ORIGINAL RESEARCH ORİJİNAL ARAŞTIRMA

DOI: 10.5336/healthsci.2024-106492

The Effect of Deep Neck Extensor Muscle Endurance on Pain, Disability and Sleep Quality Among University Students with Smartphone Addiction: A Descriptive and Cross-Sectional Study

Akıllı Telefon Bağımlılığı Olan Üniversite Öğrencilerinde Derin Boyun Ekstansör Kas Enduransının Ağrı, Yeti Yitimi ve Uyku Kalitesine Etkisi: Tanımlayıcı ve Kesitsel Bir Araştırma

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ABSTRACT Objective: The aim of the study is to investigate the effect of neck extensor muscle endurance on neck pain, neck disability and sleep problems among university students with smartphone addiction. **Material and Methods:** A total of 192 university students aged 18-25 years participated in the study. "Smartphone Addiction Scale-Short Form" was used to determine smartphone addiction. Neck extensor muscle endurance was assessed using the "Cervical Extension Endurance Test", neck pain at rest and during activity was analyzed using the "Visual Analog Scale", neck disability was assessed using the "Neck Pain and Disability Index", and sleep problems were investigated with the "Pittsburgh Sleep Quality Index". **Results:** It was found that 45.8% of the university students were addicted to smartphones. Neck extensor muscle endurance (p=0.029) was significantly lower, neck disability (p=0.039) and neck pain (rest pain p=0.050; activity pain p=0.012) were significantly higher in the smartphone addicted group. Neck extensor muscle endurance was not found to be associated with pain, neck disability and sleep quality among the participants with smartphone addiction. However, it was maintained that there is a positive correlation between neck disability, pain and sleep quality (p<0.005). **Conclusion:** Smartphone addiction causes neck pain, neck disability and sleep problems by weakening neck functions. Neck injury is linked to pain and sleep quality in smartphone addicts. Our results emphasize the importance of informing individuals about the risks of smartphone addiction. Especially in individuals with smartphone addiction, it is recommended to reduce the duration of phone use.

Keywords: Smartphone; neck muscles; neck pain; sleep

ÖZET Amaç: Çalışmanın amacı akıllı telefon bağımlılığı olan üniversite öğrencilerinde boyun ekstansör kas enduransının boyun ağrısı, boyun yeti yitimi ve uyku sorunlarına etkisini incelemektir. **Gereç ve Yöntemler:** Çalışma kapsamında 18-25 yaş arası 192 üniversite öğrencisi değerlendirilmiştir. Çalışmada demografik bilgiler için sosyodemografik bilgi anketi ve akıllı telefon bağımlılığını tespit etmek için "Akıllı Telefon Bağımlılık Ölçeği-Kısa Formu" kullanılmıştır. Boyun ekstansör kas enduransı "Servikal Ekstansiyon Endurans Testi", istirahat ve aktivite sırasındaki boyun ağrısı "Görsel Analog Skala", boyun yeti yitimi "Boyun Ağrı ve Dizabilite İndeksi", uyku sorunları "Pittsburgh Uyku Kalitesi İndeksi" ile değerlendirilmiştir. **Bulgular:** Çalışmada değerlendirilen üniversite öğrencilerinin %45,8'inin akıllı telefon bağımlısı olduğu görülmüştür. Akıllı telefon bağımlısı olan grupta boyun ekstansör kas enduransı (p=0,029) istatistiksel olarak anlamlı düzeyde düşük, boyun yeti yitimi (p=0,039) ve boyun ağrısı (istirahat ağrısı p=0,050; aktivite ağrısı p=0,012) ise istatistiksel olarak anlamlı düzeyde yüksek bulunmuştur. Akıllı telefon bağımlılığı olan katılımcılarda boyun ekstansör kas enduransı ile ağrı, boyun yeti yitimi ve uyku kalitesi arasında ilişki bulunamamıştır. Ancak boyun yeti yitimi ile ağrı ve uyku kalitesi arasında pozitif korelasyon olduğu saptanmıştır (p<0,005). **Sonuç:** Akıllı telefon bağımlılığı boyun fonksiyonlarının zayıflamasına neden olarak boyun ekstansör kas enduransının azalmasına, boyun yeti yitimine, boyun ağrısına ve uyku sorunlarına neden olmaktadır. Akıllı telefon bağımlılarında boyun yeti yitiminin ağrı ve uyku kalitesi ile ilişkili olduğu görülmektedir. Sonuçlarımız, bireylerin akıllı telefon bağımlılığı ve riskleri hakkında bilgilendirilmesinin önemini vurgulamaktadır. Özellikle akıllı telefon bağımlılığı olan bireylerde telefon kullanım süresinin azaltılması önerilmektedir.

Anahtar Kelimeler: Akıllı telefon; boyun kasları; boyun ağrısı; uyku

TO CITE THIS ARTICLE:
Özcan NT, Öztürk ÇP, Başkurt Z, Başkurt F. The effect of deep neck extensor muscle endurance on pain, disability and sleep quality among university students with smartphone addiction: A descriptive and cross-sectional study. Turkiye Klinikleri J Health Sci. 2025;10(2):460-8.

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Peer review under responsibility of Turkiye Klinikleri Journal of Health Sciences.

Received: 27 Oct 2024 ***Received in revised form:*** 10 Jan 2025 ***Accepted:*** 15 Jan 2025 ***Available online:*** 17 Apr 2025

Smartphones make people's lives easier with their numerous features. However, smartphone addiction causes both physical and psychological problems. The concept of nomophobia (no mobile phone), which refers to smartphone addiction, was first used in a study conducted in the United Kingdom in 2008. It has been observed that nomophobic people feel uncomfortable and anxious when they have a problem accessing their smartphone.[1] In a study conducted on the subject, it was mentioned that physical problems, depressive feelings and anxiety caused by excessive use of smartphones, difficulty in controlling the duration of smartphone use, frequent use of smartphones to escape from problems are associated with nomophobic attitude.[2]

It can be said that smartphone addiction has become a serious problem especially among young people and related studies are mostly focused on young people.[3] Smartphone addiction can cause physical inactivity, musculoskeletal problems, neurological problems and sleep disorders.[4,5] In addition, increased levels of anxiety, symptoms of depression have been reported in studies of the psychological effects of smartphone addiction.[3]

In studies examining the regional effects of smartphone use, it has been shown that long-term smartphone use causes pain in the cervical region, loss of sense of position, increased activity in the neck extensor muscles, decreased regional pain threshold in the shoulder region, wrist and thumb-related problems, increased pressure in the carpal tunnel, decreased nerve conduction velocity and overload in the tendons, due to being fixed in the flexion position.[6-10]

In studies examining the correlation between smartphone addiction with cervical muscle strength and endurance, different results were found. Although there are studies in the literature showing that cervical extensor muscle strength and endurance decreases among individuals with pain complaints during smartphone use, there are also studies showing that flexor muscle strength and endurance are maintained in the smartphone addicted group, as well as studies showing that flexor muscle endurance is reduced but extensor muscle endurance is kept at the same level.[7,11-13]

The purpose of this study is to measure neck extensor endurance among smartphone addicted group, to analyze the effects of addiction on extensor endurance and observe the relationship between endurance, neck disability, pain, and sleep.

MATERIAL AND METHODS

All volunteer students studying in the physiotherapy programme of Suleyman Demirel Universty, Isparta Health Services Vocational School were involved in the study. A total of 192 students participated in the study. Ethical approval for this study was granted from the from Clinical Trials Ethics Committee of Suleyman Demirel University, Faculty of Medicine (date: September 27, 2024, no: 80) and was performed in accord with the ethical standards of the Declaration of Helsinki.

The study inclusion criteria were to continue studying at university, having and using a smartphone for at least 2 years, being aged between 18 and 25. Participants were excluded from the study if they were receiving treatment for pain or sleep problems, had systemic or malignant disease, connective tissue or inflammatory disease, active localised osseous and disc pathology in the cervical region, a history of congenital abnormalities or fractures in the cervical region, a diagnosis of fibromyalgia, or a diagnosis of temporomandibular joint dysfunction.

In our study; "Sociodemographic data form", "Smartphone Addiction Scale-Short Form", "Visual Analogue Scale", "Neck Pain and Disability Index", "Pittsburg Sleep Quality Index (PSQI)", "Neck Extensor Muscle Endurance Test" were used. "Neck Extensor Muscle Endurance Test" was performed by a blinded researcher to the participants' smartphone addiction level.

Sociodemographic data form: Participants' sociodemographic information (gender, age, weight, height, smoking, sports habits) were recorded with the sociodemographic data form created by the researchers.

Smartphone Addiction Scale-Short Form: The Smartphone Addictino Scale, a 10-item, 6-point Likert-scale, was developed by Kwon et al. to determine smartphone addiction.[14] Turkish validity and re-

liability was determined by Noyan et al.[15] The responses on the scale are expressed as 1 "strongly disagree", 2 "disagree", 3 "partly disagree", 4 "partly agree", 5 "agree", 6 "strongly agree". Scale scores range from 10 to 60. As the score obtained from the scale increases, the risk of addiction rises. The scale is single-factor and has no subscales. Cut-off score is 31 for males and 33 for females.[14,15]

Visual Analogue Scale: Participants were questioned about resting and activity pain using a standard Visual Analogue Scale (VAS) (0-10) (0="no pain" 10="excruciating pain").[16]

Neck Pain and Disability Index: The Neck Pain and Disability Index is a form for the functional assessment of neck pain that was developed by Wheeler et al.[17] and Turkish validity and reliability study was conducted.[18] The questions investigated the severity of neck pain and its impact on recreational activities, occupational life, social and functional status related to life and its relationship with emotional factors. Each question is scored on a scale of 0-5. High scores indicate severe neck disability.

PSQI: It was developed by Buysse et al. in 1989.[19] The validity and reliability of the Turkish version was carried out by Ağargün et al.[20] The PSQI is a reliable, valid and standardised index that measures sleep quality over a 1-month period and enables clinical evaluation of various sleep disorders that may affect sleep quality. The PSQI includes 19 self-rate questions and 5 questions to be assessed by a housemate or roommate, if any. A 7 component scores generated from 19 self-assessment questions (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction). Each component is scored between 0-3. A score of "0" indicates no difficulty, while a score of "3" indicates severe difficulty. The scores of the 7 components are summed to obtain a total PSQI score, which ranges from 0 to 21. A high score indicates poor sleep quality. In our study, those with a total PSQI score greater than 5 were considered to have poor sleep quality; those with a total PSQI score of 5 or less were considered to have good sleep quality.[19]

Neck Extensor Muscle Endurance Measurement: "Cervical Extension Endurance Test" was used for the measurement of neck extensor muscle endurance. During the test, the participant lay prone position with their head protruding from the treatment table and their arms along their trunk. A belt was placed at the level of T6 to stabilize the upper thoracic spine. The participant's head was placed so that the cervical goniometer read 0 degrees and then was asked the participant to hold the head position steady with the chin retracted and the cervical spine in a horizontal position. The time spent in this position was recorded.[12] The test was terminated in the event of uncomfortable pain in the cervical region or a change in head angle of 5 or more degrees. Cervical extensor test has an intrarater reliability of 0.77 (95% CI of 0.55-0.89) and 0.9 (0.79-0.95) for 2 raters.[21] We had to change the original test because of the motion capture equipment. Unlike the current study, we used a goniometer instead of the laser in our study.[12]

STATISTICAL ANALYSIS

Before statistical analysis, the normality of the data was assessed. In the comparison of the data belonging to the groups with and without smartphone addiction, for independent groups, the t-test was used if the normality assumption was met. If the normality assumption was not met, the Mann-Whitney U test was used. Pearson correlation analysis was applied to investigate the relationship between the smartphone addiction score and neck extensor muscle endurance, neck disability and the PSQI score, since the data met the normality assumption. The relationship between the smartphone addiction score and pain severity was assessed using Spearman correlation analysis, since the data did not meet the normality assumption. The association was considered weak if the r value was <0.3, moderate if the r value was between 0.3 and 0.7, and strong if the r value was >0.7.[22]

RESULTS

The present study was planned to determine the effect of neck extensor muscle endurance on pain, neck disability and sleep quality among university students with smartphone addiction, the data collected from 192 university students were analyzed.

In our study, 141 (73.4%) of the participants were female and 51 (26.6%) were male. In both groups, the number of participants who smoked and exercised regularly was very close to each other, 67 (34.9%) participants smoked and 51 (26.6%) participants exercised regularly. It was observed that the mean smartphone addiction score of the participants in our study was 31.51, which is close to the cut-off (cut-off value for male: 31, cut-off value for female: 33). Eighty-eight participants (45.8%) were found to be addicted to smartphones and when the smartphone addiction levels according to the gender of participants were analysed, it was seen that the addiction level in women was higher than in men (Figure 1). It was also observed that 81 (42.2%) of the participants had pain at rest and 53.1% had pain during activity. One hundred two participants (77.2%) had sleep problems.

When comparing participants, smartphone addicted group and non-smartphone addicted group, there was no statistically significant difference between the groups regarding age, height, weight and body mass index, and the groups were similar considering these variables (Table 1).

When comparing the groups in terms of neck extensor muscle endurance, neck disability score and pain level, a statistically significant difference was stated. Pain level was found to be significantly higher in smartphone addicted group both at rest and during activity. Although there was no significant difference between the groups regarding sleep problems, there was a difference at the level of 92.6% (Table 2).

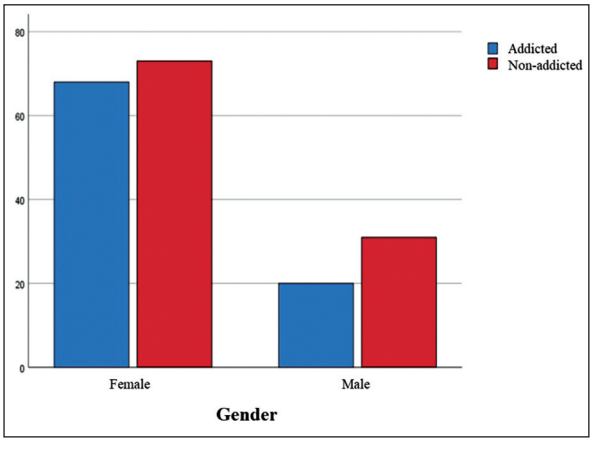

FIGURE 1: Smartphone addiction according to gender

TABLE 1: Comparison of demographic data between groups

	Smartphone addicted group n=88 (X̄±SD)	Non-smartphone addicted group n=104 (X̄±SD)	p value
Age (year)	20.09±1.378	20.29±1.46	0.316
Height (m)	1.67±0.08	1.67±0.08	0.983
Weight (kg)	61.44±11.94	61.60±12.32	0.927
BMI (kg/m^2)	21.79±3.36	21.82±3.39	0.948

Student t-test; SD: Standard deviation; m: Meter; kg: Kilogramme; BMI: Body Mass İndex

TABLE 2: Comparison of muscle endurance, neck disability, pain and sleep quality in smartphone addicted group and non-smartphone addicted group

	Smartphone addicted group n=88 (X̄±SD)	Non-smartphone addicted group n=104 (X̄±SD)	p value
Muscle endurance (sec)	88.30±51.98	107.72±69.96	**0.029**[b]
Neck disability score	22.40±17.54	17.09±17.71	**0.039**[b]
VAS (activity)	1.43±1.83	1.00±1.63	**0.050**[b]
VAS (resting)	2.20±2.24	1.53±2.25	**0.012**[b]
PSQI score	7.34±3.08	6.50±3.34	0.074[a]

[a]Student t-test; [b]Mann-Whitney U test; Values with p<0.05 are highlighted in bold; SD: Standard deviation; sec: Second; VAS: Visual analogue scale; PSQI: Pittsburg Sleep Quality Index

Figure 2 shows the graph comparing the means of neck extensor muscle endurance, neck disability and pain levels of the smartphone addicted group and non-addicted group.

In this study, when the relationship between the smartphone addiction score with neck extensor muscle endurance, neck disability, sleep problems, activity pain and resting pain was assessed, there was a weak, positive, bidirectional and statistically significant relationship between smartphone addiction with neck disability, sleep problems, resting pain and activity pain (respectively p: 0.001, r: 0.240; p: 0.001, r: 0.246; p: 0.008, r: 0.251; p:<0.001; r: 0.251). There was no relationship between smartphone addiction score and neck extensor muscle endurance (Table 3).

When the data of the smartphone addicted group were analysed, neck extensor muscle endurance was not associated with neck disability, pain and PSQI score. However, there was a moderately, positive, statistically significant relationship between neck disability score with PSQI score, resting and activity

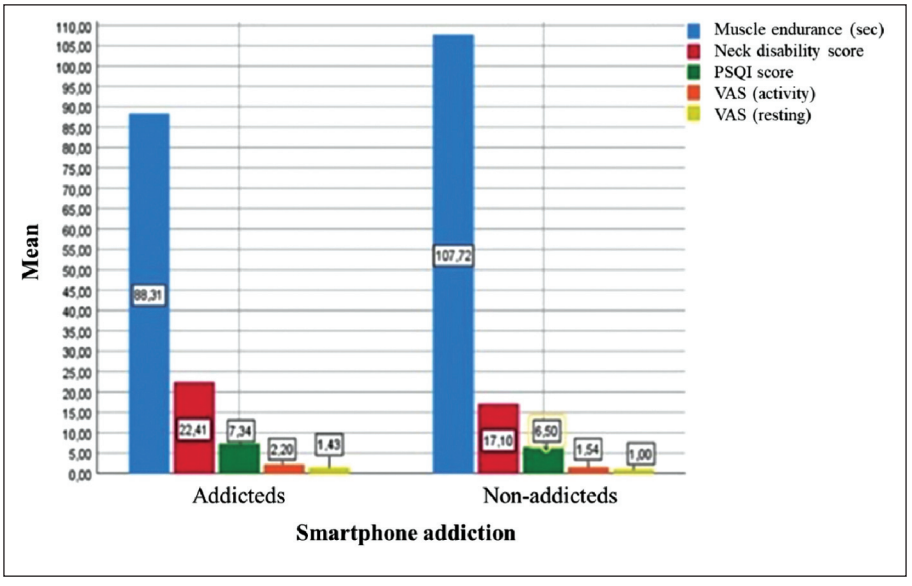

FIGURE 2: Mean values of muscle endurance, neck disability, pain and sleep quality in smartphone addicted and non-smartphone addicted groups

TABLE 3: The relationship between smartphone addiction score and muscle endurance, neck disability, pain and sleep quality

		Smartphone addiction score
Muscle endurance (sec)	Pearson r	-0.107
	p value	0.141
	n	192
Neck disability score	Pearson r	0.240
	p value	**0.001**
	n	192
VAS (activity)	Pearson r	0.251
	p value	**0.000**
	n	192
VAS (resting)	Spearman r	0.251
	p value	**0.008**
	n	192
PSQI score	Spearman r	0.246
	p value	**0.001**
	n	192

Values with p<0.05 are highlighted in bold; sec: Second; VAS: Visual analogue scale; PSQI: Pittsburg Sleep Quality Index

TABLE 4: Relationship of muscle endurance and neck disability with sleep quality and pain n smartphone addicted group

		Muscle endurance (sec)	Neck disability score
Muscle endurance (sec)	Pearson r	1	-0.097
	p value	-	0.368
	n	88	88
Neck disability score	Pearson r	-0.097	1
	p value	0.368	-
	n	88	88
VAS (activity)	Pearson r	0.136	0.519*
	p value	0.205	**0.000**
	n	88	88
VAS (resting)	Spearman r	-0.038	0.594*
	p value	0.726	**0.000**
	n	88	88
PSQI score	Spearman r	0.054	0.316*
	p value	0.614	**0.003**
	n	88	88

Values with p<0.05 are highlighted in bold; sec: Second; VAS: Visual analogue scale; PSQI: Pittsburg Sleep Quality Index

pain (respectively p: 0.03, r: 0.316; p: 0.000, r: 0.594; p: 0.000, r: 0.519) (Table 4).

DISCUSSION

As a result of our study conducted to determine the effect of neck extensor muscle endurance on pain, neck disability and sleep quality among smartphone addicted university students, it was found that neck extensor muscle endurance was lower among smartphone addicted group. Additionally, neck disability, PSQI score, resting and activity pain level were found

to be higher in the smartphone addicted group. Neck pain level and sleep quality in smartphone addicts were also associated with the level of neck disability.

Kim et al. reported that smartphone addiction occurs in approximately one in three university students, and that smartphone addiction is at a higher level in females.[4] It was observed that 88 [(45.8%); (68 female, 20 male)] of the university students evaluated in this study were addicted to smartphones. In this regard, our study is compatible with the results reported in the literature.

Studies investigating the effects of smartphone usage on neck extensor muscle endurance have reported different results. Similar to our study design, in a study in which smartphone addiction was evaluated with the "Smartphone Addiction Scale-Short Form" and neck extensor muscle endurance was evaluated with isometric muscle test, it was shown that neck extensor muscle endurance was lower in the smartphone addicted group compared to non-addicted group.[11] In a study examining the changes in the musculoskeletal system in the neck region after 30 minutes of smartphone use, it was reported that neck extensor muscle endurance was lower in individuals with neck pain during smartphone use than in individuals without neck pain, and it was found that there was a correlation between pain and endurance.[12] Alshahrani et al. evaluated smartphone addiction with "Smartphone Addiction Scale-Short Form" and neck extensor muscle endurance with isometric muscle test, found that neck extensor muscle endurance was preserved in the smartphone addicted group.[7] In our study, neck extensor muscle endurance was found to be statistically significantly lower in the smartphone addicted group compared to non-addicted group. In this sense, our study supports studies reporting decreased neck extensor muscle endurance in smartphone addicts. The reason for this result may be the higher percentage of female participants in the group with smartphone addiction. In many studies in which both healthy participants and participants with musculoskeletal problems were evaluated, it was observed that the neck extensor muscle endurance of the female gender was lower than that of the male gender. In a study in which patients with forward head posture were included, it was found that females had lower neck extensor muscle endurance.[23] In the study in which the same extensor muscle endurance measurement method was used and participants with similar demographic characteristics were evaluated, female participants had lower neck extensor muscle endurance compared to male participants.[24] It is also known that regular exercise has a positive effect on neck extensor muscle endurance.[25] We think that one of the reasons for the low muscle endurance in the smartphone addicted group may be related to the low regular exercise habits of the participants.

Neck pain is a common complaint in smartphone addicts. Moreover, neck disability was also evaluated in the studies and neck disability was found to be higher in smartphone addicts.[26,27] Guloglu et al. reported that the level of smartphone addiction was associated with neck pain and neck disability score in university students.[26] In our study, consistent with the previous studies, both pain level and neck disability were found to be higher in the group of people with smartphone addicion and both parameters were found to be associated with smartphone addiction score. In addition, in our study, it was observed that as the level of smartphone addiction increased, the resting and activity pain led by neck disability also increased. Our study and other studies show that as smartphone use increases, the level of pain and neck disability also increases. We think that this may be caused by the increased neck flexion posture during smartphone use. This posture causes changes in cervical lordosis and causes stress on the cervical spine. In addition, negative changes in muscle tissue or ligaments and deficits in proprioceptive sensation may also be associated with pain and neck disability.[11] In our study, it was found that sleep quality was poor in smartphone addicts. Poor sleep quality may also have contributed to increased pain perception and neck disability.

Exposure to blue light emitted from smartphones stimulates photoreceptors located in the retina and suppresses the hormone melatonin, which controls the sleep-wake cycle. In addition, electromagnetic waves emitted from the smartphone are known to cause changes in cerebral blood flow and electrical activity.[28] Systematic reviews on the topic show the negative effects of smartphone use on sleep health.[3,29] In our study, it was found that sleep problems were

common in smartphone addicted people and sleep problems increased as the smartphone addiction score increased. We think that the reason for this situation is due to hormonal and neural changes associated with smartphone addiction.

In our study, it was observed that there was no relationship between neck extensor muscle endurance with neck disability, pain and PSQI score in the smartphone addicted group. The reason for this may be the neck extensor muscle endurance values of the smartphone addicted group in our study. In our study, the average holding time in the smartphone addicted group was 88 seconds. In a study by Joona et al. investigating the normative values of neck extensor endurance test in 440 healthy young adult participants, it was found that the average holding time was 47 seconds for male participants and 40 seconds for female participants.[24] In our results, the mean neck extensor endurance test of the smartphone addicted group was twice the value reported by Joona et al.[24] The high neck extensor muscle endurance value of the smartphone addicted group may have contributed to neck posture and stabilisation, which may have prevented the relationship between neck extensor muscle endurance with neck disability, pain and sleep problems.

As a result of our study, we found that neck disability was found to be related to neck pain and sleep problems in smartphone addicts. Excessive use of smartphones can lead to habitual repetitive and continuous movements of the head and neck toward the screen throughout the day. Such movements are associated with a high risk of neck pain and may explain the association between neck disability and pain.[30] It is also known that there is a significant positive correlation between sleep quality and neck disability.[31] Munoz et al. investigated trigger points, neck disability and sleep quality in individuals with neck pain and, suggested that neck disability was associated with pain and sleep quality.[32] In addition, sleep problems lead to an increase in pain perception.[33] In this context, sleep problems were found in the smartphone addicted group may be a reason for the observed relationship between neck disability with pain and sleep problems by causing an increase in pain perception.

Other studies of smartphone addiction in the literature have assessed neck function or the relationship between addiction score and neck function in addicted and non-addicted groups. Differently from these studies, we think that our study will contribute to the literature in terms of examining the effect of addiction level on neck extensor muscle endurance, neck disability, pain and sleep problems in smartphone addicts and determining the relationship between these parameters.

There are some limitations to this study. In the method used for neck extensor muscle endurance measurement, the participant was asked to maintain the extension position as long as possible. Measurement involves motivation. This is an important factor that may vary from person to person and the result is recorded on a sensitive variable such as seconds. This may have affected the correlation between muscle endurance and other functional measures.

CONCLUSION

As a result of our study, it was found that neck extensor muscle endurance was lower, neck disability, PSQI score, resting and activity pain were higher in university students with smartphone addiction compared to the non-addicted group. In addition, neck disability level was found to be associated with neck pain and sleep quality in smartphone addicts. In this context, raising awareness of smartphone addiction and its consequences in the whole society, especially in young generations, and offering solutions will have a positive effect on individuals' health. Additionally, we believe that investigating the effects of approaches such as posture training or exercise programmes for individuals with smartphone addiction on complaints associated with smartphone addiction will contribute to the literature.

Acknowledgement

We are grateful to lecturer Ayşe SALTIK for her valuable guidance and support in the writing of this study.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that

has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Nadir Tayfun Özcan, Çağlayan Pınar Öztürk;* ***Design:*** *Nadir Tayfun Özcan, Zeliha Başkurt;* ***Control/Supervision:*** *Zeliha Başkurt, Ferdi Başkurt;* ***Data Collection and/or Processing:*** *Nadir Tayfun Özcan, Çağlayan Pınar Öztürk;* ***Analysis and/or Interpretation:*** *Çağlayan Pınar Öztürk;* ***Literature Review:*** *Nadir Tayfun Özcan, Çağlayan Pınar Öztürk;* ***Writing the Article:*** *Nadir Tayfun Özcan, Çağlayan Pınar Öztürk;* ***Critical Review:*** *Zeliha Başkurt, Ferdi Başkurt;* ***References and Fundings:*** *Nadir Tayfun Özcan, Çağlayan Pınar Öztürk;* ***Materials:*** *Nadir Tayfun Özcan, Çağlayan Pınar Öztürk.*

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