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THE EFFECT OF SMARTPHONE ADDICTION LEVEL ON NECK PAIN, FUNCTIONAL STATUS, AND MUSCLE ACTIVATION

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ABSTRACT

Objective: *The study was conducted on 112 university students to determine the smartphone addiction level of youths and to investigate the effect of addiction level on neck pain, functional level, muscle sensitivity, and muscle activation level of neck muscles (upper trapezius (UT), cervical erector spinae (CES), sternocleidomastoideus (SCM)).*

Material and Method: *The cervical muscles were evaluated bilaterally. Muscle activation levels were assessed using surface electromyography through measurements taken during rest and maximum isometric contraction. Muscle sensitivity was assessed using pressure pain threshold measurements. Additionally, the Smartphone Addiction Scale was used to determine the level of smartphone addiction, the Neck Disability Index was employed to assess functional status, and the Visual Analog Scale was utilized to evaluate pain intensity.*

Results: *There was a negative relationship between the level of smartphone addiction and the pressure pain threshold level of the right and left CES and left UT and functional level. As the smartphone addiction levels of the participants increased, their functional levels worsened, and their limitations increased. There was a positive relationship between the level of smartphone addiction and right CES and UT muscle activation. In addition, as the neck muscle activation level increased, the functional level decreased, the sensitivity and the pain level increased.*

Conclusion: *As a result, it was determined that smartphone addiction in youths affects the functional level, activation, and sensitivity of neck muscles. Taking into account the effects of smartphone addiction in the study, it is necessary to take necessary precautions regarding smartphone usage and addiction in youths.*

Keywords: *Functional status, muscle activation, neck muscles, pain, sensitivity, smartphone addiction.*

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AKILLI TELEFON BAĞIMLILIK DÜZEYİNİN BOYUN AĞRISI, FONKSİYONEL DÜZEY VE KAS AKTİVASYONUNA ETKİSİ

ÖZET

Amaç: Çalışmada, 112 üniversite öğrencisinde akıllı telefon bağımlılık düzeyini belirlemek ve bağımlılık düzeyinin boyun ağrısı, fonksiyonel düzey, boyun kaslarının (üst trapezius (ÜT), servikal erector spinae (SES), sternokleidomastoideus (SKM)) basınç ağrı eşiği düzeyi ve kas aktivasyonu üzerindeki etkisini araştırmak amaçlanmıştır.

Materyal ve Metot: Katılımcıların boyun çevresi kasları bilateral olarak değerlendirilmiştir. Kas aktivasyon düzeyleri, dinlenme ve maksimum izometrik kontraksiyon sırasında alınan ölçümlerle yüzeyel elektromiyografi yöntemi kullanılarak değerlendirilmiştir. Kas hassasiyeti, basınç ağrı eşiği ölçümleriyle değerlendirilmiştir. Ayrıca, akıllı telefon bağımlılık düzeyini belirlemek için Akıllı Telefon Bağımlılık İndeksi, fonksiyonel durumu değerlendirmek için Boyun Özür Ölçeği ve ağrı şiddetini değerlendirmek için Görsel Analog Skala kullanılmıştır.

Bulgular: Akıllı telefon bağımlılığı düzeyi ile sağ ve sol SES ve sol ÜT ve basınç ağrı eşiği düzeyi ve fonksiyonel düzey arasında negatif bir ilişki bulunmuştur. Katılımcıların akıllı telefon bağımlılığı düzeyleri arttıkça fonksiyonel düzeylerinin kötüleştiği ve kısıtlılıklarının arttığı gözlemlenmiştir. Akıllı telefon bağımlılık düzeyi ile sağ SES ve ÜT kas aktivasyonu arasında pozitif bir ilişki bulunmuştur. Ayrıca boyun kası aktivasyon düzeyi arttıkça fonksiyonel düzeyin azaldığı, hassasiyet ve ağrı düzeyinin arttığı tespit edilmiştir.

Sonuç: Sonuç olarak, gençlerde akıllı telefon bağımlılığının boyun kaslarının fonksiyonel seviyesi, aktivasyonu ve hassasiyeti üzerinde etkili olduğu bulunmuştur. Çalışmada akıllı telefon bağımlılığının etkileri göz önüne alındığında, gençlerde akıllı telefon kullanımı ve bağımlılığı konusunda gerekli önlemlerin alınması gerekmektedir.

Anahtar kelimeler: Akıllı telefon bağımlılığı, ağrı, boyun kasları, hassasiyet, fonksiyonel düzey, kas aktivasyonu.

INTRODUCTION

Smartphones are increasingly essential in daily life, especially among adolescents, and offer a wide variety of mobile applications for entertainment, communication, and information.[1] Smartphone users encompass a diverse range of profiles, including teenagers, adults, and children, regardless of their employment status. However, when examining the smartphone user profile, it is observed that the largest proportion is among the young population.[2]

Today, many psychological, physiological, and social problems are encountered due to smartphone addiction, which turns into a behavioral addiction with the increase in usage frequency.[3] These problems can be categorized into two main types: psychological disorders, which include sleep disturbances, depressive symptoms, high anxiety levels, low life satisfaction, school dropouts, and personality disorders; and physiological disorders, which involve neck or back pain, postural issues, musculoskeletal disorders, and migraines.[2-4] One major concern regarding the impact on physical health is the increase in neck and back pain, and a reduction in daily living activities and overall functional level.[4,5] The effects of smartphone usage on the functional level correlate with the cervical posture and the spasm, sensitivity, and proprioceptive disorders in the neck structures created by this improper posture. Both computer and smartphone addiction, which exhibit similar effects, have been correlated with neck pathologies and disabilities in youths.[6] Research indicates that smartphone addiction in students adversely affects physical health by reducing physical activity levels, such as walking.[7] In the literature, prolonged smartphone usage has been associated with increased muscle and sensitivity in the cervical erector spinae (CES) and upper trapezius (UT) muscles.[5,8] Although there is existing data on the negative effects of smartphone usage on various physiological parameters, such as pain and functional levels, more clinical trial is needed to evaluate the impact of smartphone addiction, which has become a critical concern in recent years.

Improper posture while using a smartphone is the primary cause of musculoskeletal disorders.[9-11] When using a smartphone, individuals often adopt a position where their head is flexed forward, and their shoulders are protracted for extended periods to view the device.[9,11] Studies show that the load on the neck muscle increases when the head is flexed.[11] This prolonged position affects the muscles of the neck,

spine, and shoulder, leading to muscle imbalances.[12] In current studies, it has been emphasized that poor posture during smartphone usage changes the activity of the hand muscles, neck extensor muscles, CES muscle, and UT muscle.[9,10]

Numerous studies have investigated the acute effects of smartphone usage on changes in muscle activation, the musculoskeletal system, and daily living activities.[10] However, it is thought that there is a need for a study that correlates smartphone addiction with musculoskeletal problems such as pain and sensitivity, muscle activation changes in the neck muscles, and changes in functional status. It is thought that the determination of physiological effects, such as neck pain and muscle activations that they cause even when they do not use phones, is thought to be effective in terms of drawing attention to the importance of preventing them. In light of the information, our study aimed to investigate how smartphone addiction levels affect neck pain, muscle activation, and functional status.

MATERIAL and METHOD

Study Design

This prospective clinical study investigated the effect of smartphone addiction levels on functional status, neck pain, and muscle activation. Ethical approval was obtained from the Clinical Research Ethics Committee (No: 72867572.050.01.04) before the study began, in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants, ensuring compliance with the principles of privacy, benefit, and information gathering throughout the study.

Participants

The study included a total of 112 male university students. Inclusion criteria were: (1) volunteering to participate in the study, and (2) smartphone use of at least two hours per day for the past six months. Exclusion criteria were: (1) a history of surgical intervention or traumatic injury to the spine and upper extremity; (2) a chronic disease affecting the musculoskeletal system includes osteoarthritis, and other connective soft tissue diseases; (3) a sensory impairment in the spine or upper extremities related to neurological or orthopedic conditions; (4) engaging in activities like long-term reading that may affect head flexion posture in the past month; and (5) having performed exercises involving neck muscles in the last month..[13,14]

A questionnaire was administered, which included the Smartphone Addiction Scale, the Neck Disability Index, the Visual Analogue Scale, and demographic information (age, height, weight, dominant extremity, etc.). Data were collected through in-person interviews. Given the potential acute effects of the intensive use of smartphones during the day, the evaluations were carried out in the early hours of the day. Additionally, cervical erector spinae, the upper trapezius, and sternocleidomastoideus (SCM) muscles were evaluated bilaterally in the participants. Muscle activation levels were assessed using a superficial electromyography device, focusing on resting and maximum isometric contractions. In the muscle sensitivity assessment, the pressure pain threshold (PPT) was examined in the relevant evaluation positions of six selected muscles.

Outcome Measures

Neck Pain Intensity

The Visual Analogue Scale (VAS) was utilized to evaluate the intensity of neck pain. This continuous scale consists of a 100 mm long horizontal line, marked by two endpoints: zero, which represents no pain on the left side, and ten, indicating the worst imaginable pain on the right side. Participants were asked to mark the point on the line that corresponds to the intensity of their pain. The numerical value determined by their mark reflects the severity of the participants' pain.[15,16]

Smartphone Addiction Level

The level of smartphone addiction was evaluated using the Smartphone Addiction Scale (SAS), which was developed by Kwon et al. in 2013. The Turkish version of this scale was assessed for validity and reliability in a younger population by Demirci et al. in 2014.[17,18] The SAS is an appropriate tool for measuring smartphone addiction levels among young people. The scale consists of 7 factors that evaluate daily life disturbance and tolerance (1st factor), withdrawal symptoms (2nd factor), positive expectation (3rd factor), cyber-oriented relationships (4th factor), excessive use (5th factor), social network addiction (6th factor), and physical symptoms (7th factor). The scores on the scale can range from 33 to 198. The high score indicates a more serious smartphone addiction level. [6,18]

Functional Level

Functional level was evaluated using the Neck Disability Index (NDI), which was developed by Vernon et al. The validity and reliability assessment of its Turkish version was carried out by Aslan et al. in 2008.[19] Survey questions: Daily life activities, such as lifting, working, driving, and resting consist of 4 titles, optional activities in daily life, such as personal care consist of 2 titles, and subjective symptoms, such as pain sensitivity, headache, concentration, and sleep consist of 4 titles. The highest score is 50, and the lowest score is 0. The classification based on total score is as follows: 0-4 points indicate no disability, 5-14 points indicate mild disability, 15-24 points indicate moderate disability, 25-34 points indicate severe disability, and 34 points and above indicate complete disability.[8] Participants were asked to respond to the questions based on the neck pain they experienced over the past week.

Pain Sensitivity Level

Pressure pain threshold (PPT) is used to assess sensitivity to pain and pressure perception. Using a Wagner Instruments Force Dial (Greenwich, CT, USA) device, a constant force of 1 kg / cm^2 was applied to the CES, UT, and SCM muscles bilaterally. The PPT was evaluated three times at each site, and the average of these measurements was used for further analysis. Participants rested for 5 minutes between each measurement.[4]

Muscle Activation Level

The activation of neck muscles consisting of SCM, UT, and CES muscles was measured by surface electromyography (sEMG). Measurements were made in the resting position bilaterally. For the resting position, the patient was evaluated in a chair without back support, in a sitting position with arms supported in the front, and in a posture without pain.[10,20] The skin was prepared to reduce impedance to below 10 kΩ by shaving hair at electrode sites, gently abrading the skin with light sandpaper, and cleaning the area with alcohol.[21] Superficial electromyography signals were recorded using the MYOQUICK- EMG EP LINE Device and System PLUS EVOLUTION program.[22]

Electrodes were placed according to the criteria determined by SENIAM (Surface Electromyography for the Non-Invasive Assessment of Muscles).[23] The received raw sEMG records were processed using a 20-500 Hz High Pass Filter, and a bandpass filter was applied to maximize the continuous range while reducing the probability of false negatives.[21] Muscle activation for the CES, UT, and SCM muscles was recorded superficially, both at rest and during voluntary maximum isometric contraction. These recorded values were used in the normalization process to compare the cases. With the maximum voluntary isometric contractions (MVC) method used for the normalization process, it becomes suitable for analysis, such as comparison and statistical processes, as the sEMG signals are shown as a percentage of the maximum values specific to that muscle and person. MVC and the resting position electrical activity were recorded for each muscle separately. The superficial electromyography recording in the resting position was evaluated after 30 seconds of recording, as optimal activity was observed at that point, and the mean value was taken into account. The maximum isometric contraction records of the muscles to be evaluated were taken in the relevant muscle evaluation position of the muscle to be evaluated.[24-26]

Data Analysis and Statistics

The required sample size was calculated using G*POWER statistical software. To detect a large effect size between SAS and NDI, with an α value of 0.05, 61 participants were deemed sufficient.[27] The analysis was conducted using version 20.0 of the Statistical Package for the Social Sciences (SPSS) for Windows, and complementary statistics were included in the assessment. A statistical significance level was established at a p-value of less than 0.05. In analyzing the data, we examined the number of cases, along with the mean, standard deviation (SD), and percentage distributions to evaluate demographic information. The normal distribution of measurable data was assessed using the Kolmogorov–Smirnov test. For correlation analysis, both Spearman's and Pearson's correlation tests were utilized. In this study, effect sizes were interpreted based on the magnitude of the Spearman correlation coefficients, with values between 0.10–0.29 considered small, 0.30–0.49 as medium, and values of 0.50 or above as large, in accordance with Cohen's (1988) guidelines.[28]

RESULTS

General Characteristics of Participants

The participants in the study were aged between 18 and 25 years, with a mean age of 21.42±1.61 years. The average body weight of the participants

was 74.39±10.94 kg, their average height was 177.98±5.35 cm, and their average BMI values were 23.46±3.16 kg / m2. The dominant extremity of only 12 of 112 participants is left-handed. Of the subjects participating in the study, 33% had smoking habits, 14.3% had alcohol habits, and 55.4% had exercise habits. Within the study sample, statistical analyses revealed no significant associations between the level of smartphone addiction and demographic variables such as age, body mass index (BMI), smoking status, alcohol use, and exercise habits (Table 1).

The average score of smartphone addiction level was determined as 81.92±21.26 points (Table 2). The average values of 7 sub-parameters of smartphone addiction level were examined. While the highest mean value is associated with the positive expectation sub-parameter (third factor- positive expectation), the lowest mean value belongs to the sub-parameter (fourth factor- cyber-oriented relationships) that evaluates cyber-focused relationships.

The pain levels of the participants ranged from 0 to 6. It was found that the mean of the right PPT levels in the CES, UT, and SCM muscles was higher than the averages of the left PPT levels of the same muscles (Table 2). The mean score of the NDI for participants was 6.08±3.74 points (Table 2). It was determined that there was no disability in 38.4% of the cases, mild disability was present in 60.7%, and moderate disability was found in 0.9%. In normalized muscle activation rates, the highest activation was observed in the CES muscles and the lowest in the SCM muscles. Increased activation was noted in the left CES muscle compared to the right, in the right UT muscle compared to the left, and in the right SCM muscle compared to the left.

Table 1. The relationship between smartphone addiction level and demographic variables

			Smartphone Addiction Scale 81.92 ± 21.26	
Variables Mean±Sd		n	z/r	*p*
Age (years) (r) 21.42 ± 1.61		112	-0.170	0.074
BMI (kg/m2) (r) 23.46 ± 3.16		112	-0.180	0.058
Smoking Habits (z)	Yes	37	0.306	0.759
	No	75		
Alcohol Habits (z)	Yes	16	0.133	0.894
	No	96		
Exercise Habits (z)	Yes	62	-0.419	0.676
	No	50		

BMI: Body Mass Index, r: Pearson Correlation Analysis, z: Mann-Whitney U Test, **SD:** Standard deviation, *$p<0.05$

Table 2. The mean score of smartphone addiction level, pain, pressure pain threshold, and neck disability levels of the participants

		Mean	Standard Deviation
Smartphone Addiction Scale		81.92	21.26
VAS		1.25	1.74
Pressure Pain Threshold	CES-Right	5.39	2.31
	CES-Left	4.84	2.34
	UT-Right	6.26	3.08
	UT-Left	5.61	2.70
	SCM-Right	2.38	0.97
	SCM-Left	2.08	1.03
Neck Disability Index		6.08	3.74

CES: Cervical Erector Spinae, **UT:** Upper Trapezius, **SCM:** Sternocleidomastoideus, **PPT:** Pressure Pain Threshold, **VAS:** Visual Analogue Scale, **SAS:** Smartphone Addiction Scale

Smartphone Addiction Level on Neck Pain, Functional Status, and Muscle Activation

There was no significant correlation between the level of smartphone addiction and pain in the neck region (r=0.130, *p*=0.893). However, statistically significant negative correlations were found between smartphone addiction levels and the PPT levels of the right CES (r=-0.256, *p*=0.006) and the left CES (r=-0.188, *p*=0.047) muscles, as well as the left UT muscle (r=-0.176, *p*=0.043). Additionally, a statistically significant positive correlation was observed between the NDI score and the level of smartphone addiction (r=0.327, *p*=0.000) (Figure), as well as the activation of the right CES muscle (r=0.254, *p*=0.007) and the right UT muscle (r=0.200, *p*=0.035) (Table 3). When pain, PPT level, and functional level, which are related to muscle activation level, were examined, a positive correlation between PPT and muscle activation level in the left CES muscle (r=0.258, *p*=0.047), and a negative correlation between pain and muscle activation level in the left CES muscle (r=-0.262, *p*=0.005) was determined. Additionally, a positive correlation was observed between the activation level of the right CES muscle (r=0.193, *p*=0.042), the right UT (r=0.289, *p*=0.002), and the left UT (r=0.256, *p*=0.007) muscles, and the NDI score. It has been shown that the level of muscle activation in the neck muscles increases as the functional level decreases, the PPT level decreases, and the pain level increases (Table 4). The correlation between the NDI score and smartphone addiction demonstrated a medium effect size, whereas all other statistically significant correlations showed small effect sizes (Tables 3 and 4).

Table 3. The relationship between smartphone addiction level and neck pain, functional status, and muscle activation

Smartphone Addiction Scale		*r*	*p*
VAS		0.130	0.893
Pressure Pain Threshold	CES-Right	-0.256	0.006*
	CES-Left	-0.188	0.047*
	UT-Right	-0.091	0.340
	UT-Left	-0.176	0.043*
	SCM-Right	-0.153	0.107
	SCM-Left	-0.135	0.157
Neck Disability Index		0.327	$p<0.001$*
Muscle Activation Level	CES-Right	0.254	0.007*
	CES-Left	0.070	0.461
	UT-Right	0.200	0.035*
	UT-Left	0.040	0.675
	SCM-Right	-0.155	0.103
	SCM-Left	-0.116	0.222

CES: Cervical Erector Spinae, **UT:** Upper Trapezius, **SCM:** Sternocleidomastoideus, **PPT:** Pressure Pain Threshold, **VAS:** Visual Analogue Scale, **SAS:** Smartphone Addiction Scale
Spearman Correlation Analysis, *$p<0.05$

Table 4. The relationship between muscle activation level and pain, pressure pain threshold level, and functional level of participants

		Muscle Activation Level					
		CES-Right	CES-Left	UT-Right	UT-Left	SCM-Right	*SCM-Left*
PPT	*r*	0.128	0.158	-0.072	-0.012	-0.128	-0.104
	p	0.178	0.047*	0.451	0.896	0.180	0.276
VAS	*r*	-0.090	-0.262	0.050	0.002	0.130	0.009
	p	0.347	0.005*	0.603	0.986	0.170	0.923
NDI	*r*	0.193	0.080	0.289	0.256	0.057	0.086
	p	0.042*	0.400	0.002*	0.007*	0.550	0.365

CES: Cervical Erector Spinae, **UT:** Upper Trapezius, **SCM:** Sternocleidomastoideus, **PPT:** Pressure Pain Threshold, **VAS:** Visual Analogue Scale, **NDI:** Neck Disability Index
Spearman Correlation Analysis, *$p<0.05$

DISCUSSION

In the study, which was planned to investigate the smartphone addiction level of young people and to examine the effect of smartphone addiction level on functional level, neck pain, neck muscles sensitivity and muscle activation; it has been shown that increased sensitivity and activation in neck muscles can be encountered with increasing smartphone addiction and that smartphone addiction has negative effects at the functional level. In addition, muscle activation levels in the neck muscles have been shown that the muscle activation increase as the functional level decreases, sensitivity increases, and pain level increases.

Research on smartphone addiction has revealed varying levels of addiction among different groups. One study conducted with 366 medical students reported an addiction level of 80.96 points. In contrast, another study by Kwon et al., which involved 197 participants, found a higher average addiction level of 110.02 points.[17,29] In our results, the average addiction level score of 112 students was determined as 81.92±21.26 points. In our sample, the level of smartphone addiction is similar to medicine students in Turkey, but it appears to be lower than that in Korea. In a survey conducted in 2013 in South Korea smartphone usage rate was reported as 67%, while 19% was reported in Turkey.[30] Differences in smartphone addiction levels may be related to usage rates and cultural factors, according to the study data.

College students showed a high prevalence of neck pain and smartphone addiction, but these were not reported to be statistically related.[31] Similarly, in our study, we found no correlation between the level of smartphone addiction and the severity of neck pain. A study conducted in 2015 indicated that excessive smartphone use increases stress on the cervical spine, and the duration of smartphone use was correlated with the PPT levels of the SCM and UT muscles.[32] Another study shows that a neck flexion posture can cause irritation and spasms in the muscles and ligaments of the neck.[33] Furthermore, it was shown that frequent smartphone users had significantly lower PPT levels in the UT and SCM muscles.[32] Additionally, it was proven that a negative relationship was found between the PPT levels of the CES and UT muscles and smartphone usage.[8] Similarly, in our study, we also observed that as smartphone addiction levels increased, there was a corresponding decrease in the PPT level of the right and left CES and the left UT muscles. It is thought that this decrease in PPT may result from increased muscle activation or spasms caused by prolonged stress on the neck structures due to smartphone addiction.

Research has shown a correlation between neck pain, functional levels, and smartphone use among smartphone users.[6] It is accepted that increased neck flexion during smartphone usage leads to higher levels of neck disability.[1] In addition, a positive correlation has been determined between the level of smartphone addiction and neck disability level among physiotherapy students.[1] Our study similarly found that as smartphone addiction levels increase, neck disability levels increase while functional levels decrease. When smartphone usage becomes addictive, it negatively impacts an individual's functional level, related to the effects of other types of addiction, leading to feelings of physiological impairment.

In a study assessing posture and muscle activation in children using desktop and tablet computers, researchers found that children using tablets exhibited impaired neutral spine posture, increased scapular elevation, and increased activity in the CES and UT muscles.[34] Additionally, an increase in muscle fatigue and activity in the bilateral CES and UT muscles was reported after just 20 minutes of smartphone use.[35] Healthy adults also demonstrated increased muscle activity in the right UT muscle while using smartphones in both sitting and standing positions.[36] In our study, we identified a positive correlation between the activation levels of the right CES and right UT muscles and smartphone addiction. While existing literature evaluates the effects of smartphone usage on shoulder and muscle activation during phone usage, our study specifically investigates the impacts of smartphone addiction rather than acute smartphone use.

In the present study, the effect of smartphone addiction level on neck pain, functional status, and neck muscle activation level was examined. Considering the potential confounding effects of demographic variables, additional analyses were conducted to assess the associations between smartphone addiction and demographic variables such as age, BMI, smoking, alcohol consumption, and exercise habits. The findings revealed no statistically significant relationship between smartphone addiction and these demographic variables. This absence of association suggests that the observed relationship between smartphone addiction level and the primary clinical outcomes was not influenced by demographic variables. As such, the objectivity and internal validity of the findings related to neck pain, functional status, muscle sensitivity, and activation levels in relation to smartphone addiction are strengthened.

Research indicates that individuals with neck pain often experience a decreased pressure pain threshold and increased muscle activity.[37] In our study, it was shown that there was a correlation between the PPT level of the left CES muscle and muscle activity. Our findings are consistent with existing literature and suggest that increased muscle activity at rest may be associated with smartphone addiction. This increased smartphone usage could cause repetitive stress in the neck muscles and ligaments, leading to muscle spasms and increased sensitivity, especially in the neck muscles.

Research has shown that patients with myofascial pain exhibit increased spontaneous activity in the motor units of resting muscles. Many studies have reported increased muscle activity, particularly in the UT muscles.[26] Research also indicates that the activation level of the superficial neck extensor muscles increases

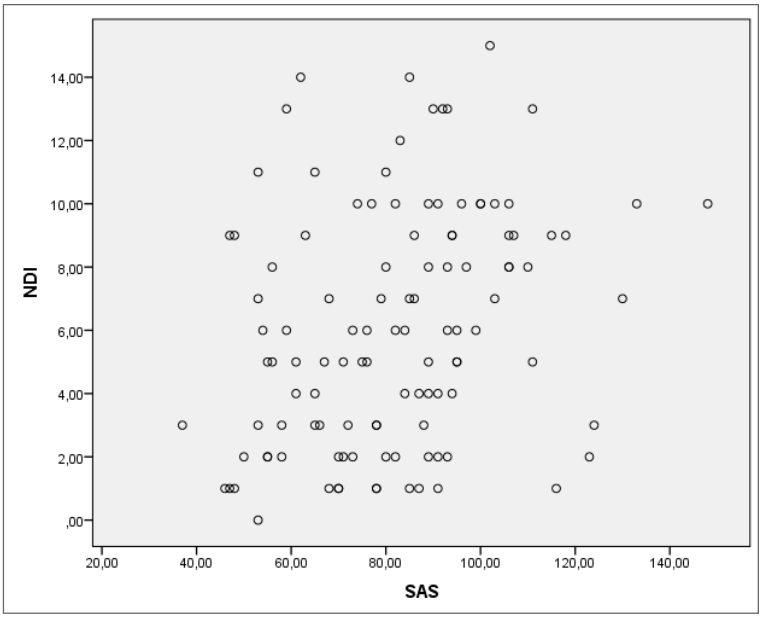

Figure. Relationship between smartphone addiction levels and neck disability scores.
NDI: Neck Disability Index, **SAS:** Smartphone Addiction Scale

in response to neck pain, while recent studies have found that the activation of the deep neck extensor muscles decreases in individuals experiencing neck pain.[38] In our study, we found a negative correlation between the left CES activity and pain levels. It is believed that the increased pain may result from an imbalance in muscle dynamics caused by repetitive stress, as well as from spasms and increased sensitivity in the neck muscles.

The study examining the activities of the SCM, CES, and UT muscles in female office workers with neck pain revealed a relationship between muscle activations and neck disability level.[39] Consistently, our study found a significant positive correlation between the activation levels of the right CES, right UT, and left UT muscles and the neck disability scale score. Muscle imbalances stemming from postural disorders, particularly in these muscles, can lead to increased muscle activation, resulting in pain and decreased functional capacity. Our findings support these conclusions and are consistent with existing literature.

In our study, differences were observed between the right and left cervical muscles in terms of muscle activation and sensitivity, particularly with stronger associations identified between smartphone addiction and the right CES and UT muscles. Such asymmetries have also been reported in previous studies and may be attributed to habitual patterns of smartphone use, including dominant hand preference, asymmetrical posture, and the tendency to hold the device predominantly on one side.[40-42] Most individuals are right-handed and may therefore use their right arm and shoulder more

intensively during smartphone interaction, potentially leading to repetitive stress and increased muscular load on the dominant side. Furthermore, prolonged one-sided usage may cause postural imbalances, resulting in localized fatigue, increased muscle tone, and altered neuromuscular control.[13,43] These findings suggest that lateralized differences in muscle response may be explained by biomechanical and behavioral factors related to device handling. Future research should consider dominant hand usage, device holding posture, and movement asymmetries to better understand the mechanisms underlying right–left muscular discrepancies in smartphone users.

In this study, the findings were evaluated not only in terms of statistical significance but also in terms of clinical relevance. Although the observed reductions in PPT levels and increases in muscle activation in the CES and UT muscles demonstrated small effect sizes, these changes may still have meaningful implications for clinical outcomes, such as neck discomfort, muscle fatigue, and functional limitations in daily life. Furthermore, the correlation between smartphone addiction and functional level yielded a moderate effect size, suggesting that higher levels of addiction may negatively impact individuals' academic, social, and occupational performance. Therefore, the current findings should be considered not only statistically significant but also clinically meaningful, as they reflect potential impacts on overall quality of life.

Limitations

The limitations of this study include the fact that it was conducted exclusively on men due to the potential influence of the menstrual cycle on superficial electromyography recordings in women. Additionally, the recordings were taken at rest to assess chronic exposure, rather than during smartphone use. The study employed wired disc electrodes for the recordings, which may have impacted the quality of the electromyography signals.

CONCLUSION

This study demonstrated that increasing smartphone addiction in young individuals negatively affects cervical muscle activation, sensitivity, and functional capacity. These findings highlight the need for both individualized rehabilitation strategies and broader public health interventions. Rehabilitation should include targeted physiotherapy approaches such as postural training, cervical stabilization exercises, and ergonomic counseling. In parallel, public health initiatives focusing on proper smartphone use, posture education, and screen time management may help prevent long-term musculoskeletal problems in the cervical region. In conclusion, a comprehensive approach combining clinical rehabilitation and preventive public health strategies is essential to address the cervical consequences of smartphone addiction.

Main Points

- Increased smartphone addiction in young individuals is associated with increased activation in the right cervical erector spinae and right upper trapezius muscles.
- Bilateral sensitivity in the cervical erector spinae muscles rises in parallel with smartphone dependency, indicating heightened neuromuscular stress.
- Increased smartphone addiction in young individuals is correlated with a decline in cervical functional level, reflecting impaired neuromuscular performance.
- Reducing smartphone addiction is essential to prevent long-term musculoskeletal dysfunction and to promote overall cervical spine health among young populations.

*The authors declare that there are no conflicts of interest.

REFERENCES

1. Shah PP, Sheth MS. Correlation of smartphone use addiction with text neck syndrome and SMS thumb in physiotherapy students. Int J Community Med Public Health 2018; 5: 2512-2516.
2. Agrawal YK, Hande D. Effect of activation of deep neck flexor muscle exercise on neck pain due to smartphone addiction. IJMTRD 2017; 4: 489-492.
3. Panova T, Carbonell X. Is smartphone addiction really an addiction? J Behav Addict 2018; 7: 252–259.
4. Lee M, Hong Y, Lee S, et al. The effects of smartphone use on upper extremity muscle activity and pain threshold. J Phys Ther Sci 2015; 27: 1743-1745.
5. Kim SY, Koo SJ. Effect of duration of smartphone use on muscle fatigue and pain caused by forward head posture in adults. J Phys Ther Sci 2016; 28: 1669-1672.
6. AlAbdulwahab SS, Kachanathu SJ, AlMotairi MS. Smartphone use addiction can cause neck disability. Musculoskelet Care 2017; 15: 10-12.
7. Kim SE, Kim JW, Jee YS. Relationship between smartphone addiction and physical activity in Chinese international students in Korea. J Behav Addict 2015; 4: 200-205.

8. So YJ, Woo YK. Effects of smartphone use on muscle fatigue and pain and, cervical range of motion among subjects with and without neck muscle pain. Phys Ther Korea 2014; 21: 28-37.
9. Eitivipart AC, Viriyarojanakul S, Redhead L. Musculoskeletal disorder and pain associated with smartphone use: A systematic review of biomechanical evidence. Hong Kong Physiother J 2019; 38: 77-90.
10. Namwongsa S, Puntumetakul R, Neubert MS, Boucaut R. Effect of neck flexion angles on neck muscle activity among smartphone users with and without neck pain. Ergonomics 2019; 62: 15241533.
11. Park J, Kim K, Kim N, et al. A comparison of cervical flexion, pain, and clinical depression in frequency of smartphone use. IJBSBT 2015; 7: 183-190.
12. Lee J, Seo K. The comparison of cervical repositioning errors according to smartphone addiction grades. J Phys Ther Sci 2014; 26: 595-598.
13. Xie Y, Szeto GP, Dai J, Madeleine P. A comparison of muscle activity in using touchscreen smartphone among young people with and without chronic neck-shoulder pain. Ergonomics 2016; 59: 61-72.
14. Park JH, Kang SY, Lee SG, Jeon HS. The effects of smartphone gaming duration on muscle activation and spinal posture: Pilot study. Physiother Theory Pract 2017; 33: 661-669.
15. Aydın OU, Aydın EU. Comparison of VAS scores recorded by nurse vs surgeon: A case-control study. JOSAM 2018; 2: 74-77.
16. Chiarotto A, Maxwell LJ, Ostelo RW, et al. Measurement Properties of Visual Analogue Scale, Numeric Rating Scale, and Pain Severity Subscale of the Brief Pain Inventory in Patients With Low Back Pain: A Systematic Review. J Pain 2019; 20: 245–263.
17. Kwon M, Lee JY, Won WY, et al. Development and validation of a smartphone addiction scale (SAS). PloS One 2013; 8: 56936.
18. Demirci K, Orhan H, Demirdas A, Akpinar A, Sert H. Validity and reliability of the Turkish Version of the Smartphone Addiction Scale in a younger population. Klinik Psikofarmakol Bülteni 2014; 24: 226-234.
19. Aslan E, Karaduman A, Yakut Y, et al. The cultural adaptation, reliability and validity of neck disability index in patients with neck pain: a Turkish version study. Spine 2008; 33: 362–365.
20. Kim GE, Yun DU, An YJ, Park DS, Ham JH. Reliability and validity of new evaluation methods using static surface electromyography in persons with neck pain. Phys Ther Rehabil Sci 2019; 8: 1-7.
21. Xie Y. A study of musculoskeletal loading in using a touchscreen smartphone among young people with and without chronic neck-shoulder pain. Master's Thesis, China: The Hong Kong Polytechnic University, Department of Rehabilitation Sciences, 2016.
22. MICROMED. Solutions for neurophysiology 2019. http://www.micromed.eu/en-us/
23. SENIAM (Surface Electromyography for the Non-Invasive Assessment of Muscles) 2019. http://www.seniam.org/
24. Bergamini M, Pierleoni F, Gizdulich A, Bergamini C. Dental occlusion and body posture: a surface EMG study. Cranio-J Craniomandib Pract 2008; 26: 25-32.
25. Hanvold TN, Wærsted M, Mengshoel AM, et al. The effect of work-related sustained trapezius muscle activity on the development of neck and shoulder pain among young adults. Scand J Work Environ Health 2013; 39: 390-400.
26. Wytrążek M, Huber J, Lipiec J, Kulczyk A. Evaluation of palpation, pressure algometry, and electromyography for monitoring trigger points in young participants. J Manip Physiol Ther 2015; 38: 232-243.
27. Chovatiya NK, Chaudhary HS, Kanabar NS. Correlation of smartphone addiction with musculoskeletal discomfort and neck disability among college students. Int J Community Med Public Health 2021; 8: 4357.
28. Maher JM, Markey JC, Ebert-May D. The other half of the story: effect size analysis in quantitative research. CBE Life Sci Educ 2013; 12: 345-51.
29. Unal MH. Identifying the cell phone addiction levels among Ankara Yildirim Beyazit University Medical School students. Master's Thesis, Ankara: Yıldırım Beyazıt University, Faculty of Medicine, Department of Family Medicine, 2015.
30. Nielsen: United States. How the Mobile Consumer Connects Around the Globe [Fact sheet] 2013. http://www.nielsen.com/us/en/insights/news/2013/how-the-mobile-consumer-connects-around-the-globe.html.
31. Foltran-Mescollotto F, Gonçalves ÉB, Castro-Carletti EM, et al. Smartphone addiction and the relationship with head and neck pain and electromyographic activity of masticatory muscles. Work 2021; 68: 633-640.
32. Park J, Kim J, Kim J, et al. The effects of heavy smartphone use on the cervical angle, pain threshold of neck muscles and depression. Adv Sci Technol Lett 2015; 91: 12-17.
33. Fredriksson K, Alfredsson L, Ahlberg G, et al. Work environment and neck and shoulder pain: the influence of exposure time. Results from a population based case-control study. Occup Environ Med 2002; 59: 182-188.
34. Straker LM, Coleman J, Skoss R, et al. A comparison of posture and muscle activity during tablet computer, desktop computer and paper use by young children. Ergonomics 2008; 51: 540-555.
35. Park JH, Kang SY, Jeon H. The effect of using smartphones on neck and shoulder muscle activities and fatigue. Phys Ther Korea 2013; 20: 19-26.
36. Kim YL, Yoo J, Kang S, et al. The comparison of muscle activity according to various conditions during smartphone use in healthy adults. Phys Ther Rehabil Sci 2016; 5: 15-21.
37. Voerman GE, Vollenbroek-Hutten MM, Hermens HJ. Upper trapezius muscle activation patterns in neck-shoulder pain patients and healthy controls. Eur J Appl Physiol 2007; 102: 1-9.
38. Schomacher J, Falla D. Function and structure of the deep cervical extensor muscles in patients with neck pain. Man Ther 2013; 18: 360366.
39. Johnston V, Jull G, Souvlis T, Jimmieson NL. Neck movement and muscle activity characteristics in female office workers with neck pain. Spine 2008; 33: 555-563.
40. Ahn SH, Jung SH, Kim HA, et al. Differences in neck muscle activity according to lying positions using a smartphone. J Back Musculoskelet Rehabil 2022; 35: 383-391.
41. Szeto GP, Straker LM, O'Sullivan PB. A comparison of symptomatic and asymptomatic office workers performing monotonous keyboard work-1: neck and shoulder muscle recruitment patterns. Man Ther 2005; 10: 270-280.
42. Young JG, Trudeau MB, Odell D, Marinelli K, Dennerlein, JT. Wrist and shoulder posture and muscle activity during touch-screen tablet use: effects of usage configuration, tablet type, and interacting hand. Work 2013; 45: 59-71.
43. Xie YF, Szeto G, Madeleine P, Tsang S. Spinal kinematics during smartphone texting–A comparison between young adults with and without chronic neck-shoulder pain. Appl Ergon 2018; 68: 160-168.