ORİJİNAL MAKALE / ORIGINAL ARTICLE

Sağlık Bilimlerinde Değer / Sağlık Bil Değer
Value in Health Sciences / Value Health Sci
ISSN: 2792-0542 sabd@duzce.edu.tr 2025; 15(1): 7-14
doi: https://dx.doi.org/10.33631/sabd.1401893

Relationship of Technology Use to Neck-Upper Extremity Musculoskeletal Problems and Perceived Fatigue

Umut ERASLAN [1], Emel TAŞVURAN HORATA [2] Hande ŞENOL [3], Suat EREL [1]

ABSTRACT

Aim: Technological device usage can cause musculoskeletal problems due to excessive static load, abnormal posture or repetitive movements in the neck and upper extremities. The aim of this study was to examine the relationship between technological device usage and musculoskeletal problems, as well as perceived local fatigue, in university students.

Material and Methods: This cross-sectional study included 388 university students between the ages of 18-30 years. Using an online questionnaire, technology use, neck and upper extremity musculoskeletal problems (via Nordic Musculoskeletal Questionnaire), perceived pain severity (via Numeric Pain Scale) and local fatigue level (via Modified Borg Scale) were assessed. Binary logistic regression analysis and Spearman correlation coefficient were used for data analysis. Statistical significance level was accepted as $p<0.05$.

Results: Of the students, 279 (71.90%) were female and 109 (28.10%) were male. Musculoskeletal complaints were most common in the neck and shoulder regions. The use of technology had no effect on the musculoskeletal complaints ($p>0.05$). Perceived pain intensity in the past week was related to the frequency and duration of laptop use, and perceived fatigue level was mostly associated with daily use of desktop computers, laptops, tablets and smartphones and daily use of these devices without breaks ($p<0.05$).

Conclusion: The use of technological devices may increase the severity of musculoskeletal system pain or perceived fatigue level. Ergonomic arrangements or planning the duration and frequency of use of technological devices can help reduce the level of pain and fatigue.

Keywords: Pain perception; musculoskeletal system; student; technology; fatigue.

Teknoloji Kullanımının Boyun-Üst Ekstremite Kas-İskelet Sistemi Problemleri ve Algılanan Yorgunluk ile İlişkisi

ÖZ

Amaç: Teknolojik cihazların kullanımı boyun ve üst ekstremitelerde aşırı statik yük, anormal postür veya tekrarlayıcı hareketler nedeniyle kas iskelet sistemi problemlerine neden olabilir. Bu çalışmanın amacı üniversite öğrencilerinde teknolojik cihaz kullanımının kas-iskelet sistemi problemleri ve algılanan lokal yorgunluk ile ilişkisini incelemekti.

Gereç ve Yöntemler: Kesitsel olarak planlanan bu çalışmaya 18-30 yaş arası 388 üniversite öğrencisi katıldı. Çevrimiçi bir anket kullanılarak teknoloji kullanımı, boyun ve üst ekstremite kas-iskelet sistemi problemleri (İskandinav Kas İskelet Sistemi Anketi ile), algılanan ağrı şiddeti (Sayısal Ağrı Ölçeği ile) ve lokal yorgunluk düzeyi (Modifiye Borg Ölçeği ile) değerlendirildi. Veri analizi için ikili lojistik regresyon analizi ve Spearman korelasyon katsayısı kullanıldı. İstatistiksel anlamlılık düzeyi $p<0,05$ olarak kabul edildi.

Bulgular: Öğrencilerin 279'u (%71,90) kadın, 109'u (%28,10) erkekti. Kas iskelet sistemi şikayetlerinin en çok boyun ve omuz bölgelerinde olduğu görüldü. Teknoloji kullanımının kas-iskelet sistemi şikayetleri üzerine etkisinin olmadığı saptandı ($p>0,05$). Son bir hafta içinde algılanan ağrı şiddeti dizüstü bilgisayar kullanım sıklığı ve süresi ile; algılanan yorgunluk düzeyi ise en çok teknolojik cihazların günlük kullanımı ve bu cihazların mola vermeden kullanımı ile ilişkili bulundu ($p<0,05$).

Sonuç: Teknolojik cihazların kullanımı kas-iskelet sistemi ağrılarının şiddetini veya algılanan yorgunluk düzeyini artırabilir. Ergonomik düzenlemeler veya teknolojik cihazların kullanım süresi ve sıklığının planlanması ağrı ve yorgunluk düzeyinin azaltılmasına yardımcı olabilir.

Anahtar Kelimeler: ağrı algısı; kas iskelet sistemi; öğrenci; teknoloji; yorgunluk.

1Pamukkale University, Faculty of Physiotherapy and Rehabilitation, Department of Orthopaedic Rehabilitation, Denizli
2Sakarya University of Applied Sciences, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Sakarya
3Pamukkale University, Faculty of Medicine, Department of Biostatistics, Denizli

Sorumlu Yazar / Corresponding Author: Umut ERASLAN, e-mail: ueraslan@pau.edu.tr
Gelis Tarihi / Received: 07.12.2023. Kabul Tarihi / Accepted: 10.10.2024

INTRODUCTION

Musculoskeletal disorders (MSDs) are the main cause of long-term pain and physical disability. Studies involving adults confirm that prolonged static posture and increased muscle load associated with computer use can lead to MSDs in the neck, shoulders, back, elbows, and wrists/hands (1). Previous research has shown that MSDs affect university students, who excessively use various electronic devices on a daily basis for both education and recreation, due to risk factors such as increased screen time, prolonged sitting, and high mental stress (1,2). It has been shown that daily computer usage time is long and computer-related MSDs are common among students with a prevalence of 52.80% (3).

In addition to these, mobile device usage for purposes such as communication and Internet access is increasing. Due to small gaps in mini keyboards, the use of mobile devices can put more static load on the hand and arm muscles compared to using a desktop or laptop computer (4,5). In general, the neck is constantly flexed and the elbows are not supported during mobile device use. This can cause the neck and shoulder to be subjected to disproportionate constant load and consequently pain (6). Also, the device is commonly carried with one hand and the thumb is used to tap the screen. These upper extremity movements repeated in static postures can result in microtrauma and associated discomfort, pain, and decreased motor skills (6,7). In mobile technology users, the lifetime prevalence of neck musculoskeletal problems has been reported as 55.80%, and the overall prevalence rate of upper extremity musculoskeletal problems as 72.50% (8). Despite the rapid increment in mobile device usage worldwide, studies that investigate the relation of usage of these devices with MSDs seem limited (1,6).

Long periods of time spent on the Internet lead to lack of physical activity and decrease in sleep hours, resulting in mental and physical fatigue, which is common in university students. Physical fatigue reflects the physical symptoms of fatigue such as musculoskeletal pain or feeling of weakness (9). Although the underlying mechanisms are not fully understood, muscle fatigue may be one of the main causes of musculoskeletal problems associated with technology use (10). Prolonged and repetitive muscle contractions during technology use can lead to muscle fatigue due to obstruction of blood flow and accumulation of lactic acid, resulting in muscle fiber injury, cumulative damage from acute trauma, and myogenic tone. This can cause musculoskeletal discomfort or pain (11,12).

In the light of the existing literature, it is understood that university students use technological devices widely and this situation is risky for MSDs. Students today use multiple devices and each device has its own risks for the development of MSDs. Considering this, knowing the relationship between the frequency and duration of device use and MSDs will make an important contribution to the literature in taking protective measures regarding technology usage periods. In addition, evaluating the same relationship in terms of local muscle fatigue, which is a risk factor for MSDs, will allow the necessary interventions to be made before permanent MSDs occur. For these reasons, this study was planned to investigate the relation of technological device usage with MSDs and perceived local fatigue in university students.

MATERIAL AND METHODS

Volunteer students from a university were included in this cross-sectional study. The inclusion criterion for the study was to be between 18 and 30 years of age. The exclusion criteria were having a history of neurologic, orthopedic, rheumatologic, metabolic, rheumatologic or metabolic diseases or surgery that may cause musculoskeletal involvement in the neck and upper extremities and having communication problems.

The sample size estimate was based on the odds ratio of 2.4 (critical z=1.959) according to the reference study's results (13). Accordingly, it was calculated that 80% power could be obtained at a 95% confidence level when at least 282 students were included in the study. Of the 403 students who completed the questionnaire, 15 were excluded due to neck or upper extremity pathology or surgery, and the study was completed with 388 students.

Demographic and educational information of the students were questioned in the first part of the questionnaire. The following sections of the questionnaire consisted of questions on technology use, Nordic Musculoskeletal Questionnaire (NMQ), Numeric Pain Scale (NPS) and Modified Borg Scale (MBS). It took about 15 minutes to answer the questionnaire applied to the students.

Regarding technology use, students were asked to answer yes or no to the questions about whether they use desktop computers, laptops, tablets and smartphones. Accordingly, the frequency and duration of usage of these devices were evaluated. This part of the questionnaire was created based on similar studies in the literature (14,15).

The NMQ is one of the self-reported and easy-to-administer questionnaires used to evaluate the severity and impact of musculoskeletal symptoms. This questionnaire investigates the presence of musculoskeletal symptoms for a 12-month period covering nine different regions of the body. In addition, there are items related to the prevention from doing normal activities in the last 12 months and the presence of musculoskeletal symptoms in the last seven days. All items are answered with a binary yes/no response. The questionnaire was adapted to Turkish and the internal consistency was reported to be excellent (Cronbach alpha=0.896). In the test-retest reliability assessment, all items showed moderate to almost excellent reliability (PABAK=0.57-0.90), and the construct validity of the questionnaire was found to be good (16). In this study, only the neck and upper extremity sections of the questionnaire were administered to the students. Turkish version of the NMQ was used with permission.

NPS was used to evaluate the intensity of perceived pain in the neck, shoulder, elbow, wrist and hand regions during the last one week. According to this scale, the students were asked to choose the number between 0-10 that would best express their perceived pain intensity. Zero on the scale means no pain at all, while score of 10 signifies unbearable pain (17). It was determined that the test-retest reliability for the NPS ranged from moderate to high (0.67-0.96), and when correlated with the Visual Analog Scale, it had convergent validity ranging from 0.79 to 0.95 (18).

The reliability (ICC) of the NPS in patients with neck pain has been reported as 0.76 (19).

MBS was used to evaluate the perceived local fatigue level in the neck, shoulder, elbow, wrist and hand regions during the use of technological devices (20). On the MBS scores from 0 to 10, zero is expressed as "no fatigue", three as "moderate fatigue", five as "severe fatigue", seven as "very severe fatigue" and 10 as "maximal fatigue" (21). In a study conducted on office workers, it was reported that the MBS was reliable (ICC=0.898) and had an acceptable level of validity due to its significant correlation with the Visual Analog Scale ($r=0.754$, $p<0.01$) (22).

Ethical Considerations

This study was completed in accordance with Research and Publication Ethics. After ethical approval for the study (10.03.2021/E-60116787-020-30365), the data were obtained using the Internet-based data collection technique. The link of the questionnaire created using Google Forms® was sent to the students via e-mail and social media. The informed consent form was published in the preliminary part of the online questionnaire and after confirmation to participate, students were able to access the entire questionnaire.

Statistical Analysis

All statistical analyses were conducted with SPSS 25.0 (IBM SPSS v.25 (Armonk, NY: IBM Corp.)). Conformity of the data to normal distribution was evaluated by the Kolmogorov-Smirnov test. Continuous variables that fit the normal distribution were expressed as mean ± standard deviation. Categorical variables were expressed as number of units in the sample and percentage. Binary logistic regression analysis was used to analyze the effect of technology use on musculoskeletal problems and interference of these problems with normal activities. The relationship between perceived pain intensity and fatigue level in the neck, shoulder, elbow, wrist-hand and technology use was evaluated using Spearman correlation coefficient. Statistical significance was determined as $p<0.05$.

RESULTS

Of the 388 students included in the study, 279 (71.90%) were female and 109 (28.10%) were male. Students' mean age was 21.09±1.91 years. The mean body mass index was 22.64±3.46 kg/m2. Of the students, 289 (74.49%) were undergraduate students in health sciences, 34 (8.76%) in education, 19 (4.90%) in law, 38 (9.79%) in engineering-architecture, and 8 (2.06%) in economics faculty. One hundred and eighteen students (30.41%) were freshmen, 73 (18.81%) were second-year students, 63 (16.24%) were third-year students, and 134 (34.54%) were senior students.

According to the NMQ, the students' complaints of pain, ache, discomfort in the last 12 months, the interference of these complaints with normal activities in the last 12 months and pain complaints in the last seven days were most common in the neck and shoulder areas (Table 1).

The technological devices used by the students, and the frequency and duration of use of these devices are shown in Table 2. Technology use had no effect on the pain, ache and discomfort complaints of the students in the last 12 months, the prevention of normal activities due to these complaints in the last 12 months, and the pain complaints in the last seven days ($p>0.05$) (Table 3).

Perceived pain intensity in the past week in the neck, shoulder, elbow and wrist-hand was related to the frequency and duration of laptop use. Perceived fatigue level in the neck, shoulder, elbow, and wrist-hand was mostly associated with daily use of desktop computers, laptops, tablets and smartphones and daily use of these devices without breaks (Table 4).

DISCUSSION

This study evaluated the effect of technology use on the neck and upper extremity musculoskeletal pain and discomfort, and its relationship with the perceived pain and fatigue level. The current study demonstrated that neck (74%) and shoulder pain (60.8%) were the most common musculoskeletal problems in university students. The wrist-hand pain was the least common problem with a rate of 16%. Although the results obtained were similar to those in other studies, the frequency of neck and shoulder problems was higher compared to the results of earlier studies (23-27).

Studies in the literature were generally conducted with fewer cases and mostly evaluated the effect of only computer use. In this study, students using mobile devices were also evaluated. The fact that mobile device use requires prolonged neck flexion and proximal muscle stabilization may explain the high rate of neck and shoulder pain detected in students. In addition, the pain rates detected in students in the last 7 days in this study were lower and closer to the examples in the literature.

Table 1. Number of units in the sample and percentage of students with musculoskeletal problems in the neck and upper extremities

	Neck	Shoulder	Elbow	Wrist/Hand
	n (%)			
Pain, ache and discomfort complaints in the last 12 months	287 (74.00)	236 (60.80)	77 (19.80)	178 (45.90)
Prevention of normal activities in the last 12 months due to these complaints	89 (22.90)	71 (18.30)	11 (2.80)	45 (11.60)
Pain complaints in the last 7 days	202 (52.10)	172 (44.30)	33 (8.50)	84 (21.60)

n: Number of units in the sample

Table 2. Technology device use, frequency and duration

	Desktop computer	Laptop	Tablet	Smartphone
	n (%)			
Technology use				
Yes	74 (19.07)	325 (83.76)	54 (13.92)	373 (96.13)
No	314 (80.93)	63 (16.24)	334 (86.08)	15 (3.87)
Frequency of use				
Rarely	22 (29.73)	23 (7.08)	21 (38.89)	1 (0.27)
Several times a month	10 (13.51)	17 (5.23)	7 (12.96)	1 (0.27)
Several times a week	15 (20.27)	94 (28.92)	18 (33.33)	20 (5.36)
Everyday	27 (36.49)	191 (58.77)	8 (14.82)	351 (94.10)
Daily use (hours/day)				
1-2	46 (62.16)	100 (30.77)	47 (87.04)	14 (3.75)
2-5	15 (20.27)	144 (44.31)	6 (11.11)	124 (33.24)
5-8	10 (13.51)	60 (18.46)	1 (1.85)	140 (37.53)
>8	3 (4.06)	21 (6.46)	-	95 (25.48)
Use without break (hours/day)				
1-2	62 (83.78)	240 (73.85)	52 (96.30)	260 (69.71)
2-5	10 (13.51)	67 (20.62)	2 (3.70)	70 (18.76)
5-8	-	15 (4.62)	-	30 (8.04)
>8	2 (2.71)	3 (0.91)	-	13 (3.49)
Weekly use (day/week)				
1-2	31 (41.89)	58 (17.85)	37 (68.52)	2 (0.54)
2-4	12 (16.22)	49 (15.08)	4 (7.41)	8 (2.15)
4-6	13 (17.57)	81 (24.92)	3 (5.56)	1 (0.27)
Everyday	18 (24.32)	137 (42.15)	10 (18.51)	362 (97.04)
Total usage time (years)				
<1	9 (12.16)	50 (15.39)	8 (14.82)	4 (1.07)
1-3	8 (10.81)	71 (21.84)	12 (22.22)	17 (4.56)
3-5	3 (4.06)	54 (16.62)	11 (20.37)	45 (12.06)
>5	54 (72.97)	150 (46.15)	23 (42.59)	307 (82.31)

n: Number of units in the sample

In terms of acute pain, it may be possible to say that the pain rates in this study are similar to those in the literature. The frequency of wrist-hand problems varied in studies. While the results of the two studies were similar (23,26), according to another study, wrist-hand problems were the most common problem after neck problems with a rate of 53% (24). Since this last study was conducted in the past years, when desktop computer and accordingly mouse use were more common, students may have had more wrist-hand problems.

The students in our study mostly preferred the use of smartphones and laptops, followed by desktop computers and tablets. When compared to the other studies, it can be said that the frequency of technological device usage has increased (23,25). In our study, compared to previous studies, the frequency of use of laptops (75.7%) and smartphones (93%) was higher, while the frequency of use of desktop computers (60%) was lower (25,26). Technological developments in laptops, tablets and smartphones that offer portable and easy use can be the reason for the decrease in desktop computer usage frequency.

According to our study, technology usage did not pose a risk of neck, shoulder, elbow, or wrist/hand pain or discomfort, and disability in normal activities. This may be because the study consisted of university students. Previous studies have confirmed that older individuals are at greater risk of developing MSDs than younger individuals (28,29). Similarly, evidence has been presented in the literature that the relationship between computer use and musculoskeletal pain is limited (30,31). In a study, it was shown that university students had a high rate of neck, shoulder and wrist pain, and it was explained that these problems may have developed due to prolonged/wrong sitting position, uncomfortable laboratory chairs during computer use and psychological factors (27). In addition, in another study, it was determined that there was a relationship between MSDs and computer use (25). Although our study showed that the use of technology did not pose a risk in terms of musculoskeletal pain and disorders, it was determined that the duration and frequency of daily use of technological devices were associated with the severity of neck, shoulder and elbow pain. In our study, the use of

Table 3. The effect of technology use on musculoskeletal problems and interference of these problems with normal activities

NMQ		Desktop computer use		Laptop use		Tablet use		Smartphone use	
		p*	OR (%95.0 CI)	p*	OR (%95.0 CI)	p*	OR (%95.0 CI)	p*	OR (%95.0 CI)
Pain, ache and discomfort complaints in the last 12 months	Neck	0.124	1.643 (0.873-3.090)	0.260	1.401 (0.779-2.520)	0.724	1.128 (0.578-2.204)	0.267	0.426 (0.094-1.920)
	Shoulder	0.789	0.932 (0.556-1.562)	0.710	1.110 (0.641-1.922)	0.518	1.219 (0.669-2.221)	0.258	1.817 (0.645-5.119)
	Elbow	0.824	0.930 (0.488-1.770)	0.862	1.062 (0.536-2.108)	0.529	0.782 (0.365-1.679)	0.988	0.990 (0.272-3.598)
	Wrist/hand	0.191	1.403 (0.844-2.331)	0.599	1.157 (0.671-1.995)	0.126	1.571 (0.881-2.802)	0.325	1.730 (0.580-5.159)
Prevention of normal activities in the last 12 months due to these complaints	Neck	0.544	0.825 (0.442-1.539)	0.612	0.851 (0.456-1.589)	0.831	1.076 (0.548-2.112)	0.783	1.199 (0.331-4.345)
	Shoulder	0.856	0.941 (0.485-1.826)	0.867	0.943 (0.473-1.878)	0.423	1.332 (0.661-2.683)	0.614	1.475 (0.325-6.688)
	Elbow	0.407	0.416 (0.052-3.305)	0.522	1.968 (0.247-15.654)	0.642	0.611 (0.077-4.874)	0.379	0.386 (0.046-3.225)
	Wrist/hand	0.814	0.907 (0.404-2.040)	0.895	1.059 (0.450-2.492)	0.904	0.946 (0.380-2.354)	0.831	0.847 (0.185-3.881)
Pain complaints in the last 7 days	Neck	0.703	1.104 (0.664-1.834)	0.620	1.146 (0.668-1.966)	0.973	0.990 (0.557-1.760)	0.532	0.715 (0.249-2.048)
	Shoulder	0.276	1.326 (0.798-2.203)	0.984	0.994 (0.578-1.712)	0.232	1.421 (0.799-2.528)	0.853	0.907 (0.322-2.552)
	Elbow	0.892	0.938 (0.373-2.361)	0.116	3.216 (0.750-13.796)	0.756	0.841 (0.284-2.496)	0.795	1.314 (0.167-10.317)
	Wrist/hand	0.995	0.998 (0.539-1.846)	0.227	1.563 (0.758-3.222)	0.340	0.691 (0.323-1.477)	0.432	1.832 (0.405-8.281)

* Logistic regression analysis, OR: Odds Ratio, CI: Confidence Interval, NMQ: Nordic Musculoskeletal Questionnaire

Table 4. The relationship of pain intensity and fatigue level in neck, shoulder, elbow, wrist-hand with the frequency and duration of technology use

		Frequency and duration of technology use									
		Frequency of use		Daily usage time (hours)		Daily use without breaks (hours)		Weekly usage time (days)		Total usage time (years)	
		NPS	**MBS**	**NPS**	**MBS**	**NPS**	**MBS**	**NPS**	**MBS**	**NPS**	**MBS**
Device	**Region**	r p*	r p*	r p*	r p*	r p*	r p*	r p*	r p*	r p*	r p*
Desktop computer	Neck	0.035 0.494	0.256 **0.028**	0.033 0.516	0.269 **0.021**	0.042 0.407	0.216 0.065	0.034 0.507	0.171 0.145	0.041 0.418	0.255 **0.028**
	Shoulder	0.440 0.385	0.201 0.086	0.043 0.398	0.290 **0.012**	0.049 0.334	0.188 0.109	0.040 0.429	0.168 0.153	0.046 0.370	0.204 0.081
	Elbow	-0.012 0.815	0.034 0.777	-0.009 0.857	0.023 0.846	0.002 0.971	-0.113 0.340	-0.016 0.756	-0.057 0.627	-0.002 0.963	0.139 0.239
	Wrist/hand	-0.008 0.876	0.002 0.986	0.001 0.986	-0.027 0.822	0.005 0.928	-0.092 0.437	-0.008 0.875	-0.104 0.380	0.002 0.972	0.132 0.261
Laptop	Neck	0.127 **0.012**	0.164 **0.003**	0.119 **0.019**	0.214 **<0.001**	0.067 0.190	0.187 **0.001**	0.091 0.072	0.144 **0.010**	0.054 0.291	0.112 **0.044**
	Shoulder	0.062 0.225	0.142 **0.010**	0.114 **0.025**	0.158 **0.004**	0.120 **0.018**	0.161 **0.004**	0.058 0.252	0.093 0.093	0.005 0.917	0.055 0.319
	Elbow	0.112 **0.027**	0.095 0.089	0.133 **0.009**	0.103 0.063	0.100 **0.049**	0.071 0.202	0.115 **0.023**	0.061 0.273	0.090 0.076	0.064 0.248
	Wrist/hand	0.069 0.178	0.107 0.054	0.092 0.071	0.144 **0.009**	0.070 0.167	0.151 **0.006**	0.040 0.432	0.038 0.496	0.052 0.303	0.140 **0.012**
Tablet	Neck	0.007 0.893	0.311 **0.022**	0.007 0.894	0.441 **0.001**	0.007 0.898	0.256 0.062	0.004 0.931	0.493 **<0.001**	0.005 0.923	0.030 0.829
	Shoulder	0.058 0.258	0.394 **0.003**	0.056 0.273	0.516 **<0.001**	0.056 0.269	0.295 **0.030**	0.054 0.291	0.472 **<0.001**	0.051 0.318	0.111 0.426
	Elbow	-0.008 0.876	0.287 **0.035**	-0.011 0.829	0.425 **0.001**	-0.014 0.787	0.325 **0.016**	-0.011 0.836	0.389 **0.004**	-0.016 0.752	0.123 0.376
	Wrist/hand	-0.037 0.472	0.333 **0.014**	-0.034 0.502	0.364 **0.007**	-0.037 0.462	0.273 **0.045**	-0.037 0.468	0.438 **0.001**	-0.038 0.455	0.120 0.387
Smart phone	Neck	-0.010 0.839	0.020 0.705	0.067 0.189	0.186 **<0.001**	0.040 0.426	0.103 **0.046**	0.035 0.496	0.078 0.133	0.014 0.787	0.074 0.155
	Shoulder	0.003 0.946	-0.030 0.569	0.050 0.330	0.165 **0.001**	0.071 0.163	0.114 **0.027**	-0.009 0.863	0.017 0.739	0.055 0.281	0.028 0.583
	Elbow	0.067 0.190	-0.027 0.601	-0.088 0.084	0.130 **0.012**	0.025 0.629	0.097 0.061	-0.023 0.650	0.058 0.264	-0.066 0.195	0.083 0.109
	Wrist/hand	0.041 0.421	0.017 0.742	0.006 0.898	0.119 **0.021**	0.039 0.446	0.151 0.004	0.090 0.076	0.071 0.168	0.063 0.218	0.069 0.181

* Spearman correlation coefficient, NPS: Numeric Pain Scale, MBS: Modified Borg Scale

technological devices was questioned with a binary response option of yes/no and the effect on pain was evaluated with this data. This suggests that the use of technological devices alone may not be a factor in the presence of pain, and as seen in other results, pain and discomfort can be understood in more detail with information about the frequency and duration of device use. Indeed, it has been reported in the literature that many factors such as posture, age, gender, psychosocial status, mental stress, frequent repetitive and forceful movements during the day may play a role in the development of musculoskeletal problems (32,33). However, since our study focused on data on the rates of technological device use and the frequency/duration of use of these devices, no evaluation was made regarding the presence or exclusion of other factors that may lead to MSDs.

In the present study, the duration and frequency of use of technological devices were found to be related to the perceived neck and shoulder fatigue in desktop computer users, neck, shoulder, wrist and hand fatigue in laptop users, and neck, shoulder, elbow and wrist-hand fatigue in tablet and smartphone users. There are also studies in the literature suggesting that physical fatigue contributes to MSDs (9,34,35). This is data that supports the results of our study. These studies in the literature reported that increasing the frequency of breaks, and taking breaks of any duration, including micro breaks, reduces fatigue. The fact that the students in our study generally use technological devices every day, that the majority of those who use especially laptops and smartphones for long periods of time such as 2-5 or 5-8 hours daily, and that most of the students use these devices for at least 1-2 hours without a break explain the relationship found in our study. In addition, we think that prolonged static or abnormal postures of students during mobile technological device use and inadequate ergonomic design in those using desktop computers may affect fatigue, although postural and ergonomic factors were not evaluated. In light of our findings on the relationship between fatigue and the duration and frequency of technological device use, we believe that it would be beneficial to inform students about the importance of taking breaks while using these devices. Many previous studies have investigated the relationship between technology use and musculoskeletal pain. Our study is one of the few studies evaluating also the effects of smartphone use, which has become widespread today. In addition, the high number of cases and the evaluations made with quantitative results are among the strengths of the study. One of the limitations of the study is that the questionnaires used in the study were administered via the Internet. This may have caused the frequency and duration of use of technological devices to be overestimated. However, the fact that the study was conducted among university students and that most of them used the Internet more intensively may reduce the effect of this limitation on the results of the study. Another limitation of our study is that the frequency of technological device use was evaluated as personal feedback that did not reflect objectivity.

CONCLUSION

As a result, the use of technological devices is increasing day by day. This may increase the severity of musculoskeletal pain or the perceived level of fatigue. Ergonomic arrangements or planning the duration and frequency of use of technological devices can help reduce the level of pain and fatigue.

Conflict of Interest

The authors declared no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Authors's Contributions: Idea/Concept: U.E., S.E.; Design: U.E.; Data Collection and/or Processing: E.T.H.; Analysis and/or Interpretation: H.Ş.; Literature Review: U.E., E.T.H.; Writing the Article: U.E., E.T.H.; Critical Review: U.E., S.E.

REFERENCES

1. Woo EHC, White P, Lai CWK. Musculoskeletal impact of the use of various types of electronic devices on university students in Hong Kong: An evaluation by means of self-reported questionnaire. Man Ther. 2016; 26: 47-53.
2. Parto DN, Wong AY, Macedo L. Prevalence of musculoskeletal disorders and associated risk factors in Canadian university students. BMC Musculoskelet Disord. 2023; 24(1): 501.
3. Dockrell S, Bennett K, Culleton-Quinn E. Computer use and musculoskeletal symptoms among undergraduate university students. Comput Educ. 2015; 85: 102-9.
4. Berolo S, Wells RP, Amick BC 3rd. Musculoskeletal symptoms among mobile hand-held device users and their relationship to device use: a preliminary study in a Canadian university population. Appl Ergon. 2011; 42(2): 371-8.
5. Eitivipart AC, Viriyarojanakul S, Redhead L. Musculoskeletal disorder and pain associated with smartphone use: A systematic review of biomechanical evidence. Hong Kong Physiother J. 2018; 38(2): 77-90.
6. Zirek E, Mustafaoglu R, Yasaci Z, Griffiths MD. A systematic review of musculoskeletal complaints, symptoms, and pathologies related to mobile phone usage. Musculoskelet Sci Pract. 2020; 49: 102196.
7. Kim GY, Ahn CS, Jeon HW, Lee CR. Effects of the use of smartphones on pain and muscle fatigue in the upper extremity. J Phys Ther Sci. 2012; 24(12): 1255-8.
8. Xie Y, Szeto G, Dai J. Prevalence and risk factors associated with musculoskeletal complaints among users of mobile handheld devices: A systematic review. Appl Ergon. 2017; 59(Pt A): 132-42.
9. Bachleda C, Darhiri L. Internet addiction and mental and physical fatigue. The International Technology Management Review. 2018; 7(1): 25-33.
10. Kim JH, Johnson PW. Fatigue development in the finger flexor muscle differs between keyboard and mouse use. Eur J Appl Physiol. 2014; 114(12): 2469-82.
11. 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(6): 1669-72.
12. Agatha S, Thanaya SAP, Sundari LPR, Nugraha MHS. Overview of musculoskeletal disorders in undergraduate students. Physical Therapy Journal of Indonesia. 2022; 3(2): 49-53.
13. Hakala PT, Saarni LA, Punamäki RL, Wallenius MA, Nygård CH, Rimpelä AH. Musculoskeletal symptoms and computer use among Finnish adolescents-pain intensity and inconvenience to everyday life: a cross-sectional study. BMC Musculoskelet Disord. 2012; 13: 41.
14. Bubric K, Hedge A. Differential patterns of laptop use and associated musculoskeletal discomfort in male and female college students. Work. 2016; 55(3): 663-71.
15. Verbrugghe J, Haesen M, Spierings R, Willems K, Claes G, Olivieri E, et al. Skill training preferences and technology use in persons with neck and low back pain. Disabil Rehabil Assist Technol. 2017; 12(8): 801-7.
16. Kahraman T, Genç A, Göz E. The Nordic Musculoskeletal Questionnaire: cross-cultural adaptation into Turkish assessing its psychometric properties. Disabil Rehabil. 2016; 38(21): 2153-60.
17. Yeşilyurt M, Faydalı S. Use of one-dimensional scales in pain assessment. Anadolu Hemşirelik ve Sağlık Bilimleri Dergisi. 2020; 23(3): 444-51.
18. Kahl C, Cleland JA. Visual analogue scale, numeric pain rating scale and the McGill Pain Questionnaire: An overview of psychometric properties. Phys Ther Rev. 2005; 10(2): 123-8.
19. Young IA, Dunning J, Butts R, Mourad F, Cleland JA. Reliability, construct validity, and responsiveness of the neck disability index and numeric pain rating scale in patients with mechanical neck pain without upper extremity symptoms. Physiother Theory Pract. 2019; 35(12): 1328-35.
20. Borg GAV. Psychophysical bases of perceived exertion. Med Sci Sports Exerc. 1982; 14(5): 377-81.
21. Bandak E, Amris K, Bliddal H, Danneskiold-Samsøe B, Henriksen M. Muscle fatigue in fibromyalgia is in the brain, not in the muscles: a case–control study of perceived versus objective muscle fatigue. Ann Rheum Dis. 2013; 72(6): 963-6.
22. Shariat A, Cleland JA, Danaee M, Alizadeh R, Sangelaji B, Kargarfard M, et al. Borg CR-10 scale as a new approach to monitoring office exercise training. Work. 2018; 60(4): 549-54.
23. Borhany T, Shahid E, Siddique WA, Ali H. Musculoskeletal problems in frequent computer and internet users. J Family Med Prim Care. 2018; 7(2): 337-9.
24. Lorusso A, Bruno S, L'Abbate N. Musculoskeletal disorders among university student computer users. Med Lav. 2009; 100(1): 29-34.
25. Osama M, Ali S, Malik RJ. Posture related musculoskeletal discomfort and its association with computer use among university students. J Pak Med Assoc. 2018; 68(4): 639-41.
26. Queiroz LB, Lourenço B, Silva LEV, Lourenço DMR, Silva CA. Musculoskeletal pain and musculoskeletal syndromes in adolescents are related to electronic devices. J Pediatr (Rio J). 2018; 94: 673-9.
27. Rakhadani PB, Goon DT, Mandeya A. Musculoskeletal problems associated with university students computer users: a cross-sectional study. Online J Health Allied Sci. 2017; 16(2): 7.
28. Jafari nodoushan R, Halvani G, Vatani shoaa J, Salmani Nodousgan Z. Survey of Musculoskeletal disorders among bank staff in Yazd. Occupational Medicine Quarterly Journal. 2011; 3(1): 1-7.
29. Okunribido OO, Wynn T, Lewis D. Are older workers at greater risk of musculoskeletal disorders in the workplace than young workers? - A literature review. Occup Ergon. 2011; 10(1,2): 53-68.
30. Mattioli S, Violante FS, Bonfiglioli R. Upper-extremity and neck disorders associated with keyboard and mouse use. Handb Clin Neurol. 2015; 131: 427-33.
31. Wærsted M, Hanvold TN, Veiersted KB. Computer work and musculoskeletal disorders of the neck and upper extremity: a systematic review. BMC Musculoskelet Disord. 2010; 11: 79.
32. Das D, Kumar A, Sharma M. A systematic review of work-related musculoskeletal disorders among handicraft workers. Int J Occup Saf Ergon. 2020; 26(1): 55-70.
33. Feng Q, Liu S, Yang L, Xie M, Zhang Q. The prevalence of and risk factors associated with musculoskeletal disorders among sonographers in central China: A cross-sectional study. PLoS One. 2016; 11(10): e0163903.
34. Luger T, Maher CG, Rieger MA, Steinhilber B. Work-break schedules for preventing musculoskeletal symptoms and disorders in healthy workers. Cochrane Database Syst Rev. 2019; 7(7): CD012886.
35. Prins JB, van der Meer JW, Bleijenberg G. Chronic fatigue syndrome. Lancet. 2006; 367(9507): 346-55.