS score and other scale scores are shown in Table 4.

**Discussion.** In this study, we observed that in migraine patients, the intensity of headache increases, pain duration and frequency are affected, quality of life and sleep quality decrease and daytime sleepiness increases with smartphone overuse.

Migraine negatively affects daily life and can cause functional disability in work and social lives. Mayda Domaç et al.\(^3\) have shown that the frequency and intensity of migraine attacks are some of the most important factors of disability related to migraine. In our study, the disability level was severe in 54% and moderate in 23.8% of the patients, according to MIDAS, and there was no difference between the groups in terms of disability. However, when evaluated in terms of pain frequency and duration, there was a significant difference between the groups. The pain duration and frequency were higher in the HSPU group than in the LSPU group, indicating that smartphone use increases the duration and frequency of headache in migraine patients. Similarly, Demirci et al.\(^7\) have shown that headache complaints, headache duration and attack frequency are higher in university students with smartphone overuse than in those with no overuse. Moreover, it was reported that response to analgesic medication is higher in those with smartphone overuse than in non-users. In our study, pain intensity according to VAS was higher in the HSPU group, and there was a significant difference between the groups; however, pharmacological evaluation was not included in our study.

A study evaluating the type and incidence of subjective symptoms regarding smartphone use in Polish users has shown that headache is significantly more frequently reported by people who talk more frequently and longer, that 26% of the participants reported continuous headache and that headache lingers for \( >6 \) h after the end of a phone call.\(^3\) In a study conducted by Demirci et al.,\(^7\) headache complaints were shown to be related to the degree of smartphone use. Researchers have suggested that during or after smartphone use, the changing conditions during mobile phone use such as exposure of the blood–brain barrier and dopamine–opioid systems to radio frequency, psychological factors, temperature change, noise and various combinations of these may cause headaches.\(^5,24,25\)

Migraine negatively affects the life of patients who exhibit symptoms such as nausea, phonophobia, photophobia, blurred vision and vomiting. Thus, their quality of life is also negatively affected.\(^26-28\) In a study that evaluated headaches particularly caused by smartphone use, it was stated that 4 days of pain per week develops migraine characteristics such as photophobia and nausea and those can be aggravated by routine physical activity.\(^29,30\) However, in terms of migraine-related findings in our study, there was no statistically significant difference between the groups. This result suggested that smartphone overuse does not have an effect on factors accompanying migraine. However, further studies are required in this regard.

According to the literature, chronic migraine patients report difficulty in maintaining sleep with less sleep time compared with others and the majority wake up feeling tired.\(^31,32\) Problems falling asleep and maintaining sleep have been described in one-third of migraine patients. Smartphone users experience problems falling asleep and lack of sleep, with prolonged use affecting the quality of life.\(^33\) Using smartphones before sleep increases sleep disorders.\(^34\) Loughran et al.\(^35\) have reported adverse effects of electromagnetic fields emitted from mobile phones in sleep electroencephalograms. Elhai et al.\(^36\) state that use of a smartphone has led to sleep problems due to reasons such as blue light emitted from smartphones can interfere with sleep and increasing work demands to stay digitally connected can cause stress and burnout.

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Excessive smartphone use at night, could keep one awake late, thus impairing sleep, and influencing stress and depression. Cain and Gradisar have explained the relationship between electronic media use and poor sleep by the relationship among electronic media and cognitive, emotional or physiologic stimuli, effects of light emission from the device, keeping mobile phone in the bedroom and sleep interruption by untimely messages and calls.

Demirci et al have shown a strong relationship between smartphone overuse and sleep quality, sleep disorder and daytime dysfunction in healthy people. Additionally, they have shown that daytime dysfunction, which is related to poor sleep quality, is higher in the HSPU group than in the LSPU group. In our study, there was a negative correlation between the MPPUS score and sleep quality in migraine patients, whereas there was a strong positive correlation between the MPPUS score and daytime sleepiness. As smartphone overuse increases in migraine patients, sleep quality decreases and daytime sleepiness increases.

In our study, we showed that smartphone overuse is related to sleep quality and daytime sleepiness, but according to PSQI’s cut-off value, there was no significant difference between the groups because sleep quality was affected at a pathologic level of >90% in both groups; when evaluated in terms of daytime sleepiness, pathologic sleepiness was higher in the HSPU group. This result showed that it is necessary to consider that decreased sleep quality and increased daytime sleepiness due to smartphone use, besides the already existing sleeplessness problem in migraine patients, can cause additional problems. However, Lemola et al have shown that smartphone use is related to sleeping at a later hour but is unrelated to sleep disorders.

Daytime sleepiness is seen more frequent in migraine patients than in the general population, and this increases with an increasing frequency of migraine attacks. Considering the possible side effects of smartphone overuse demonstrated in migraine patients in the present study, smartphone use must be carefully addressed in this particular patient group.

Moreover, sleep quality has been shown to be a determining factor for depression and anxiety. In addition smartphone use has been shown to be associated with anxiety and depression in the literature. Unfortunately, we did not assess symptoms of depression and anxiety in our study. Further studies are needed on symptoms of depression and anxiety caused by smartphone use in migraine patients.

In a study including 90 migraine patients, 46 of whom had chronic migraine, quality of life was impaired in chronic migraine patients compared with that in others. In our study, there was a negative correlation between the MPPUS and 24-h MQoLQ scores. The quality of life is impaired with increasing smartphone use; it was lower in the HSPU group than in the LSPU group, and the difference between the groups was statistically significant. This shows that smartphone addiction negatively affects the quality of life in migraine patients. This also shows that migraine patients must be advised to limit and consciously use smartphones while developing recommendations to prevent worsening of the quality of life in migraine patients that is already affected by the disease.

There are some limitations in our study. The information obtained with our measurement methods is acquired from self-reports of patients. In order to reduce the negative effects of this situation, physiological measurement methods such as actigraphy, blood pressure and heart rate should be included for sleep measurements in future studies. There is need for further longitudinal studies with different age groups, especially in the geriatric population. Sleep duration can be affected by smartphone use but we did not investigation sleep duration. This is another limitation of the study. Furthermore, no classification between episodic and chronic migraine was made while including migraine patients, and sufficient data are not present in the literature on the effects of smartphone use in migraine patients.

In conclusion, this study showed that headache, sleep quality, daytime functions and quality of life are affected depending on the extent of smartphone use in migraine patients. To prevent the harmful effects of smartphone use, its effects on health should be monitored with more detailed and long-term studies. Our study can pave way for future studies on migraine patients who are smartphone users and on the necessary behavioural and medical interventions for these patients.

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