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Research Article

Potential Role of Smartphone Addiction on Sleep Quality and Perceived Neck Pain Among Undergraduate Physiotherapy Students: A Multicentered Cross-Sectional Study

Fizyoterapi Lisans Öğrencileri Arasında Akıllı Telefon Bağımlılığının Uyku Kalitesi ve Algılanan Boyun Ağrısı Üzerindeki Potansiyel Rolü: Çok Merkezli Kesitsel Bir Çalışma

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ABSTRACT

Purpose: This study aimed to analyze the possible associations between smartphone addiction, perceived neck pain, and sleep quality among undergraduate physiotherapy students. **Material and Methods:** Students were asked to fill out the Smartphone Addiction Scale (SAS), the Neck Bournemouth Questionnaire (NBQ), and the Pittsburgh Sleep Quality Index (PSQI) on the Google Forms platform, accessed online via a QR code. **Results:** 355 physiotherapy students were included in this study. Considering the threshold value of 5 in PSQI which is accepted as an indicator of poor sleep, 285 out of 355 students (80.3%) showed higher scores (mean:9.73±2.68) than this threshold. A structural equation model showed that the NBQ had a significant effect on the SAS (B= .223; p=.031), and the SAS, in turn, had a significant effect on the PSQI (B=.021; p=.003). It was shown that 7% of the association between the NBQ and the PSQI was explained by the SAS acting as a mediator. **Conclusion:** Smartphone addiction should be considered to prevent future potential musculoskeletal complaints as well as to preserve and improve the academic performance of students from the perspectives of the associations between sleep quality and perceived neck pain.

Keywords: Smartphone, Neck pain, Sleep quality.

ÖZ

Amaç: Bu çalişmanin amaci, fizyoterapi lisans öğrencileri arasinda akilli telefon bağimliliği, algilanan boyun ağrisi ve uyku kalitesi arasindaki olasi ilişkileri analiz etmektir. **Gereç ve Yöntem:** Öğrencilerden Akilli Telefon Bağimliliği Ölçeği (ATBÖ), Boyun Bournemouth Anketi (BBA) ve Pittsburgh Uyku Kalitesi İndeksi (PUKİ) bir QR kod araciliğiyla online olarak erişilerek Google Formlar platformunda doldurmalari istendi. **Sonuçlar:** Bu çalişmaya 355 fizyoterapi lisans öğrencisi dahil edildi. PUKİ'de kötü uykunun göstergesi olarak kabul edilen 5 eşik değeri göz önüne alindiğinda, 355 öğrenciden 285'i (%80,3) bu eşik değerden daha yüksek puan (ortalama:9.73±2.68) gösterdi. Yapisal eşitlik modeli, BBA'nin ATBÖ üzerinde anlamli bir etkisinin olduğunu (B= ,223; p=,031) ve ATBÖ'nün de PUKİ üzerinde anlamli bir etkisinin olduğunu (B=.021; p=.003) gösterdi. BBA ile PUKİ arasindaki ilişkinin %7 'sinin ATBÖ'nün araci rol oynamasiyla açiklandiği gösterildi. **Tartişma:** Akilli telefon bağimliliği, uyku kalitesi ve algilanan boyun ağrisi arasindaki ilişkiler, öğrencilerin akademik performansini korumak ve iyileştirmenin yani sira gelecekteki potansiyel kas-iskelet sistemi şikayetlerini önlemek için dikkate alinmalidir.

Anahtar Kelimeler: Akilli telefon, Boyun ağrisi, Uyku kalitesi.

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Smartphones, which were brought by dramatically advancing technology as well as the digitalizing world in the center of our daily lives in the last decade are now accepted as an indispensable part of our daily routines (Fu, Chen & Zheng, 2021). They have brought many opportunities and conveniences to our lives by not only making calls but also connecting us to the whole world (Abbasi, Jagaveeran, Goh et al., 2021). From 2020 to 2026, the estimated increase in smartphone usage was reported to be nearly 50% (Puntumetakul, Chatprem, Saiklang et al., 2022). In another study, it was also reported that global smartphone penetration was around 41.5% (Ertemel & Ari, 2020). Achangwa et al. (Achangwa, Ryu, Lee et al., 2022) recently reported that nearly 97% of the Korean population was penetrated with a smartphone with 100% of the penetration rate achieved in younger people between the ages of 20 and 30. Besides, half of the teenage population reported that they believe themselves addicted to smartphones (Cohen, 2016).

The other side of the coin is getting dark associated with the use of smartphones. Just like any other addiction, smartphone addiction now has been in attention due to unexpected dramatic potential effects on a wide variety of perspectives such as deterioration in sleep quality, postural and musculoskeletal problems, anxiety, depression, economic, academic success, and so forth (Dewi, Efendi, Has et al., 2018; Hawi & Samaha, 2017; Inal & Serel Arslan, 2021; Samaha & Hawi, 2016). Specifically focusing on students, it was stated that increased time spent on social media in prolonged periods of static posture affects not only their academic performance but also their gaining bad postural habits as well as predisposing their future musculoskeletal complaints (Metin, Topuz & Yagci, 2023). Shoulder and upper extremity pain specifically wrist, neck, upper back, and lower back problems are the most common ones reported in the literature associated with smartphone addiction (Barrett, McKinnon & Callaghan, 2020; Bruno, Burkhart, Allaire et al., 2017; Eitivipart, Viriyarojanakul & Redhead, 2018; Inal & Serel Arslan, 2021).

The neck region is reported to be one of the most vulnerable regions associated with musculoskeletal problems due to smartphone usage associated with the increased angle of flexion of the cervical vertebrae (Paek, 2017; Park, Kang, Lee et al., 2017). Metin et al. (Metin, Topuz & Yagci, 2023) also indicated that the use of smartphones has an impact on gait characteristics. Researchers also highlighted that potential deterioration of the visual and vestibular system due to smartphone use might cause decreased stability and functionality (Pakdee & Sengsoon, 2020).

On the other hand, the most prominent impact of smartphone usage was pointed out on sleep quality. It is a well-known fact that sufficient sleep is indisputable for a healthy lifestyle and well-being, especially for younger people (Jo & Lee, 2019; Kubiszewski, Fontaine, Rusch et al., 2014). Disrupted sleep patterns, diminished sleep hygiene, and decreased sleep quality are the risk factors not only for prolonged cumulative potential effects on health but also academic performance among students due to hazardous effects on memory, cognition, learning, concentration, procrastination, etc (Achangwa, Ryu, Lee et al., 2022; Inal & Serel Arslan, 2021). Although there might be various factors associated with disrupted sleep quality, the use of smartphones at bedtime might be accounted for as the most remarkable factor these days since some studies report that the time spent using smartphones at bedtime should not be underestimated (Dewi, Efendi, Has et al., 2018). Nonetheless, it should also be noted that sleep quality can be affected by many reasons. Yet, the potential role of perceived neck pain on sleep quality in the case of smartphone addiction should be studied in detail.

Therefore, this study aims to assess perceived neck pain, smartphone usage, and sleep quality among undergraduate physiotherapy students in two different universities as well as to investigate the potential factors related to increased smartphone addiction such as gender.

METHODS

Study Design

This study was designed as a cross-sectional study and followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline (Elm, 2007). Ethical approval for the study was obtained from the Izmir Bakircay University Non-Interventional Clinical Research Ethics Committee (Protocol No:1254/1234-25102023). This study was held in October 2023 within a non-probability sampling method. All procedures in this study were performed according to the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Participants

This study was carried out at Izmir Bakircay University and Izmir Demokrasi University, Faculty of Health Sciences, Department of Physiotherapy and

Rehabilitation.

The sample size of the research was determined according to the correlation analysis (Bivariate normal model) due to the cross-sectional and descriptive nature of the research. Accordingly, considering a low correlation effect size (0.2), the required sample size was calculated as 319 with a 95% confidence interval and a minimum of 80% power. However, it was planned to include 350 students in the research to eliminate possible errors and deficiencies. The analyses were performed using the GPower 3.1.9 (Faul, Erdfelder, Lang et al., 2007)

Formal university students who were actively studying in the Department of Physiotherapy and Rehabilitation at Izmir Bakircay University and Izmir Demokrasi University were included in the study. Students who did not have proficiency in Turkish communication did not use a smartphone, had been actively taking sleep medication for the last 6 months, and/or had any sleep disorder diagnosed by a physician, students who have had minor/major surgery or neurological pain associated with neck region were excluded from the study. Students who agreed to participate accessed the consent form through Google Forms, and following their approval, were able to access the questionnaires.*Instruments*
The sociodemographic data of the participants was collected during face-to-face interviews. Participants' balance, pain level, functional capacity, mobility, depression level, and upper extremity disability were evaluated by the same researcher (İC).

Questionnaires
The data was collected via Google Forms. The questions were defined on the form, and a QR code was generated. Students accessed the questions through this QR code and filled them out online on their smartphones. It took approximately 15-20 minutes to answer the questions.
Demographic Information: The gender, age, height, weight, and years of using a smartphone of the students were recorded.
Neck Bournemouth Questionnaire (NBQ): It is a neck-specific questionnaire that evaluates pain intensity, daily life activities, social functions, anxiety, depression, and fear avoidance areas. The questionnaire consists of 7 questions scored on a scale of 0-10 points. The possible score range is 0-70. Higher scores indicate higher levels of pain and disability. The Turkish validation and adaptation of this questionnaire was held by Agce et al. (Agce, Sahin, Yaran et al., 2020) with excellent internal consistency and test-retest reliability values.
The Smartphone Addiction Scale (SAS): SAS is a 6-item Likert-type (1:Absolutely Not, 6: Absolutely Yes) self-report scale consisting of 33 items developed by Kwon et al. (Kwon, Lee, Won et al., 2013) to assess the risk of smartphone addiction. The total score ranges from 33 to 198. Higher scores indicate a higher risk of smartphone addiction. The internal consistency of the scale was determined as Cronbach alpha 0.96. Turkish validity and reliability of the SAS were conducted by Demirci et al. (Demirci, Orhan, Demirdas et al., 2014) among university students.
Pittsburgh Sleep Quality Index (PSQI): It is a self-report index that provides information about the quality of sleep, and the type and severity of sleep disorder in the last month. It consists of 24 questions scored between 0-3, including 7 components (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance/disorder, use of sleep medication, and daytime dysfunction). A total score of 5 or above indicates poor sleep quality (Buysse, Reynolds III, Monk et al., 1989). The Turkish validity and reliability of the questionnaire were conducted by Agargun (Agargun, 1996).

Statistical Analysis
The data were shown as means and standard deviations or median and percentages according to the type of data whether it is continuous or categorical. The normality was checked via Kolmogorov Smirnov-Shapiro Wilk tests as well as skewness and kurtosis. Independent samples t-test was used to analyze the continuous variables between genders. Pearson's r or Spearman's rho correlation coefficient was used to analyze correlations between variables according to the normality assumptions. To explore the complex associations among neck pain, mobile phone addiction, and sleep quality, a mediation model was generated with 5000 random sample bootstrapping confidence intervals using the Hayes PROCESS macro (Hayes, 2017). The mediator effect of mobile phone addiction on the association between neck pain and sleep quality was tested by using Model 4. Neck pain, sleep quality, and mobile phone addiction were regarded as the independent, dependent, and mediator variables, respectively. A p-value less than 0.05 was determined as an indicator of statistical significance. IBM SPSS v.26 was used to analyze the data (IBM Corp, New York).

RESULTS

A total of 355 undergraduate university students from two different undergraduate physiotherapy and rehabilitation programs were included in this study. The mean age and body mass index (BMI) of participants were 20.92±2.10 years and 24.29±19.63 kg/m2, respectively. The great majority of participants were female (263 out of 355, 74%). 93.5% of participants were using smartphones for five years or more (332 out of 355).

The mean score of SAS was found as 97.30±23.69 in the total group. Male students were found to have higher scores on SAS compared to the female students (98.82±23.64 vs. 96.77±23.73), yet it did not reach significance (t= -.713, p=.476). Although we did not use the short version of the SAS in which the threshold was reported to be 31 (nearly equal to 51.6% of the highest score in the range of 6-60) indicates that addictive behavior on smartphones, we have tried to compare the rate of addictive students by calculating the ratio of each student's SAS score by multiplying 0.516. Results showed that nearly 39.2% of the total sample who had scored over 102.16 according to the previous calculation showed themselves as addicted to smartphones. The floor and ceiling effects were obtained in the 22nd and 32nd items (item 22: "Not being able to use my smartphone would be as painful as losing a friend", item 32: "Using my smartphone longer than I had intended") of SAS, respectively. 185 out of 355 students (52.1%) responded to item 22 as absolutely not while 56 out of 355 students (15.8%) responded absolutely yes to item 32.

The mean scores of perceived neck pain between genders were also not significant (24.24±11.86 vs. 24.92±13.06, t= -.464, p=.643). Although the total score of PSQI was shown itself higher in females compared to the males (8.79 vs. 8.29), there was also no significant difference between genders (t=1.437, p=.152). Yet, when considering the threshold value of 5 in PSQI which is accepted as an indicator of poor sleep, 285 out of 355 students (80.3%) showed higher scores (mean:9.73±2.68) than this threshold. There were also significant differences in perceived neck pain and smartphone addiction scores in groups who had PSQI scores over five or lower scores than five against the group who had bad sleep quality. (t=-4.010, p<0.001 for NBQ and t=-3.211, p=.001 for SAS, respectively). When PSQI was analyzed according to its sub-tests, "sleep disturbances" was found to have higher scores compared to the other sub-tests in the total group (2.04±.64). There were no significant differences in all sub-tests (sleep latency, sleep duration, sleep disturbances, sleeping medication, daytime dysfunction, habitual sleep efficiency, and subjective sleep quality) of PSQI between genders. The descriptive features of participants and between-group comparisons are shown in Table 1.

Table 1. Demographic and clinical characteristics of the participants.

n=355	**X±SD**		
Age (years)	20.92±2.10		
BMI (kg/m^2)	24.29±19.63		
Smartphone usage (years)			
1-3	4 (1.1)		
3-5	19 (5.4)		
5 years or more	332 (93.5)		
Gender	**n (%)**		
Female	263 (74)		
Male	92 (36)		
	X±SD		
SAS		**p**	**t**
Female	96.77±23.73	.476	-.713
Male	98.82±23.64		
NBQ			
Female	24.24±11.86	.643	-.464
Male	24.92±13.06		
PSQI			
Female	8.79±3.38	.152	1.437
Male	8.29±2.88		

SAS: Smartphone Addiction Scale, NBQ: Neck Bournemouth Questionnaire, PSQI: Pittsburgh Sleep Quality Index, t: Independent samples t-test, p<0.05

There were also significant correlations that were noteworthy to be acknowledged. The PSQI total score was significantly correlated with the NBQ (r=.293, p<.001) and with SAS (r=.197, p<.001). Perceived neck pain was also significantly correlated with SAS (r=.143, p=.007) and with the following specific sub-tests of PSQI: sleep latency (r=.139, p=.009), sleep duration (r=.107, p=.044), sleep disturbances (r=.251, p<.001), daytime dysfunction (r=.306, p<.001), habitual sleep efficiency (r=.107, p=.044) and with subjective sleep quality (r=.232, p<.001), respectively. SAS total also showed significant correlations with sleep disturbances (r=.181, p<.001), daytime dysfunction (r=.271, p<.001), and with subjective sleep quality (r=.157, p=.003). Significant correlations are shown in Table 2.

Table 2. Significant correlations between SAS, NBQ and PSQI

n=355	SAS		NBQ		PSQI	
	r	p	r	p	r	p
SAS						
NBQ	.143	.007			.293	<.001
PSQI (Total)	.197	<.001				
Sleep Latency			.139	.009		
Sleep Duration			.107	.044		
Sleep Disturbances	.181	<.001	.251	<.001		
Daytime Dysfunction	.271	<.001	.306	<.001		
Habitual Sleep efficiency			.107	.044		
Subjective Sleep Quality	.157	.003	.232	<.001		

SAS: Smartphone Addiction Scale, NBQ: Neck Bournemouth Questionnaire, PSQI: Pittsburgh Sleep Quality Index, r: Pearson correlation coefficient, p<.05

To explore the complex relationships between perceived neck pain, sleep quality, and smartphone usage, structural equation modeling was performed. Following a basic mediation model (Hayes model 4), the NBQ had a significant effect on the SAS (B= .223; p=.031), and the SAS, in turn, had a significant effect on the PSQI (B=.021; p=.003). As a next step, the total effects, direct effects (independent of SAS), and indirect effects (mediated by SAS) of the NBQ on the PSQI were examined. The total (B=.075; p<.001), direct (B=.071; p<.001), and indirect (B=.005; bootstrap CI did not include zero, which indicates a significant effect) effects were significant, showing that 7% of the association between the NBQ and the PSQI was explained by the SAS acting as a mediator (Table 3 and Figure 1).

Table 3. The mediating effect of SAS in the association of the NBQ and PSQI.

Model pathways		B	95% CI	t	p
NBQ → SAS		0.223	0,021 to 0.426	2,169	0.031
SAS → PSQI		0.021	0.007 to 0.035	3,033	0.003
NBQ → SAS → PSQI					
	Direct effects	0.071	0.044 to 0.097	5.171	**<0.001**
	Indirect effects	0.005	0.000 to 0.012	-	**-**
	Total effects	0.075	0.048 to 0.102	5.493	**<0.001**
% Total effects mediated by SAS: 7%					

Bootstrap N=5000. B: unstandardized coefficients; CI: confidence interval; NBQ: Neck Bournemouth Questionnaire, SAS: Smartphone Addiction Scale; PSQI: Pittsburgh Sleep Quality Index

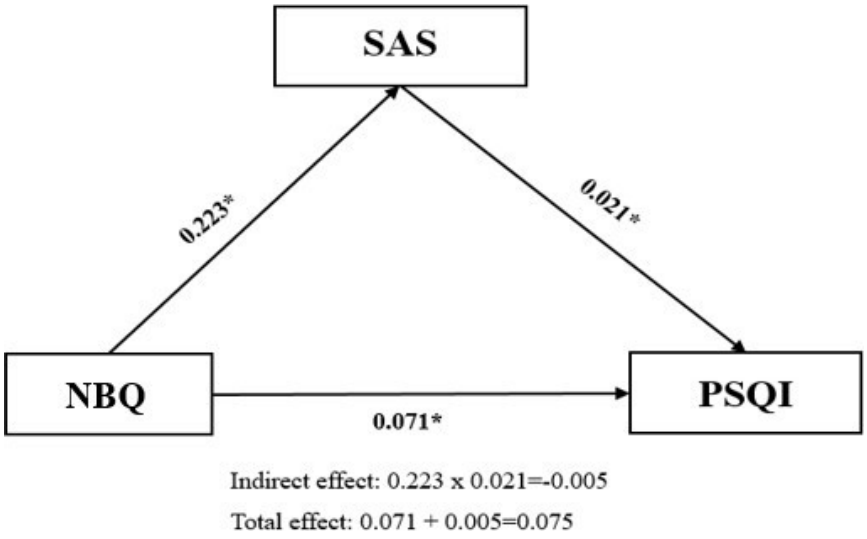

Figure 1. *The mediation model illustrates the mediator role of SAS in the association between NBQ and PSQI. Notes: Unstandardized regression weights are shown for the associations between each variable. *p<0.05*

DISCUSSION

The present study showed the remarkable rate of disrupted sleep quality among undergraduate university students which should be addressed further to prevent future chronic problems due to its currently hazardous levels of the risk of cumulative impact on health and well-being. On the other hand, the mean scores of the smartphone addiction scale which was nearly equal to half of the maximum score also highlighted the need for taking action to manage future side effects related to the usage of smartphones from the perspective of musculoskeletal complaints by taking into account significant correlations between perceived neck pain. Although the cumulative effect of the mediator role of smartphone usage on perceived neck pain and sleep quality, the significant results were also noteworthy to be studied in detail. Since the highest scores were obtained in the sleep disturbances subscale in PSQI, it should be noted that providing good sleep hygiene is important for students in order to improve their academic success.

Since smartphones have become an essential part of our daily lives over the last decade, the dramatic increase was also observed not only in having one but also in spending time in a prolonged static body position which could further cause musculoskeletal complaints by its cumulative effect (Ratan, Parrish, Zaman et al., 2021). Prolonged static posture while using a smartphone can cause deterioration in spinal alignment, pain, and discomfort by increasing the flexion angle of the cervical region which could also further have an impact on thoracolumbar pain by affecting spinal curvatures as well as increased activation of contractile and non-contractile tissues, respectively (Barrett, McKinnon, & Callaghan, 2020; Bruno, Burkhart, Allaire et al., 2017). In this regard, the upper extremities, hand, wrist, and shoulder are the common ones that are studied in detail associated with smartphone addiction. Kim and Kim (Kim & Kim, 2015) reported that the neck region is the most vulnerable one to be affected related to smartphone usage. Inal and Serel Arslan (Inal & Serel Arslan, 2021) reported that addiction to smartphones could cause bad postural habits which further affect shoulder and upper extremity pain among university students. In our study, the mean scores of NBQ did not differ each other between male and female students. A weak but significant correlation between NBQ and SAS was also noteworthy to be studied in detail of possible effect of smartphone usage on perceived neck pain, therefore by performing a structural equation modeling, we were also able to show significant mediator effect of smartphone addiction on the effect of perceived neck pain to the sleep quality. Yet, the weak correlation coefficients in our study seem in parallel with the literature (Inal & Serel Arslan, 2021). The estimated cumulative effect was found as below 10% in our study on the effect of NBQ on PSQI in the presence of the mediator effect of SAS. This small effect might be the result of the questionnaire that was used to assess perceived neck pain due to many items of NBQ covering patients who were already suffering from neck pain. Our results seem in parallel with the literature findings. Paek (Paek, 2017) reported that prolonged time spent with a smartphone was a significant risk

factor for neck pain. Lee (Lee, 2016) reported a decreased neck muscle endurance and increased neck disability index scores in university students associated with prolonged smartphone usage. Inal and Serel Arslan (Inal & Serel Arslan, 2021) reported a positive significant correlation between neck, upper back, lower back, and smartphone addiction. On the other hand, Metin et al. (Metin, Topuz & Yagci, 2023) reported no significant correlation between perceived neck pain and smartphone addiction, however, the same authors reported a significant correlation between back pain and smartphone addiction. Nonetheless, we think that the relative discrepancies regarding the rate of correlation coefficients between studies might also be attributable to the different questionnaires used regarding the perceived musculoskeletal complaints. On the other hand, nearly 40% of our sample can be classified as addicted to smartphones according to the previous calculation of threshold level in SAS-SV. This relatively higher might be attributable to the recall bias and/or using the long version of the SAS in our study. Recently, Peng et al. (Peng, Chen, Ren et al., 2023) reported the rate of problematic smartphone usage at the rate of 21.1% within over a sixty thousand adolescents with an acceptable and good sensitivity and specificity results by using the Smartphone Application-Based Addiction Scale (SABAS). Osorio-Molina et al. (Osorio-Molina, Martos-Cabrera, Membrive-Jiménez et al., 2021) also reported the estimated rate of smartphone addiction among nursing students as 22%. The same researchers also stated that the general trend of the rate of smartphone addiction is approximately over 20% in different studies. Yet, some studies also reported a rate of nearly 50% by taking into account daily usage time of over 4 hours (Akturk & Budak, 2019). Ayar et al. (Ayar, Gerçeker, Özdemir et al.,2018) also reported the rate of daily smartphone usage for 4-6 hours as 22.8%.

Adequate sleep and quality of sleep components such as sleep hygiene and duration is an indisputable part of a healthy well-being for all people but especially for younger ones and students who are under active growth period. It is a well-known fact that sleep problems are becoming common in today's world among younger people and adolescents associated with digitalizing lives (Kubiszewski, Fontaine, Rusch et al., 2014). It was also reported that two-thirds of younger people have engaged in the use of digital devices such as smartphones before or during bedtime in darkness which is also reported to be one of the important risk factors for poor sleep quality (Carter, Rees, Hale et al., 2016; Hysing, Pallesen, Stormark et al., 2015; Mireku, Barker, Mutz et al., 2019). Not only sleep quality, but also decreased academic performance was also reported to be associated with the increased use of smartphones (Samaha & Hawi, 2016). We were able to show the hazardous level of disrupted sleep quality in our sample by having 80% of our sample suffer from poor sleep quality according to scores over five in PSQI. In addition, a significant but weak correlation between poor sleep quality and smartphone addiction was also evident in line with the literature findings (Achangwa, Ryu, Lee et al., 2022; Choi, 2015; Jo & Lee, 2019). In addition, recently Gao et al. (Gao, Hu, Ji et al., 2023) also reported that sleep quality significantly mediated the effect of smartphone addiction and depression among university students. However, this research was conducted during the pandemic period, which is characterized by lockdowns, therefore the higher cumulative variances compared to ours might be attributed to this timeline. On the other hand, the higher score was obtained in the "sleep disturbances" sub-test of PSQI in our study which is mostly characterized by sleep hygiene and maintaining sleep. It might have an expected result due to getting to bed late and/or using smartphones in darkness before sleep might prevent maintaining or falling asleep. Moreover, not only in the perspectives of disrupted sleep quality, gaining bad postural habits, experiencing musculoskeletal complaints as well as academic success, but also there is an important point which should be discussed further specifically for undergraduate students for health sciences just like in this study. For instance, Cho and Lee (Cho & Lee, 2016) reported that over 60% of nursing students use their smartphones during their clinical practice. Greer (Greer, 2019) indicated that 90% of nursing students use their smartphones during clinical practice. To the best of our knowledge, there is no data specifically for physiotherapy students. However, when considering the relatively poor rate of a ceiling effect of item 32 in which the duration of smartphone usage as resulted in only 15.8% of the total sample, there is an evident need for management of problematic smartphone usage as early as possible before the clinical practice, especially for physiotherapy students who needed to be cautious during longer time of rehabilitation sessions in future.

This study has some strengths and limitations. Since there was a cross-sectional design in this study, causal relationships might not have been

documented adequately. Second, this study included only physiotherapy students instead of covering the whole students in health sciences. Third, due to relatively higher numbers of items that should have been scored by students, a recall bias or arbitrary filling could not be ruled out. We were also unable to analyze data between two different institutions due to simultaneously collecting the data in the same timelines. A random potential sampling bias may also account for latent limitation. However, the multicenter nature of this study can be accounted for as a strength for this study. Using the long version of the SAS questionnaire instead of the short version allowed us to draw conclusions in a wider aspect. In addition, performing a structural equation modeling analysis has yielded to draw our conclusions in a more detailed manner.

The present study showed the hazardous levels of disrupted sleep quality and its association with smartphone addiction and perceived neck pain among undergraduate physiotherapy students. The weak but significant mediating role of smartphone addiction on the effect of perceived neck pain and sleep quality which corresponds to nearly 7% of cumulative variance should be taken seriously in order to prevent future potential musculoskeletal complaints as well as to preserve and improve the academic performance of students. We think there is also a need for further longitudinal studies in which the responsive and ongoing effect of smartphone addiction on academic success and perceived neck pain will be analyzed instead of the ones with cross-sectional designs.

Ethical Approval

The study was approved by the Non-Interventional Clinical Researches Ethics Committee of İzmir Bakirçay University (Decision no: 1254).

Authors' Contribution

Alper Tuğral: Study design, Concept, Data collection, Data analyzing, Interpretation, Literature search, Critical reviewing. *Yağmur Çam:* Study design, Concept, Data collection, Critical reviewing.

Conflicts of Interest Statement

The authors declare that there is no conflict of interest.

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