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The association between mobile phone usage duration, neck muscle endurance, and neck pain among university students

Ata Elvan, Seval Cevik, Kivanc Vatansever & Ilknur Erak

The mobile phone is essential in daily life, especially during the pandemic. Prolonged use can cause postural issues, leading to common neck pain. This study aims to determine the correlation between mobile phone use duration, addiction, neck muscle endurance, and neck pain in university students. The study included 62 participants (30 female, 32 male) aged 18–35 years. Inclusion criteria required participants to have experienced neck pain at least twice in the past year and to have no other concomitant issues, as well as to volunteer for the study. Demographic information and daily mobile phone usage time were collected. Neck pain was assessed with the Visual Analogue Scale, smartphone addiction with the Smartphone Addiction Scale, and cervical muscle endurance was evaluated. Correlation analysis reveals a moderate relationship between neck pain severity (NPS) and cervical extensor muscle endurance (CEME), a strong relationship between NPS and cervical flexor muscle endurance (CFME), as well as a strong relationship among daily phone usage time (DPUT), CFME, and NPS, with a moderate relationship between DPUT and CEME. Participants were divided into two groups based on their DPUT, revealing that those who used their phone for four hours or more showed significantly higher levels of pain ($p < 0.05$) and reduced endurance in cervical flexor muscles. Our study found a strong correlation between neck pain, muscle endurance, and daily phone usage. Participants using their phones for more than four hours daily reported increased neck pain and decreased muscle endurance. We suggest integrating phone usage duration into neck pain assessments, promoting ergonomic practices, and offering detailed usage guidelines for users.

Keywords Mobile phone, Time, Neck pain, Endurance

Neck pain is a growing issue in society[1,2], affecting individuals of all ages, but particularly young adults due to long-term computer/phone use, desk work, poor posture habits, stress, and decreased physical activity[3]. A study conducted on university students revealed that 58.3% of the participants experienced neck pain within 1-year period[4]. Neck pain can limit daily activities, reduce work productivity, and negatively impact overall quality of life. Chronic neck pain can lead to psychological problems, including depression, anxiety, and sleep disorders[1]. The impact of neck pain on work efficiency and health expenditures has resulted in an increase in research on the topic[3].

A considerable body of literature exists on the relationship between neck pain and neck muscle endurance. Despite the existence of differing scholarly perspectives on the correlation between neck muscle endurance and neck pain, there is a general consensus among researchers regarding the significance of this factor as a contributing cause[5,6]. Adequate endurance of the neck flexor and extensor muscles is crucial for stabilizing the cervical spine and maintaining its position. Insufficient endurance of these muscles can lead to deficiencies in supporting the cervical vertebrae and difficulty in stabilizing the neck segments[7]. Long-term static positions, such as working at a computer for extended periods, may cause neck muscle overload[8]. Lee et al. found a correlation between prolonged phone use and increased discomfort, indicating the importance of muscle endurance[9]. Research has shown that neck muscle endurance is significantly lower in individuals with neck pain[10]. Weak neck muscles can impair the ability to maintain postural stability, leading to abnormal forces on the cervical vertebrae. The findings of this research are supported by the observation that insufficient endurance of the neck muscles may play an important role in the pathophysiology of neck pain[11]. It has been documented that individuals with chronic

Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Izmir University of Economics, Sakarya, Balcova, 35330 Izmir, Turkey. email: ata.elvan@ieu.edu.tr

neck pain exhibit diminished endurance of the extensor muscles and reduced proprioception[12]. Research has indicated that the deep flexor muscles of the cervical region, in particular, are often delayed in their activation in cases of neck pain, which can subsequently lead to the development of neck pain[13–15]. However, in a study conducted on individuals with postural neck pain, it was reported that no deterioration in endurance or increase in fatigue was observed[5]. Despite the contradictory results in the literature, it is suggested that systematic exercise programs to increase the endurance of neck muscles may be an effective strategy in the prevention or treatment of neck pain[16]. Increasing the endurance of neck muscles may be an important strategy for maintaining and improving neck health[10].

In the post-pandemic era, the significance of digital platforms and mobile phones in the daily lives of university students is on the rise. It is well documented that digital platforms and mobile phones were expanded in universities following the onset of the pandemic[17]. This is evidenced by the fact that the average daily mobile phone usage time has increased[18]. Recent research indicates a correlation between increased mobile phone use and a rise in cases of neck pain[19]. A systematic review of the literature examining risk factors for neck pain in university students revealed a strong association between long-term use of electronic devices and the development of neck pain[20]. The study indicates that the prolonged use of electronic devices, exceeding three hours per day, represents a significant risk factor[20]. Long-term usage of mobile phones can lead to the development of fixed head and neck positions, placing increased pressure on the neck muscles and spine. With the increasing prevalence of mobile phone usage in the contemporary era, the likelihood for posture deterioration may increase as muscle receptors adapt to this new situation[21,22]. Frequent tilting of the head forward to look at a mobile phone can cause excessive tension and strain in the neck muscles[19,23]. Prolonged use of mobile phones can increase pressure on the discs and ligaments between the cervical vertebrae, leading to the development of neck pain over time. The forward head position can cause a flexion posture in the cervical and thoracic regions, leading to muscle imbalance. Static activities of the upper extremity while maintaining this posture, such as using a mobile phone, may further increase neck pain[24,25]. Furthermore, non-ergonomic posture habits formed due to long-term mobile phone use may also contribute to increased neck pain[26]. There is insufficient evidence in the literature on the relationship between neck muscle endurance and duration of phone use among the causes of neck pain in university students. The aim of this study is to ascertain whether there is a correlation between the duration of mobile phone use, mobile phone addiction, neck muscle endurance and neck pain in university students.

Materials and methods

Study design

The study was conducted as a cross-sectional research study at Izmir University of Economics, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Turkey.

Participants

A total of 62 individuals (30 female and 32 male) aged between 18 and 35 years were included in the study. A preliminary briefing was provided to university students on their involvement in the study. Those who had experienced neck pain at least twice in the previous year and/or who did not have any other concomitant problems and who volunteered to participate in the study were included in the study. The inclusion criteria were as follows: actively recording mobile phone usage time per day, not having prepared for any exam or homework in the last month. The exclusion criteria were as follows: having any musculoskeletal, neurological or cardiorespiratory disease requiring hospital admission in the last one year, having a history of surgery, having any form of upper extremity range of motion limitation. The requisite sample size was calculated using the G*Power program (version 3.1.9.7, Universitat Kiel, Germany). The effect size of 0.80, α:0.05 and β:0.80 were used to calculate the sample size of t-test, which was planned to be 60 participants. However, two additional participants were included in the study to allow for potential attrition (about 5% of participants). 108 volunteers applied to the announcements made at the university and 62 of them were randomly selected.

The preliminary evaluation was conducted on participants who had signed the informed consent form. The preliminary evaluation involved the collection of demographic information and daily mobile phone usage time. Neck pain was assessed using the Visual Analogue Scale. The level of smartphone addiction was assessed using the "Smartphone Addiction Scale". In addition, the endurance of the cervical flexor and extensor muscles was evaluated.

The evaluation of neck pain

The evaluation of neck pain utilised a visual analogue scale (VAS). This is a frequently employed, straightforward method for assessing the pain severity. The scale, comprises a 10-cm (100-mm) length and is divided into two sections. The value "0" indicates "no pain" and the value "10" indicates "the most severe pain". The patient was requested to indicate on the line the intensity of pain experienced. The numerical value found shows the patient's pain intensity[27].

Evaluation of smartphone addiction level

The Smartphone Addiction Scale (SAS) was employed to assess the level of smartphone addiction. The SAS is a six-point Likert-type self-reported scale comprising 33 items with scores ranging from 1 (definitely not) to 6 (definitely yes).[28]. A high total score on the scale indicates a high risk of smartphone addiction. This index was adapted to Turkish by Demirci et al., and its validity and reliability were established[29]. Subscales have been identified as daily-life disturbance, positive anticipation, withdrawal, cyberspace-oriented relationship, overuse and tolerance.

Evaluation of cervical extensor muscle endurance
The cervical extensor muscle endurance (CEME) of the individuals was evaluated in the prone position. The head and neck were positioned to hang off the bed from the individuals' chest level, belt was fastened and tightened at T6 thoracic level to support the thorax. The two kg sand weight was placed on the head, with the hands placed at the sides. The movement of the head position was monitored with the help of a goniometer. The fixed arm of the goniometer was placed in a parallel orientation to the ground, while the movable arm was positioned to align with the vertical angle of the mandible. A 5-degree change in the movable arm of the goniometer was selected as the criterion for terminating the test. The maximum time that individuals could maintain this position was recorded in seconds[30].

Evaluation of the endurance of the cervical flexor muscles
The cervical flexor muscle endurance (CFME) of the individuals was evaluated in the supine hook position. The individual was asked to look at chest level by pulling his chin inward. The maximum duration that the subject was able to maintain this position, with his head elevated by approximately 2.5 cm. The testing was terminated if the chin skin folds began to separate due to the loss of the chin fold or if the occiput made contact with the hand for a period exceeding one second. Test result was recorded in seconds[31].

Statistics

Statistical data analysis was performed using the SPSS 25 (SPSS Inc., Chicago, IL) program. Descriptive data were given as mean and standard deviation. The normality of the data distribution was assessed using the Kolmogorov–Smirnov test. The results indicated that the data were normally distributed ($p > 0.05$). Pearson's correlation coefficients were used to assess the strength of associations between data variables. Independent samples *t*-test was used to determine any difference between the participants who were divided into two groups according to their daily phone usage time (DPUT). The significance level was accepted as $p < 0.05$.

Results

The study was conducted with 62 participants (30 female, 32 male). Table 1 presents the demographic characteristics of the participants and their DPUT. Table 2 displays the participants' pain intensity, Smartphone Addiction Scale and endurance test results. The correlation between the participants' Smartphone Addiction Scale, neck pain severity, endurance tests, and DPUT results was evaluated using Pearson's Correlation Coefficient. Table 3 shows information regarding these correlations. A comparison of the measurement results is presented in Table 4, which compares the participants who were divided into two groups according to their DPUT.

Correlation analysis indicates that there is a moderate relationship between NPS and CEME, a strong relationship between NPS and CFME. There is a strong relationship between DPUT, CFME and NPS, a moderate relationship between DPUT and CEME (Table 3).

Upon dividing the participants into two groups based on their DPUT, it was observed that those who used the phone for four hours or more exhibited significantly higher pain levels ($p < 0.05$) and lower cervical flexor muscle endurance ($p < 0.05$) (Table 4).

Features	Mean (SD)
Age (years)	20.18 (2.51)
Height (cm)	168.14 (13.75)
Body mass (kg)	72.44 (18.29)
BMI (kg/cm^2)	25.18 (2.19)
DPUT (hours)	4.24 (1.13)

Table 1. Demographic characteristics of participants. *BMI* Body mass index, *DPUT* daily phone usage time, *SD* Standard deviation.

Features	Mean (SD)
Neck pain severity (point)	5.2 (1.8)
CFME (s)	41.58 (14.21)
CEME (s)	249.52 (125.19)
SAS scores	90.11 (14.23)

Table 2. SAS, neck pain severity and endurance tests. *SD* Standart deviation, *SAS* Smartphone addiction scale, *CFME* Cervical flexor muscles endurance, *CEME* Cervical extensor muscles endurance.

Features		CFME	CEME	NPS
NPS	Pearson correlation	− 0.689	− 0.492	–
	Sig (2-Tailed)	0.000**	0.023*	
DPUT	Pearson correlation	− 0.654	− 0.488	0.762
	Sig (2-Tailed)	0.000**	0.031*	0.000**
SAS	Pearson correlation	− 0.209	− 0.197	0.375
	Sig (2-Tailed)	0.143	0.216	0.081

Table 3. Correlation of SAS, neck pain severity, endurance tests and DPUT. **Pearson Correlation Coefficients significant at the 0.01 level (2-tailed). *Pearson Correlation Coefficients significant at the 0.05 level (2-tailed). *SAS* Smartphone Addiction Scale, *NPS* Neck Pain Severity, *CFME* Cervical flexor muscles endurance, *CEME* Cervical extensor muscles endurance, *DPUT* Daily phone usage time.

Parameters	DPUT (n:30) <4 h Mean (SD)	DPUT (n:32) >4 h Mean (SD)	*p*-value
NPS	4.3 (0.9)	5.8 (1.2)	0.001*
CFME	49.38 (6.41)	38 (11.81)	0.028*
CEME	258.52 (112.19)	227.52 (128.19)	0.061

Table 4. Comparison of Neck Pain Severity and endurance tests between groups. *$p < 0.05$, *p* Independent sample t-test, *NPS* Neck Pain Severity, *CFME* Cervical flexor muscles endurance, *CEME* Cervical extensor muscles endurance, *DPUT* Daily phone usage time.

Discussion

The mobile phone has become an increasingly indispensable tool in our daily lives. Its use is now so pervasive that it serves as the primary means of conducting many activities, particularly in the wake of the pandemic. The pandemic has led to an increase in mobile phone usage among students who take university courses on digital platforms and in their socialization environments. This increase is due to the reliance on digital platforms for studies. As the duration of mobile phone use increases, postural problems may arise, with neck pain being especially common. This study examined the relationship between neck pain, mobile phone usage time and addiction, and neck muscle endurance. The findings indicate a significant relationship between neck pain, endurance of the cervical extensor and flexor muscles, and the duration of mobile phone use. A comparison of two participant groups, based on their daily mobile phone usage, demonstrated significantly lower endurance in the cervical flexor muscle group, along with a significantly higher level of neck pain in those with prolonged usage.

Despite varying viewpoints in the literature, a consensus exists regarding the relationship between neck muscle endurance and the duration of mobile phone usage and addiction. It has been reported that the endurance of the flexor and extensor muscle groups is negatively correlated with neck pain. A study performed on adolescent individuals indicated that the development of neck pain is associated with a reduction in the endurance of the flexor and extensor muscles[32]. Gong et al.'s study has demonstrated that changing the posture of the neck can greatly affect the endurance of neck muscles[6]. However, the study conducted by Edmonston et al. revealed that no significant difference in endurance was observed in individuals with neck pain[5]. It is well established that neck flexion, which is the most common posture during phone use, is a risk factor for pain. The posture of individuals experiencing neck pain while using a mobile phone highlights the importance of neck muscles during phone use[33]. Yoon et al. investigated the necessity of neck muscles during various postures, including sitting, standing, and walking. The results indicated that a walking posture in which both hands are in contact with the phone increases the demand on neck muscles[34]. A study performed by Song et al. indicated that the discomfort associated with prolonged mobile phone usage may not be directly related to the fatigue of the neck muscles[35]. Nonetheless, other studies report that loss of cervical muscle endurance leads to fatigue and pain. Research using surface electrodes has shown that a flexed posture exceeding 15° increases the demand on neck muscles[36]. The study conducted by Yana et al. demonstrated that neck pain was alleviated through exercises targeting the deep neck flexors[37]. Our study revealed a correlation between diminished endurance of both the neck flexors and extensors and the presence of neck pain. Upon dividing the participants into two groups according to the duration of their phone use, it was determined that the cervical flexor muscle endurance of the students who used the phone for more than four hours per day was significantly lower. Therefore, it could be argued that prolonged mobile phone usage among university students leads to a notable decrease in muscle endurance, consequently resulting in discomfort.

There is a body of literature indicating that the duration of mobile phone use is associated with an increased prevalence of neck pain. Derakhshanrad et al. reported that the likelihood of neck pain increases sixfold as the duration of mobile phone use increases[38]. Another study lends further support to the findings of another study which reported that the prevalence of neck pain increases with the duration of heavy mobile phone use[39]. This finding is aligned with previous research indicating that prolonged forward head posture is associated with increased pain in the neck joints. Additionally, a recent study has demonstrated that extended mobile phone use, in excess of 10 min, may contribute to the development of neck-related discomfort and pain, which is believed to be influenced by biomechanical factors[40]. It was reported that the duration of phone usage was associated with neck pain, and that university students increased their phone usage for reasons such as browsing social media and playing games[41]. The results of our study indicate a significant relationship between neck pain and phone usage duration. As the duration of phone use increases, the severity of neck pain also increases. According to reports, university students spend an average of 4–5 h per day on their phones[42,43]. However, in our study, it was found that the usage time was slightly more than 4 h. When the participants were divided into two groups according to the duration of phone use, it was determined that the severity of neck pain was significantly higher in individuals who used the phone for a long time. The results indicated that the duration of phone use was a key factor in the development and severity of neck pain.

Studies are investigating the effects of phone addiction on neck pain, in addition to the duration of phone use. It has been reported that phone addiction causes neck pain and has negative effects on the neck muscles. In a study of young adults, neck pain and headaches increased significantly and neck mobility decreased as phone use increased[44]. A study by Torkamani et al. showed that there is a negative correlation between neck muscle endurance and mobile phone addiction[45]. Another study reports that ergonomic training should be provided to reduce the negative effects of phone addiction and that neck pain increases[46]. A study conducted on students revealed that phone addiction not only causes neck pain, but also shoulder, elbow and hand problems. The results of the study indicated the necessity for students to be more aware of the potential issues associated with excessive mobile phone use[47]. The findings of our study reveal significant variability in the understanding of mobile phone addiction among students. Consequently, it is advisable to utilize diverse methodologies for assessing this phenomenon.

It should be noted that this study has certain limitations. Firstly, it did not record the usage time of other electronic devices, such as laptops, tablets and gaming consoles, in addition to mobile phone use. Consequently, it is not possible to ascertain the impact of these devices on neck pain and endurance. Secondly, the study did not collect data on the proportion of students' usage hours spent with increased neck flexion, given that the average daily usage time for mobile phones was four hours.

Conclusions
The findings of our study reveal a substantial association between neck pain, muscle endurance, and the duration of phone usage. Comparative analysis indicates that students who use their phones for more than four hours daily exhibit diminished flexor muscle endurance and report increased pain levels. It is suggested that the duration of daily phone usage should be integrated into the assessment of neck pain, and ergonomic interventions should be implemented for individuals with prolonged phone use. However, there is also a discernible need for improvements in neck positioning during phone use and the provision of comprehensive guidance on daily phone usage practices.

Data availability
The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

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Author contributions

S.C., K.V. and I.E. collected the data. A.E. wrote the main manuscript.

Competing interests

The authors declare no competing interests.

Ethics committee approval

Ethics committee approval was obtained from the Izmir University of Economics Health Sciences Research Ethics Committee Non-Interventional Ethics Committee (B.30.2.IEUSB.0.05.05-20-266) in accordance with the Declaration of Helsinki. All participants were informed about the study and their consent to volunteer to participate in the study was obtained.

Additional information

Correspondence and requests for materials should be addressed to A.E.