RESEARCH ARTICLE

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Musculoskeletal Pain in Young Adults: The Role of Smartphone Use, Concentration, Body Awareness, and Sleep Quality

Genç Yetişkinlerde Kas-İskelet Sistemi Ağrısı: Akıllı Telefon Kullanımı, Konsantrasyon, Beden Farkındalığı ve Uyku Kalitesinin Rolü

ABSTRACT

Objective

This study aimed to compare smartphone addiction, concentration, body awareness, and sleep quality between young adults with and without musculoskeletal pain, to determine whether these health-related domains differ based on the presence of pain.

Method

Sixty-four young adults with musculoskeletal pain, whose mean duration was 3.53±0.88 months, and mean pain intensity was 5.60 out of 10 (Musculoskeletal Pain Group), and 64 age and sex-matched young adults without musculoskeletal pain (No Pain Group) were included. Data were collected using the Smartphone Addiction Scale–Short Version (SAS-SV), Adult Concentration Inventory (ACI), Body Awareness Questionnaire (BAQ), and Pittsburgh Sleep Quality Index (PSQI), along with sociodemographic and smartphone use characteristics.

Results

Musculoskeletal Pain Group demonstrated significantly higher scores on the SAS-SV, ACI, and PSQI, and lower scores on the BAQ compared to No Pain Group ($p<0.05$). They also reported greater daily smartphone holding duration, more frequent forward head posture during use, and a higher prevalence of finger deformities associated with smartphone use ($p<0.05$). Binary logistic regression analysis revealed that smartphone addiction, impaired concentration, and poor sleep quality were significant risk factors for musculoskeletal pain, while greater body awareness served as a protective factor.

Conclusions

The findings suggest that musculoskeletal pain in young adults is associated not only with excessive smartphone use but also with impaired concentration, disrupted sleep, and diminished interoceptive awareness. These results underscore the importance of adopting integrated strategies that encompass screen-time regulation, posture training, sleep hygiene, and body awareness-based interventions to mitigate the adverse health effects of smartphone overuse.

Key Words

Body awareness, Cognitive performance, Musculoskeletal pain, Screen time, Sleep quality

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ÖZ

Amaç

Bu çalışmanın amacı, kas-iskelet sistemi ağrısı olan ve olmayan genç yetişkinler arasında akıllı telefon bağımlılığı, bilişsel performans, beden farkındalığı ve uyku kalitesini karşılaştırmak ve bu sağlıkla ilişkili alanların ağrı varlığına göre farklılık gösterip göstermediğini belirlemektir.

Yöntem

Ortalama ağrı süresi 3,53±0,88 ay ve ortalama ağrı şiddeti 10 üzerinden 5,60 olan 64 genç yetişkin (Kas-İskelet Ağrısı Grubu) ile yaş ve cinsiyet açısından eşleştirilmiş, ağrısı olmayan 64 genç yetişkin (Ağrısız Grup) çalışmaya dâhil edildi. Veriler; Akıllı Telefon Bağımlılığı Ölçeği–Kısa Versiyon (ATBÖ-KV), Yetişkin Konsantrasyon Envanteri (YKE), Beden Farkındalığı Anketi (BFA) ve Pittsburgh Uyku Kalitesi İndeksi (PUKİ) kullanarak ve sosyodemografik ve akıllı telefon kullanım özellikleri sorgulanarak toplandı.

Bulgular

Kas-İskelet Ağrısı Grubu, ATBÖ-KV, YKE ve PUKİ ölçeklerinden anlamlı derecede daha yüksek; BFA ölçeğinden ise daha düşük puanlar aldı ($p<0,05$). Ayrıca, bu grup daha uzun günlük telefon tutma süresi, kullanım sırasında daha sık öne eğilmiş baş postürü ve akıllı telefon kullanımına bağlı parmak deformitelerinin daha yüksek prevalansını bildirdi ($p<0,05$). İkili lojistik regresyon analizi, akıllı telefon bağımlılığı, bilişsel kopukluk ve kötü uyku kalitesinin kas-iskelet ağrısı için anlamlı risk faktörleri olduğunu, yüksek beden farkındalığının ise koruyucu bir faktör olduğunu ortaya koydu.

Sonuç

Bulgular, genç yetişkinlerde kas-iskelet sistemi ağrısının yalnızca aşırı akıllı telefon kullanımıyla değil; aynı zamanda bilişsel yorgunluk, bozulmuş uyku düzeni ve azalmış içsel beden farkındalığı ile ilişkili olduğunu göstermektedir. Bu sonuçlar, ekran süresi düzenlemesi, postür eğitimi, uyku hijyeni ve beden farkındalığı temelli müdahaleleri içeren bütüncül stratejilerin benimsenmesinin, akıllı telefon kullanımının olumsuz sağlık etkilerini azaltmada önemli olduğunu vurgulamaktadır.

Anahtar Kelimeler

Beden farkındalığı, Bilişsel performans, Kas-iskelet sistemi ağrısı, Ekran süresi, Uyku kalitesi

INTRODUCTION

Smartphones have become the most widely used technological devices in modern life, integrating into nearly every aspect of daily living. Over the past decade, the average daily time spent online on smartphones has more than doubled, increasing from 1 hour and 38 minutes in 2014 to 3 hours and 45 minutes in 2024, reflecting an increase of approximately 2 hours and 7 minutes per day (1). The Digital 2025 report indicates that average daily screen time across all devices has reached approximately 6 hours and 40 minutes, with around 4 hours and 37 minutes spent on smartphones alone, highlighting their central role in digital behaviour (2). Despite the numerous advantages smartphones bring to modern life, such as enhanced communication, instant access to information, and increased productivity, their excessive use has been increasingly associated with a range of adverse physical and psychological outcomes in young adults (3-5). Excessive smartphone use has been linked to various musculoskeletal complaints, particularly in the neck, shoulders, and upper back, and attributed mainly to prolonged static postures, forward head alignment, and repetitive thumb and wrist movements associated with device handling (6, 7). In addition to causing physical pain, using screens too much, especially in uncomfortable positions for a long time, can lead to problems with focus, shorter attention spans, and mental tiredness from constantly switching tasks and being overloaded with information (8, 9). Smartphone overuse may also disrupt interoceptive and postural awareness, diminishing the ability to detect and respond to bodily signals such as fatigue, discomfort, or satiety (8, 9). Furthermore, evening smartphone use has been shown to negatively affect sleep latency, duration, and quality, primarily due to exposure to blue light and cognitive overstimulation, which disrupts circadian rhythms (10). These multifaceted effects may interact synergistically, resulting in compounded impairments in physical and cognitive functioning.

Despite increasing concerns, few studies have comprehensively investigated the combined impact of musculoskeletal pain and smartphone use on concentration, body awareness, and sleep quality, domains that are critical to overall health and daily functioning in young adult populations (8, 11, 12). Therefore, the present study aimed to compare smartphone addiction, concentration, body awareness, and sleep quality between young adults with and without musculoskeletal pain to determine whether these health-related domains differ based on the presence of pain.

METHOD

Study Design and Setting

The present study was a cross-sectional study conducted in two different universities in Istanbul from November 2024 to May 2025.

Ethical Approval

The study protocol was approved by the Biruni University Scientific Research Ethics Committee at Biruni University (approval number: 2024-BİAEK/03-11 on 14/08/2024). The study was carried out in accordance with the Declaration of Helsinki. Before the data collection, all participants provided written informed consent.

Participants

All participants were undergraduate students from Istanbul Medeniyet University and Biruni University. Recruitment was conducted consecutively from the university population during the same time period. Eligibility was determined based on predefined inclusion and exclusion criteria. Participants were eligible for inclusion if they were between 18 and 35 years old, could read and understand Turkish, had used a smartphone regularly for at least the past 5 years, and voluntarily agreed to participate in the study. Individuals were excluded if they had a diagnosed musculoskeletal disorder, spinal deformities such as scoliosis, kyphosis, or kyphoscoliosis, a history of musculoskeletal surgery within the past month, were currently pregnant, or had experienced pain due to a recent acute trauma or injury.

After eligibility screening, group allocation was determined based on responses to the Nordic Musculoskeletal Questionnaire (NMQ) (13, 14). Participants were categorized into two groups: The Musculoskeletal Pain Group comprised 64 individuals who reported musculoskeletal pain persisting for at least three months within the past 12 months in at least one of the following regions: neck, upper back, lower back, shoulder, elbow, or wrist/hand. The mean duration of pain in the Musculoskeletal Pain Group was 3.53 ± 0.88 months. The average pain intensity, as measured by the Visual Analog Scale (VAS), was 5.60 out of 10. No Pain Group comprised 64 individuals who reported no musculoskeletal pain in any body region during the same period. Individual 1:1 matching was performed after eligibility assessment. Controls were matched to cases based on exact sex and age (±1 year). The matching procedure was conducted sequentially from the pool of eligible control participants to ensure comparability. Frequency matching was not used. Identical inclusion and exclusion criteria were applied to both groups to minimize selection bias and enhance internal validity.

Sample Size Calculation

The sample size was calculated using G*Power software (version 3.1.9.2). Based on a two-tailed t-test for the comparison of two independent means, assuming a medium effect size ($d = 0.50$), a significance level (α) of 0.05, and a statistical power of 0.80, the required sample size was determined to be 64 participants per group. The total of 128 participants who met the inclusion criteria were included in the study (15).

Outcome Measures

The outcome measures for this study were the Smartphone Addiction Scale-Short Version, Body Awareness Questionnaire, Adult Concentration Inventory, and the Pittsburgh Sleep Quality Index. In addition to these outcome measures, sociodemographic characteristics and smartphone usage patterns were assessed in all eligible participants. Data on age, sex, height, weight, body mass index (BMI), education level, level of physical activity (categorized as low, moderate, or vigorous), and smartphone-related variables were collected. Smartphone-related variables included duration of smartphone use, daily screen time, hand used to hold the smartphone, presence of a smartphone finger deformity, typical smartphone use posture, primary hand used to operate the smartphone, and primary purposes of smartphone use. Smartphone finger deformity was determined by face-to-face clinical examination, based on visible morphological changes of the finger (e.g., abnormal curvature, indentation, or deviation) noted during physical inspection. Typical smartphone use posture was assessed during a face-to-face evaluation. Participants were asked to self-report the posture they most frequently adopted while using their smartphone. Specifically, they were asked to indicate which predefined posture category best represented their usual smartphone-use position.

The Smartphone Addiction Scale–Short Version (SAS-SV) is a reliable and valid tool for assessing the risk of smartphone addiction. It comprises 10 items that assess key aspects of problematic smartphone use, including daily-life disturbance, withdrawal, and tolerance. Each item is rated on a 6-point Likert scale ranging from 1 (strongly disagree) to 6 (strongly agree). The total score ranges from 10 to 60, with higher scores indicating a greater risk of smartphone addiction (16, 17).

The Body Awareness Questionnaire (BAQ) is a self-report instrument that assesses awareness of internal bodily processes. It is composed of 18 items grouped into four subdimensions: changes in bodily processes, sleep-wake cycle awareness, prediction of illness onset, and prediction of bodily reactions. Each item is rated on a 7-point Likert scale ranging from 1 (not at all true of me) to 7 (very true of me). The total score is obtained by summing all item responses, resulting in a total score range of 18 to 126, with higher scores indicating greater body awareness and sensitivity (18, 19).

The Adult Concentration Inventory (ACI) is a self-report instrument used to assess symptoms of cognitive disengagement syndrome. It consists of 15 items, each rated on a 4-point Likert scale ranging from 0 (never) to 3 (very often). The total score is obtained by summing all item responses, resulting in a score range of 0 to 45, with higher scores indicating greater levels of cognitive disengagement and attentional difficulty (20, 21).

The Pittsburgh Sleep Quality Index (PSQI) is a self-report instrument that assesses subjective sleep quality over the past month. It consists of 19 items grouped into seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Each component is scored from 0 to 3, and the global PSQI score is obtained by summing the component scores, resulting in a total score range of 0 to 21. Higher scores indicate poorer sleep quality (22, 23).

Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) version 20.0, developed by IBM, was used to perform statistical analyses. Descriptive statistics are presented as mean±standard deviation for continuous data, whereas binary and categorical variables are shown as numbers and frequencies. Before performing statistical analyses, normality of continuous variables was evaluated using the Shapiro–Wilk test, along with inspection of skewness and kurtosis values. The Shapiro–Wilk test results and corresponding p-values for the primary Variables were examined. Although minor deviations from normality were observed in some variables, skewness and kurtosis values were within acceptable limits (|skewness| < 2 and |kurtosis| < 7). Given the adequate sample size in each group (n = 64), parametric tests were considered appropriate based on the Central Limit Theorem. Independent samples t-tests were therefore used for group comparisons. The level of statistical significance was set at $p < 0.05$.

Comparisons of demographic data between the two groups were made using the chi-square test for categorical variables and independent t-tests for continuous variables. In addition to independent samples t-tests, standardized effect sizes were calculated for group comparisons using Cohen's d, with 95% confidence intervals (CIs), to quantify the magnitude of differences between groups. Effect sizes were interpreted as small (0.20), medium (0.50), and large (0.80) (15). To control for potential inflation of type I error due to multiple comparisons in group analyses, a Bonferroni correction was applied. Since four primary continuous outcomes (SAS-SV, ACI, BAQ, and PSQI) were compared, the adjusted significance level was set at $\alpha = 0.0125$ (0.05/4).

Binary logistic regression analysis was performed to identify factors associated with the presence of musculoskeletal pain. Multicollinearity among predictors was assessed using variance inflation factors (VIF), calculated from equivalent linear regression models. A VIF value >10 was considered indicative of problematic multicollinearity (24). The linearity of the logit for continuous predictors was evaluated using the Box–Tidwell procedure.

Model calibration was assessed using the Hosmer–Lemeshow goodness-of-fit test. Model discrimination was evaluated by calculating the area under the receiver operating characteristic curve (AUC) with 95% confidence intervals. The proportion of variance explained by the model was reported using Nagelkerke's R^2.

RESULTS

A total of 140 healthy young adults were screened for eligibility, and 128 participants who met the inclusion criteria and volunteered to participate were enrolled in the study (Figure 1. Flowchart of this study). There were no statistically significant differences between the Musculoskeletal Pain Group and the No Pain Group in age, sex, education level, BMI, physical activity level, duration of smartphone use, or primary smartphone-hand use ($p > 0.05$). Among the participants in the Musculoskeletal Pain Group (n=64), the most commonly reported pain regions were the neck (53.1%) and the upper back (45.3%), followed by the lower back (34.4%), shoulders (29.7%), wrist/hand (20.3%), and elbow (10.9%). Several participants reported experiencing pain in more than one anatomical region.

In terms of smartphone usage patterns, participants in the Musculoskeletal Pain Group reported significantly higher weekly screen time than those in the No Pain Group (mean difference = 6.55 hours/week, 95% CI: 3.42–9.68; $t = 4.10$, $p < 0.001$). Daily smartphone holding duration was also significantly greater in the Musculoskeletal Pain Group (mean difference = 2.56 hours/day, 95% CI: 2.19–2.93; $t = 13.57$, $p < 0.001$). The prevalence of smartphone finger deformity was significantly higher in the Musculoskeletal Pain Group (43.7%) compared to the No Pain Group (10.9%) ($\chi^2 = 17.34$, $p < 0.001$), corresponding to a fourfold increased risk (RR = 4.00, 95% CI: 1.89–8.49). Significant differences were also observed in smartphone usage posture ($\chi^2 = 8.06$, $p = 0.018$). A greater proportion of participants in the Musculoskeletal Pain Group reported using smartphones while sitting with their heads bent forward (RR = 1.62, 95% CI: 1.14–2.28), whereas lying down and standing/walking postures were relatively more common in the No Pain Group. No statistically significant differences were found between groups regarding the primary purposes of smartphone use ($\chi^2 = 0.87$, $p = 0.93$) (Table I).

Participants in the Musculoskeletal Pain Group demonstrated significantly higher scores on the SAS-SV, the PSQI, and the ACI (all p=0.001), along with significantly lower scores on the BAQ (p=0.004), compared to participants in the No Pain Group (Table II). Effect size analysis indicated large to very large between-group differences. Smartphone addiction showed a very large effect (d = 1.57, 95% CI: 1.19–1.94). Large effects were observed for concentration (d = 1.31, 95% CI: 0.94–1.67) and sleep quality (d = 1.37, 95% CI: 1.00–1.73). Body awareness also demonstrated a large effect size (d = −0.92, 95% CI: −1.29–−0.56), indicating substantially lower body awareness in participants with musculoskeletal pain.

Table I. Comparison of Sociodemographic Characteristics and Smartphone Usage Patterns between Groups

Variables	Group 1 (n=64)	Group 2 (n=64)	t /χ^2	Cohen's d (95% CI) / Relative Risk (95% CI)	p-value
Age (years)	24.81± 3.12	24.72± 3.25	0.16	0.09 (−1.02 – 1.20)	0.62
Sex					
Female	36 (56.3%)	36 (56.3%)	0.00	1.00 (0.74–1.36)	1.00
Male	28 (43.7%)	28 (43.7%)			
Body mass index, kg/m²	23.74 ± 2.82	23.37 ± 2.59	0.76	0.37 (−0.58 – 1.32)	0.47
Education (years)	15.22 ± 2.17	15.5 ± 2.46	0.68	−0.28 (−1.09 – 0.53)	0.68
Level of physical activity					
Low	28 (43.7%)	22 (34.4%)	1.18	1.27 (0.82–1.97)	0.21
Moderate and Vigorous	36 (56.3%)	42 (65.6%)			
Duration of smartphone usage (years)	7.20 ± 2.17	7.54 ± 1.99	0.91	−0.34 (−1.07 – 0.39)	0.56
Screen time (hours/week)	39.52 ± 9.34	32.97 ± 8.53	4.10	6.55 (3.42 – 9.68)	***0.03****
Holding smartphone in hand (hours/day)	5.97 ± 1.10	3.41 ± 1.02	13.55	2.56 (2.19 – 2.93)	***0.04****
Smartphone finger deformity					
Presence	28 (43.7%)	7 (10.9%)	17.34	4.00 (1.88–8.46)	***0.04**†*
Absence	36 (56.3%)	57 (89.1%)			
Typical smartphone usage posture					
Sitting with head bent forward	42 (65.6%)	26 (40.6%)	8.06	1.62 (1.14–2.28)	***0.01**†*
Lying down (on bed or couch)	14 (21.9%)	25 (39.1%)			
Standing or walking	8 (12.5%)	13 (20.3%)			
Primary smartphone operating hand					
Right hand	38 (59.4%)	40 (62.5%)	0.22	0.95 (0.72–1.25)	0.89
Left hand	4 (6.3%)	3 (4.7%)			
Both hands	22 (34.4%)	21 (32.8%)			
Primary purpose of smartphone use					
Social media	25 (39.1%)	22 (34.4%)			
Messaging	10 (15.6%)	14 (21.9%)			
Work or study	12 (18.8%)	14 (21.9%)	0.87	1.14 (0.72–1.79)	0.93
Gaming	5 (7.8%)	4 (6.3%)			
Watching videos or streaming	4 (6.3%)	5 (7.8%)			
Browsing or reading news/articles	4 (6.3%)	3 (4.7%)			

Group 1: Participants with musculoskeletal pain; Group 2: Participants without musculoskeletal pain.
Data are expressed as mean±standard deviation or number (percentage).
*Independent samples t-test, significance was accepted as $p < 0.05$. Statistically significant p-values are in bold.
†Chi-square test, significance was accepted as $p < 0.05$. Statistically significant p-values are in bold.

Binary logistic regression analysis identified smartphone addiction (B=0.40, OR=1.47, 95% CI=1.10–1.93, p=0.010), impaired concentration (B=0.20, OR=1.22, 95% CI=1.00–1.49, p=0.037), and poor sleep quality (B=0.60, OR=1.84, 95% CI=1.22–2.77, p=0.002) as significant predictors of musculoskeletal pain, with ORs expressed per 5-point increase in each scale score. In contrast, greater body awareness was found to be a protective factor (B = -0.25, OR = 0.77, 95% CI = 0.64–0.95, p = 0.016). Model performance: AUC = 0.81 (95% CI: 0.74–0.87); Hosmer–Lemeshow $\chi^2 = 6.12$, p = 0.64; Nagelkerke $R^2 = 0.29$ (Table III). The number of events per variable (EPV) in the logistic regression model was 16 (64 events and four predictors), exceeding the commonly recommended minimum threshold of 10 events per variable, indicating adequate model stability and reduced risk of overfitting. Although BMI, physical activity, and education were considered potential confounders, preliminary analyses demonstrated that their inclusion did not meaningfully improve model fit nor alter the effect estimates of the primary predictors (change in OR <10%). Therefore, to preserve model parsimony and avoid overfitting, these variables were not retained in the final model.

Table II. Comparison of Smartphone Addiction Level, Concentration, Body Awareness, and Sleep Quality between Groups

Variables	Group 1 (n=64)	Group 2 (n=64)	p-value	Cohen's d (95% CI)
Smartphone Addiction Scale-Short Version	48.62 ± 6.21	39.20 ± 5.77	**0.001***	1.57 (1.19 – 1.94)
Body Awareness Questionnaire	62.30 ± 9.81	71.54 ± 10.22	**0.004***	−0.92 (−1.29 – −0.56)
Adult Concentration Inventory	29.19 ± 5.50	22.47 ± 4.83	**0.001***	1.31 (0.94 – 1.67)
Pittsburgh Sleep Quality Index	10.22 ± 2.94	6.38 ± 2.66	**0.001***	1.37 (1.00 – 1.73)

Group 1: Participants with musculoskeletal pain
Group 2: Participants without musculoskeletal pain
Data are expressed as mean±standard deviation.
*Independent samples t-test, Bonferroni-adjusted significance level for multiple comparisons was set at $p < 0.0125$ (0.05/4).
Statistically significant p-values are in bold.

Table III. Logistic Regression Model Predicting the Presence of Musculoskeletal Pain Based on Smartphone Use, Concentration, Body Awareness, and Sleep Quality

Predictor Variable	B (β)	SE	Wald	OR (Exp(B))	95% CI for OR	p-value
Smartphone Addiction[a]	0.40	0.03	6.72	1.47	1.10–1.93	***0.010****
Concentration[b]	0.20	0.02	4.34	1.22	1.00–1.49	***0.037****
Body Awareness[c]	0.60	0.02	5.76	1.84	1.22–2.77	***0.016****
Sleep Quality[d]	-0.25	0.04	9.21	0.77	0.64–0.95	***0.002****

Model performance: AUC = 0.81 (95% CI: 0.74–0.87); Hosmer–Lemeshow $\chi^2 = 6.12$, $p = 0.64$; Nagelkerke $R^2 = 0.29$.
a As assessed by the Smartphone Addiction Scale.
b As assessed by the Adult Concentration Inventory.
c As assessed by the Body Awareness Questionnaire.
d As assessed by the Pittsburgh Sleep Quality Index.
*$p < 0.05$; **$p < 0.01$. B = unstandardized coefficient; OR = odds ratio; CI = confidence interval. All ORs are expressed per 5-point increase in scale scores

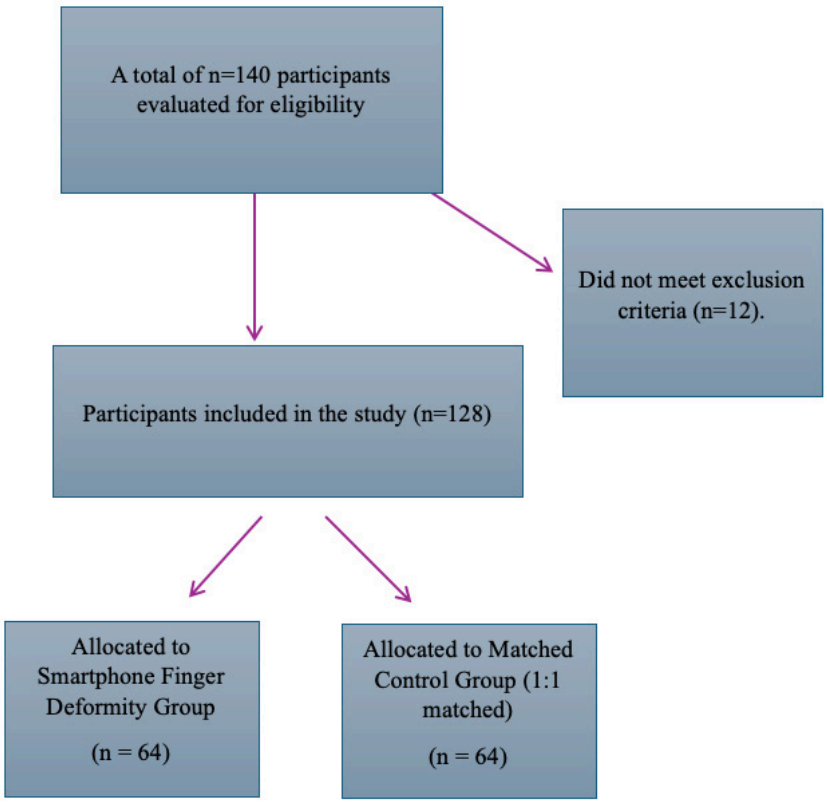

Figure 1. Flowchart of this study

DISCUSSION

This study aimed to compare smartphone addiction, concentration, body awareness, and sleep quality between young adults with and without musculoskeletal pain, and to determine whether these health-related domains vary according to pain status. The results revealed that young adults with musculoskeletal pain exhibited significantly higher levels of smartphone addiction, impaired concentration , and poorer sleep quality, along with significantly lower body awareness. Logistic regression analysis further confirmed these variables as significant factors associated with pain presence, with body awareness serving as a protective factor.

Our findings are consistent with the existing literature reporting an association between excessive smartphone use and musculoskeletal symptoms (3, 6, 7, 11, 12). Participants with musculoskeletal pain reported significantly longer daily smartphone holding durations, more frequent use in a forward head posture, and a higher prevalence of smartphone finger deformities compared to those without musculoskeletal pain (7, 12). For instance, 65.6% of participants with musculoskeletal pain reported using their smartphones while sitting with their heads bent forward, compared to 40.6% of those without musculoskeletal pain. Additionally, the prevalence of smartphone-related finger deformities was higher in the pain group (43.7%) than in the non-pain group (10.9%). These findings indicate that certain postural behaviors and prolonged smartphone use are more commonly observed among individuals reporting musculoskeletal pain. However, given the cross-sectional design of the study, causal inferences cannot be made. The observed relationships may reflect bidirectional influences or shared underlying factors rather than direct causal effects. Ergonomic factors may therefore be considered as potential correlates of musculoskeletal discomfort rather than definitive cause (7, 12).

Young adults with musculoskeletal pain scored significantly higher on the SAS-SV in our study, suggesting that smartphone addiction may have both behavioral and physiological implications. Logistic regression analysis revealed that each one-point increase in the SAS-SV score was associated with an 8% increase in the odds of experiencing musculoskeletal pain. These results align with emerging research indicating a close link between smartphone addiction and musculoskeletal complaints, attributed to both excessive physical engagement with the device and underlying compulsive usage patterns (25, 26). For example, a cross-sectional study among university students found that smartphone addiction, particularly involving gaming and music, was an independent predictor of upper limb and neck pain, and was associated with increased disability in these regions (25). Our findings further support the graded relationship previously reported between the severity of smartphone addiction and the risk of developing musculoskeletal symptoms (3, 6, 7, 11, 12). Alternative explanations should also be considered, as individuals experiencing musculoskeletal pain may increase smartphone use as a coping or distraction strategy, suggesting possible reverse causality, and unmeasured psychological factors such as depression or anxiety may contribute to both increased smartphone use and heightened pain perception.

Cognitive disengagement, as measured by the ACI, was significantly higher among young adults with musculoskeletal pain in our study. Both chronic pain and frequent smartphone use are associated with impaired attention, increased distractibility, and mental fatigue (9, 27). Pain can consume attentional resources, reduce working memory capacity, and impair decision-making processes (27). When combined with fragmented attention patterns and constant task switching that accompany excessive smartphone use, particularly through social media, messaging apps, or gaming, this can lead to persistent cognitive overload (9). Additionally, smartphone addiction often results in compulsive checking behaviors, shortened attention spans, and reward-driven engagement, which can further diminish sustained focus and mental endurance over time. The interaction between pain and addictive smartphone usage can create a feedback loop. Discomfort may prompt increased screen time as a coping strategy (e.g., distraction or avoidance), which, in turn, exacerbates cognitive fatigue and emotional dysregulation (28).

Sleep quality, as measured by the PSQI, was significantly lower among young adults with musculoskeletal pain in our study. This finding is not surprising, as both pain and excessive smartphone use are known to affect sleep quality negatively (4, 10). Chronic pain can increase physiological arousal and disrupt neural pathways related to pain, making it difficult to both initiate and maintain sleep (29). At the same time, using smartphones in the evening, primarily due to exposure to blue light and engaging content, can suppress melatonin production, delay circadian rhythms, and increase cognitive arousal before sleep (30). A recent study has shown a strong correlation between excessive smartphone use and poor sleep outcomes, including shorter sleep duration and decreased sleep efficiency, particularly among students (31). Together, these findings suggest that musculoskeletal discomfort, increased cognitive disengagement, and disrupted sleep create a problematic cycle linked to chronic smartphone overuse.

Body awareness, as measured by the BAQ, was significantly lower among young adults with musculoskeletal pain in our study. Chronic smartphone use likely disrupts body awareness by diverting attention outward, reducing awareness of bodily sensations, and promoting prolonged static postures (8). Young adults with low body awareness may be less inclined to adjust their posture, take regular breaks, or recognize subtle warning signs during extended periods of device use. Given that higher body awareness is linked to improved self-regulation, better postural control, and pain prevention, these findings underscore the

importance of interventions to enhance body awareness (32, 33). Impaired body awareness may contribute to the development or persistence of postural problems and musculoskeletal pain, particularly when compounded by prolonged and unvaried smartphone use.

In Türkiye, smartphone use among university students should be interpreted within a rapidly digitalizing higher-education context, where mobile devices increasingly serve as both social and academic tools. Digital transformation has become a strategic priority in Turkish higher education, with smartphones being integrated into teaching, assessment, and student–university communication, potentially normalizing prolonged daily exposure (34). In collectivistic settings such as Türkiye, the need for social connectedness and responsiveness to peers can reinforce compulsive smartphone checking behaviors, which are closely linked to smartphone addiction among university students (35). Social norms and pressures have also been shown to reinforce use stickiness and automatic smartphone habits, potentially competing with sleep and recovery (36). International evidence also indicates that excessive digital device use is associated with increased distraction and diminished student well-being, as highlighted by the Organisation for Economic Co-operation and Development's Managing Screen Time report based on the Programme for International Student Assessment 2022 data, supporting the notion that educational and cultural context are relevant determinants when interpreting smartphone-related musculoskeletal outcomes in young adults (37).

Limitations

This study has several limitations that should be considered when interpreting the findings. First, its cross-sectional design precludes establishing causal relationships between smartphone use patterns and musculoskeletal pain, concentration, sleep quality, or body awareness. Longitudinal studies are needed to explore the directionality and temporal dynamics of these associations. Second, all data were collected via self-report instruments, which may be subject to recall bias. Although the tools used were validated and reliable, objective measurements such as actigraphy, posture tracking, or screen-time monitoring could enhance data accuracy in future research. Third, the sample consisted solely of university students from two institutions in Türkiye, which limits generalizability to other age or occupational groups. Lastly, although some confounders were considered, important psychological variables such as depression, anxiety, stress, academic workload, or sleep disorders were not assessed. These factors are known to influence pain perception, sleep disturbances, and problematic smartphone use, and their absence may have resulted in residual confounding.

CONCLUSION

This study demonstrated that young adults with musculoskeletal pain exhibit significantly higher levels of smartphone addiction, impaired concentration, and poor sleep quality, along with lower body awareness, compared to those without musculoskeletal pain. These findings highlight the multidimensional impact of excessive smartphone use, extending beyond physical strain to include cognitive and perceptual dysfunction. The presence of a significant relationship between smartphone-related behaviors and pain emphasizes the need for comprehensive preventive strategies. Interventions targeting not only ergonomic posture and usage habits but also attention regulation, sleep routines, and interoceptive awareness may play a critical role in promoting musculoskeletal and mental well-being in digitally engaged young populations. Future research should investigate the longitudinal effects and evaluate the efficacy of integrative intervention models.

Ethical Approval

The study protocol was approved by the Biruni University Scientific Research Ethics Committee at Biruni University (approval number: 2024-BİAEK/03-11 on 14/08/2024).

Conflict of Interest

The authors have no conflict of interest to declare.

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Author Contribution

Concept: GKA and TBO; Design: GKA and TBO; Data collecting: GKA and TBO; Statistical analysis: GKA; Literature review: GKA and TBO; Writing: GKA and TBO; Critical review: GKA and TBO

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