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Comparison of posture, pain, disability and quality of life in young adults according to smartphone usage time

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ABSTRACT
Purpose. Smartphone use has increased substantially and raised concerns about its potential effects on posture, musculoskeletal pain, and overall health. However, the relationship between smartphone usage and these outcomes remains unclear. The study investigates the association between daily smartphone usage time and postural alignment, musculoskeletal pain, disability, and quality of life in young adults, while considering confounding variables like exercise habits and psychological well-being.
Methods. Our study design was cross-sectional. A total of 138 participants (94 female, 44 male) were included in the study. Participants were grouped based on daily smartphone use (≤ 4 hours and > 4 hours). Validated questionnaires used were the Visual Analogue Scale (VAS), International Physical Activity Questionnaire (IPAQ), Neck Disability Index (NDI), Beck Depression Inventory (BDI), and SF-36 (36-Item Short Form Survey). Postural assessment was performed using a mobile application. Exercise type and duration were also recorded.
Results. Participants with higher smartphone use reported significantly lower physical activity levels and exercise durations ($p < 0.05$). No significant differences were found between groups regarding the pain, disability, depression, quality of life, or posture parameters ($p > 0.05$). Secondary analysis revealed that resistance exercise was associated with a higher body mass index, longer weekly exercise duration, and reduced pain levels.
Conclusions. Smartphone usage alone was not significantly associated with posture or musculoskeletal pain among young adults. Instead, these outcomes are influenced by a multifactorial interplay involving physical activity and lifestyle habits. Future longitudinal studies using objective tools and sensitive postural assessments are needed to better understand the links between technology use, exercise, and health.
Key words: smartphone usage time, posture, pain, disability, quality of life

Introduction

Smartphone ownership and the average daily screen time have experienced a substantial and unprecedented increase across all demographic groups worldwide in recent years. This rapid escalation is largely attributable to continuous advancements in mobile technology, the proliferation of affordable smart devices, and the ubiquitous presence of social media platforms that facilitate constant connectivity [1]. The integration of smartphones into the fabric of daily life has fundamentally transformed multiple aspects of human behaviour, including communication patterns, educational methodologies, entertainment consumption, and occupational workflows on a global scale [2, 3]. The multifunctionality of smartphones provides users with immediate and convenient access to information, fosters enhanced social interactions through virtual networks, and supports a diverse range of educational and professional applications.

Although smartphones offer unparalleled convenience and functionality, growing evidence suggests that excessive use may negatively impact both mental and physical health [4, 5]. Psychologically, high smartphone dependency has been linked to increased levels of anxiety, depression, sleep disturbances, and emotional dysregulation [6, 7]. On the physical side, prolonged device usage is associated with various musculoskeletal complaints, including neck and shoulder pain, upper back tension, and hand-wrist discomfort [8–15].

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Of increasing concern is the effect of prolonged smartphone use on postural alignment, particularly in the cervical and thoracic regions. Studies have shown that individuals often adopt a forward head posture, rounded shoulders, and increased thoracic kyphosis while using handheld devices for extended periods [16, 17]. These maladaptive postures can place excessive mechanical load on the spine and surrounding musculature, potentially leading to pain and dysfunction. Postural alignment has therefore become a focal point in recent research as a primary indicator of musculoskeletal health in the context of mobile device use.

However, emerging literature emphasises that postural deviations alone are not always directly predictive of pain or dysfunction. Pain is now widely recognised as a multifactorial phenomenon, shaped by biomechanical factors, psychological states, and behavioural patterns [18–20]. Consequently, investigations into posture-related health outcomes must adopt a biopsychosocial framework, which considers not only structural alignment but also associated behaviours and psychosocial influences.

In addition to pain and postural problems, smartphone overuse has been associated with reduced physical activity, functional limitations, and lower quality of life, particularly among sedentary individuals [21–23]. These outcomes often intersect and amplify each other, resulting in a cycle of deconditioning, discomfort, and decreased well-being. Furthermore, behaviours related to the ergonomics of technology use – such as total time spent in a fixed posture, duration of use of other technological devices (e.g., laptop, tablet) – have recently garnered attention as important determinants of musculoskeletal health [22, 24, 25].

Importantly, ergonomic behaviour patterns – such as time spent in static postures and the cumulative usage of multiple screen-based devices – are seldom captured in existing smartphone-related studies. A major strength of the present study lies in its inclusion of these variables, providing a more nuanced analysis of the interaction between device usage habits and musculoskeletal outcomes.

Despite the growing body of research exploring the health impacts of smartphone use, the current literature remains constrained by several methodological limitations. One common shortcoming is the reliance on self-reported data to estimate smartphone usage duration and postural behaviour, which may introduce recall bias and reduce measurement accuracy [22, 26, 27]. Furthermore, a number of studies fail to incorporate objective postural assessments, such as photographic or sensor-based evaluations, and instead depend on participants' perceptions of their posture [22, 27]. Additionally, key behavioural and psychosocial confounders – such as sedentary time, physical activity level, and psychological stress – are often under-assessed or omitted entirely [28, 29].

To address these limitations and gaps, the present study aims to comprehensively examine the relationship between daily smartphone usage duration and multiple health-related outcomes – specifically postural alignment (primary outcome), musculoskeletal pain, functional disability, and quality of life – in healthy young adults. Postural alignment was objectively assessed using a validated mobile application that analyses photographic data. Furthermore, detailed data on smartphone use patterns, including total screen time, duration of static posture, and usage of other screen-based devices, were systematically collected. Validated self-report instruments were also employed to evaluate pain, disability, psychological status, and physical activity levels.

By integrating objective posture assessment, ergonomic behaviour profiling, and biopsychosocial variables, this study provides a comprehensive perspective on the potential health implications of smartphone overuse. It aims to generate meaningful insights that may inform future preventive and interventional strategies for young adults at risk of technology-related health impairments.

Material and methods

Study design and participants

This study employed a descriptive, cross-sectional design.

Data were collected at the university's physiotherapy and rehabilitation laboratory between June 2022 and March 2023. Individuals who were studying at university and who met the inclusion criteria were included in the study.

The inclusion criteria for the study were (1) using a smartphone, (2) being between the ages of 18 and 25, and 4) willing to volunteer to participate in the study. Exclusion criteria for the study were (1) diagnosed with any traumatic or chronic musculoskeletal/orthopaedic, neurological, cardiovascular or pulmonary disease, (2) diagnosed with a psychological disease that may affect posture, (3) diagnosed with a chronic sleep disorder, (4) history of any major surgery.

Grouping justification, sample size, and power analysis

Smartphone usage durations are commonly categorised in the literature as 0–2 hours, 2–4 hours, and 4–6 hours per day to examine dose-dependent effects [30, 31]. However, in our sample, the number of participants reporting less than 2 hours or more than 6 hours of daily smartphone use was limited. Due to this distribution and to ensure adequate group sizes for meaningful statistical comparisons, participants were classified into two groups: those using smartphones for ≤ 4 hours and those using them for > 4 hours daily. This dichotomisation allowed for balanced group sizes while maintaining consistency with common usage thresholds reported in prior studies.

Given the changes to the grouping strategy after data collection, a post hoc power analysis was conducted based on the final sample size. With a total of 138 participants, the study achieved a statistical power of 80%, assuming a medium effect size (Cohen's $d = 0.5$) and a significance level of 5% ($\alpha = 0.05$). Due to the absence of an a priori pilot study and subsequent changes in the grouping strategy after data collection, the sample size calculation was performed post hoc. In line with common practices in behavioural and clinical research, a medium effect size (Cohen's $d = 0.5$) was assumed to ensure adequate statistical power and the ability to detect clinically meaningful differences [32].

Measurements

A data recording form including all variables and related questions for the study was prepared and filled out by the participants together with the questionnaires. Postural assessments were conducted by a physiotherapist (S.K.) with 13 years of experience in this field, and questionnaire assessments were conducted by a physiotherapist (R.K.) with 18 years of experience. Participants were evaluated at consistent times of day to control for potential diurnal variations in posture and fatigue.

The demographic information (age, gender, dominant extremity, body mass index (BMI), number of comorbidities, smartphone usage by year) was requested in the data recording form. Daily usage time (minutes), maximum time of fixed posture during the day, time spent with devices such as tablets and laptops, physical activity or regular exercise habits (whether it happens, and if so, the exercise type such as aerobic, resistive or combined), information about living arrangements (e.g., living alone, with family, or in a dormitory) was also collected.

Participants were asked to report their average daily smartphone usage. Many participants utilised weekly screen time data automatically recorded by their smartphones and calculated average daily usage by dividing the total weekly screen time by the number of days the phone was used during that week. However, participants without access to this automated data – possibly due to outdated software – may have provided subjective estimates.

Pain levels for the neck and upper back were questioned with the Visual Analogue Scale (VAS), physical activity level with the International Physical Activity Questionnaire (IPAQ), disability status with the Neck Disability Index (NDI), depression levels with the Beck Depression Questionnaire (BDI), and quality of life with the SF-36 (36-Item Short Form Survey), and posture analysis (cervical and thoracic) was conducted via the PostureScreen Mobile smartphone app.

The Visual Analogue Scale (VAS) is usually 100 mm long horizontally or vertically. It consists of a line with 'No Pain' written on one end and 'Unbearable Pain' on the other. The VAS can consist of just a straight line, or words describing the pain can be written on this line at equal intervals [33]. The VAS scores of the participants were recorded before the tests.

In the literature, changes in cervical and thoracic region posture have been reported due to smartphone use [9, 10]. Cervical and thoracic posture was performed with a paid application called PostureScreen Mobile. This application was specifically designed for healthcare professionals who want to objectively assess patients' posture, movement, and body composition (PostureCo; http://postureanalysis.com/mobile/). The validity and reliability of the application have been confirmed, and its use has been found appropriate for clinical practice and research [34].

The Neck Disability Index (NDI) was developed by Vernon and Mior in 1991 [35]. It has 10 subscales. These headings are pain intensity, personal care, weight lifting, reading, headache, concentration, work, driving, sleeping, and entertainment. The validity and reliability of this form in Turkish were confirmed by Telci et al. [36]. In the assessment, each subscale is given a raw score between 0 and 5 (0: best case, 5: worst case). The total score of the NDI is calculated out of 100. The NDI % score is determined as; 0–8% no disability, 10–28% mild disability, 30–48% moderate disability, 50–68% severe disability, and over 68% complete disability [35].

Physical activity level was assessed with the International Physical Activity Questionnaire (IPAQ). IPAQ is known as the most effective method for measuring physical activity in large groups and large populations. Its Turkish validity and reliability were confirmed by Saglam et al. [37].

Depression levels of the participants were assessed with the Beck Depression Inventory (BDI). The BDI was developed by Beck et al. [38] in 1961 to measure behavioural symptoms of depression in adolescents and adults and is one of the most commonly used depression scales in theoretical and clinical practice today. Its validity and reliability have been confirmed in Turkish [39].

The SF-36 is a valid and frequently used questionnaire for assessing quality of life. It was developed by Ware and his colleagues in 1987, and its validity and reliability have been confirmed in our country [40]. It contains 36 questions in eight subscales including physical function, physical role restriction, emotional role restriction, body pain, social function, mental health, vitality, and general health. The score of each subscale varies between 0 and 100, and the quality of life is directly proportional to the score. It has two summary scales: physical component, and mental component. It is the most frequently used quality of life scale in the spinal region in the literature [41].

Statistical analysis

Data were analysed using SPSS version 29.0 (SPSS Inc, Chicago, IL, USA). Continuous variables (age, BMI, number of comorbidities, years of smartphone use, daily usage duration of other technological devices, maximum time spent in a fixed posture during the day, daily physical activity duration, weekly exercise duration, time spent on social engagement) are expressed as mean ± standard deviation (mean ± *SD*), while categorical variables (gender, dominant extremity, living arrangement, engaging in regular exercise, exercises type) are presented as frequencies and percentages. Cohen's d was calculated to determine the effect size for group comparisons of continuous variables. Skewness and kurtosis values between –2 and +2 are considered acceptable to prove a normal univariate distribution [42]. Differences in numerical variables between groups were analysed using the independent samples t-tests.

For categorical comparisons with significant Chi-Square results, post-hoc analyses were performed using adjusted standardised residuals. The Bonferroni correction was applied ($p < 0.0083$) to control for multiple comparisons. For the analysis of the regular exercise type (aerobic, resistance, or combined) by daily smartphone use duration (≤ 4 hours vs. > 4 hours), a 3 × 2 contingency table was formed. This required six post-hoc comparisons, resulting in a Bonferroni-adjusted significance threshold of $p < 0.0083$. Cell-wise significance was determined based on adjusted residuals and their corresponding *p*-values. The significance level between groups was determined as $p < 0.05$.

Results

A total of 143 volunteers participated in the study. However, the data of 5 participants, 1 of whom had a psychological problem diagnosis and 4 of whom had significant kyphosis and scoliosis, were excluded from the analysis. A total of 138 participants, 94 females and 44 males, were included in the study. The mean age of the sample was 21.07 ± 1.37 years. The overall mean daily smartphone usage time was 290 ± 105.45 minutes. When categorised by usage duration, the ≤ 4 hours group had a mean smartphone use of 180.0 ± 42.42 minutes (range: 60–240 minutes), while the > 4 hours group averaged 358.59 ± 68.01 minutes (range: 300–600 minutes). These results highlight a clear differentiation in smartphone engagement between groups, supporting the rationale for the chosen cutoff point.

There were no statistically significant differences found between the groups in terms of certain categorical variables (gender, dominant extremity, living arrangement) based on daily smartphone usage time ($p > 0.05$; see Table 1). The skewness and kurtosis values of the numerical data were within the acceptable range for a normal distribution.

Significant differences were identified between groups in terms of the number of participants engaging in regular exercise and the types of exercise performed ($p < 0.05$). The proportion of participants who exercised regularly was higher in the group with 4 hours or less of daily smartphone use. Post hoc analyses for the exercise type variable indicated that the significant association was primarily attributable to a higher number of participants performing combined exercise (aerobic and resistance) in the group with more than 4 hours of daily smartphone use, compared to what would be expected by chance. This difference remained statistically significant after applying the Bonferroni correction (adjusted $p < 0.0083$), suggesting a meaningful relationship between longer smartphone usage and engagement in structured or diverse exercise regimens. Daily physical activity duration and weekly exercise duration emerged as statistically significant among the numerical variables ($p < 0.05$; see Table 2), both showing moderate effect sizes (Cohen's $d \approx 0.4–0.5$).

Table 1. Descriptive statistics of the groups (categorical variables)

Variables		0–4 hours n = 53 (38.4%)	> 4 hours n = 85 (61.6%)	p-values
Gender	male	31 (58.5%)	63 (74.1%)	0.05
	female	22 (41.5%)	22 (25.9%)	
Dominant extremity	right	53 (100.0%)	0 (0.0%)	0.08
	left	79 (92.9%)	6 (7.1%)	
Living arrangement	alone (at home)	10 (18.9%)	12 (14.1%)	0.12
	friends (at home)	28 (52.8%)	58 (68.2%)	
	friends (in a dormitory)	8 (15.1%)	4 (4.7%)	
	family (at home)	7 (13.2%)	11 (12.9%)	
Participants who exercise regularly		34 (64.2%)	68 (80.0%)	0.03*
Participants who do not exercise regularly		19 (35.8%)	17 (20.0%)	
Exercises type	aerobic	8 (66.7%)	4 (33.3%)	0.02*
	resistive	8 (72.7%)	3 (27.3%)	
	combined	3 (23.1%)	10 (76.9%)	

* $p < 0.05$

Table 2. Descriptive statistics of the groups (continuous variables)

Variables		0–4 hours (n = 53) (mean ± SD)	> 4 hours (n = 85) (mean ± SD)	Cohen's d	p-values
Age (years)		21.32 ± 1.41	20.91 ± 1.33	0.3	0.08
BMI (kg/m²)		22.92 ± 3.79	22.50 ± 4.09	0.1	0.54
CDN		0.13 ± 0.34	0.09 ± 0.29	0.12	0.49
Smartphone usage years		7.72 ± 1.75	7.79 ± 1.95	–0.03	0.82
Daily usage duration of other technological devices (min)		88.38 ± 124.49	66.31 ± 78.69	0.14	0.41
Maximum time spent in a fixed posture (min)		134.62 ± 137.48	134.94 ± 111.1	–0.003	0.98
Daily physical activity duration (min)		105.66 ± 144.45	50.54 ± 113.39	0.43	0.01*
Weekly exercise duration (min)		154.50 ± 275.62	69.29 ± 159.22	0.4	0.04*
Exercises duration (by exercise types)	aerobic	196.29 ± 197.61	165.0 ± 75.49	0.18	0.77
	resistive	562.50 ± 357.04	580.0 ± 150.99	–0.05	0.93
	combined	500.0 ± 192.87	261.0 ± 170.90	1.36	0.06
Time spent on social engagement (min)		195.0 ± 167.03	195.73 ± 188.81	–0.004	0.98

BMI – body mass index, CDN – chronic disease number
* $p < 0.05$

In terms of physical activity, participants with lower smartphone usage reported significantly longer daily physical activity and weekly exercise durations ($p < 0.05$). Moreover, IPAQ scores were significantly higher in this group ($p < 0.05$), indicating a higher level of overall physical activity, with a moderate effect size (Cohen's d = 0.39).

Conversely, no statistically significant differences were observed between groups in pain intensity or other patient-reported outcomes such as the Neck Disability Index (NDI), Beck Depression Inventory (BDI), or SF-36 scores (Table 3).

Similarly, posture assessments revealed no significant group differences in cervical and thoracic translation or angulation values ($p > 0.05$; Table 4). In addition, the corresponding effect sizes (Cohen's d) for postural variables were consistently small, ranging from 0.04 to 0.26, indicating minimal group-level differences in objective posture assessments.

The effect of exercise type (aerobic, resistive, or combined) on the group variables was examined based on the significant differences identified across exercise categories. Participants who engaged in regular exercise constituted 26% of the total sample, with a similar number of participants in each exercise subgroup. According to the analyses, statistically significant differences were observed in BMI ($p < 0.001$), years of smartphone use, time spent on social engagement, weekly exercise duration, and VAS scores ($p < 0.05$).

Table 3. Comparison of pain level and self-reported questionnaires according to smartphone usage times

Variables	0–4 hours (n = 53) (mean ± SD)	> 4 hours (n = 85) (mean ± SD)	Cohen's d	p-values
VAS score	2.91 ± 2.18	3.1 ± 2.24	–0.08	0.62
IPAQ	2.36 ± 0.65	2.11 ± 0.63	0.39	0.02*
NDI	8.40 ± 4.67	8.36 ± 4.37	–0.11	0.49
BDI	11.51 ± 7.19	12.36 ± 7.22	0.007	0.96
SF-36 – physical	75.94 ± 12.07	72.95 ± 14.02	0.22	0.20
SF-36 – mental	55.08 ± 17.44	52.12 ± 18.81	0.16	0.35

VAS – Visual Analogue Scale, IPAQ – International Physical Activity Questionnaire, NDI – Neck Disability Index, BDI – Beck Depression Inventory, SF-36 – 36-Item Short Form Survey (physical: physical component summary, mental: mental component summary)
* $p < 0.05$

Table 4. Comparison of translational and angular metrics derived from PostureScreen according to smartphone usage duration

Variables	0–4 hours (n = 53) (mean ± SD)	> 4 hours (n = 85) (mean ± SD)	Cohen's d	p-values
Head anterior translation (in)	0.21 ± 0.22	0.25 ± 0.29	–0.14	0.39
Head anterior angulation (°)	1.69 ± 2.67	2.2 ± 2.6	–0.2	0.24
Head lateral translation (R) (in)	1.49 ± 0.61	1.52 ± 0.63	–0.04	0.78
Head lateral angulation (R) (°)	14.93 ± 5.83	15.1 ± 5.51	–0.02	0.86
Shoulder anterior translation (in)	0.25 ± 0.5	0.24 ± 0.2	0.03	0.85
Shoulder anterior angulation (°)	1.21 ± 2.21	1.32 ± 1.72	–0.06	0.73
Shoulder lateral translation (R) (in)	1.01 ± 0.7	0.89 ± 0.63	0.16	0.33
Shoulder lateral angulation (R) (°)	2.45 ± 2.3	2.05 ± 2.21	0.17	0.30
Head posterior translation (in)	0.2 ± 0.17	0.22 ± 0.2	–0.13	0.45
Head posterior angulation (°)	0.53 ± 1.35	0.78 ± 1.61	–0.16	0.34
Head lateral translation (L) (in)	1.46 ± 0.62	1.55 ± 0.79	–0.12	0.48
Head lateral angulation (L) (°)	14.96 ± 6.5	15.53 ± 7.53	–0.07	0.65
Shoulder posterior translation (in)	0.23 ± 0.19	0.2 ± 0.17	0.16	0.36
Shoulder posterior angulation (°)	0.67 ± 1.22	0.7 ± 1.2	–0.01	0.91
Shoulder lateral translation (L) (in)	1.21 ± 0.91	1.07 ± 0.74	0.18	0.30
Shoulder lateral angulation (L) (°)	3.12 ± 2.9	2.64 ± 2.48	0.18	0.29
Averaged head lateral translation (in)	1.47 ± 0.54	1.54 ± 0.59	–0.1	0.55
Averaged shoulder lateral translation (in)	1.11 ± 0.64	0.98 ± 0.52	0.22	0.19
Averaged head lateral angulation (°)	14.96 ± 5.54	15.33 ± 5.34	–0.06	0.69
Averaged shoulder lateral angulation (°)	2.84 ± 2.12	2.3 ± 1.99	0.26	0.14

R – right, L – left

Table 5. Variables showing significant differences based on exercise type

Variables	Aerobic n = 12 (30.5%), (mean ± SD)	Resistive n = 11 (33.3%) (mean ± SD)	Combined n = 13 (36.1%) (mean ± SD)	p-values
BMI (kg/m^2)	20.59 ± 2.94	25.92 ± 3.27	22.12 ± 2.7	< 0.001***
Smartphone usage (years)	7.75 ± 2.05	7.64 ± 2.65	6.85 ± 1.67	0.01*
Time spent in social engagement (min)	150.0 ± 132.13	278.18 ± 159.36	136.15 ± 136.72	0.04*
Weekly exercise duration (min)	184.91 ± 159.34	567.27 ± 306.36	316.15 ± 197.71	0.001*
VAS score	2.25 ± 1.86	1.36 ± 1.43	3.92 ± 2.21	0.007*

BMI – body mass index, VAS – Visual Analogue Scale
* $p < 0.05$, *** $p < 0.001$

Post hoc analysis indicated that these differences were primarily attributable to the resistive and combined exercise groups. Compared to the other groups, participants in the resistive exercise group had significantly higher BMI, increased time spent in social engagement, longer weekly exercise duration, and lower VAS scores. Additionally, the combined exercise group exhibited significantly fewer years of smartphone use than the other groups (Table 5).

Discussion

This study primarily aimed to examine whether daily smartphone usage duration is associated with objectively assessed postural alignment in healthy young adults, alongside secondary outcomes such as pain, disability, and quality of life. Due to the low number of participants reporting ≤ 2 hours or > 6 hours of daily phone use, the sample was reclassified into two groups: those using their phones for ≤ 4 hours and those using them for > 4 hours per day.

According to the Digital 2024 April Global Statshot Report data, the average daily online time spent on smartphones worldwide by adults was reported as 395 minutes. According to the same report, this average for our country was determined to be 426 minutes, which is higher than the world average. It was reported that 94% of this time was spent on smartphones [43].

In the present study, the mean smartphone usage time among the participants was 290 minutes per day. The relatively lower average observed in this study, compared to national and global figures, may be attributed to the specific characteristics of the study population, which consisted solely of university students aged 18 to 25 years. Moreover, factors such as academic workload, lifestyle habits, and unique usage patterns – particularly the balance between educational and recreational smartphone use – may have influenced the reported duration of smartphone usage.

This study adopted a comprehensive approach to the analysis of postural changes by accounting for multiple contributing variables beyond smartphone usage alone. In addition to smartphone screen time, variables such as the use duration of other technological devices (e.g., laptops, tablets), maximum time spent in a static posture, engagement in physical activity and regular exercise (including types and duration), BMI, years of smartphone use, and time spent on social interactions were considered. Group comparisons revealed significant differences in physical activity-related variables: participants in the > 4 hours group reported lower daily physical activity, weekly exercise duration, and had fewer regular exercise habits. This inverse association is in line with previous studies suggesting that increased screen time is linked to reduced physical activity [44, 45]. Importantly, the absence of significant group differences in demographic characteristics (e.g., age, BMI, comorbidities) and contextual behaviours (e.g., time spent in fixed postures, use of other devices) strengthens the interpretation that the observed postural and behavioural disparities are not merely attributable to confounding factors. Furthermore, the moderate effect sizes noted in the physical activity and exercise duration underscore the potential behavioural consequences of excessive smartphone use, particularly its association with diminished movement patterns and reduced physical engagement.

Interestingly, participants in the > 4 hours group were more likely to engage in combined exercise (aerobic + resistance training). This unexpected finding may suggest a compensatory behaviour where individuals with high screen exposure also possess high health consciousness, potentially using their devices to support their fitness routines. However, due to the cross-sectional design of this study, such interpretations remain speculative and require further investigation.

No statistically significant differences were found between groups in terms of pain intensity, NDI, BDI or SF-36 scores. While some studies have demonstrated associations between smartphone addiction and musculoskeletal or psychological complaints [9, 11, 12], others have reported no significant relationship [46]. A likely reason for these inconsistencies is the classification method used in most studies, which often dichotomises participants as ‘addicted’ vs. ‘non-addicted’ based on self-report scales. This approach may oversimplify the complex and multifactorial effects of smartphone use. Our results suggest that self-reported screen time alone may not adequately capture its multifaceted impact on musculoskeletal and psychosocial outcomes, particularly when crucial confounding variables – such as physical activity levels and the usage of other electronic devices – are not accounted for. While smartphone use was not significantly correlated with pain intensity or most self-reported psychosocial and functional measures, a moderate effect size was found in physical activity levels as measured by the IPAQ. This result is consistent with previous studies indicating that extended screen time can adversely impact physical activity engagement, even when no overt pain or disability symptoms are present. [47, 48].

The absence of significant differences in pain-related outcomes may be attributed to the relatively young and healthy profile of the study population, as well as the inherently multifactorial nature of musculoskeletal discomfort.

We argue that postural problems cannot be fully explained through self-reported addiction questionnaires alone, especially considering the observed link between addiction levels and physical activity. Given that smartphone addiction is a behavioural condition, its influence on physical health may be indirect and multifactorial [12, 49].

Moreover, prolonged use of other technological devices – such as gaming consoles or laptops – can contribute similarly to postural issues, even in individuals not classified as addicted to smartphones. An advantage of the current study is its inclusion of data regarding the usage of these additional devices. Although no statistically significant differences emerged, participants who reported using smartphones for ≤ 4 hours per day appeared to spend more time on other devices, which may have confounded the results.

Lastly, variations in the type of exercise performed among participants may have influenced both the pain intensity and questionnaire outcomes, warranting further investigation in future studies. There is ongoing controversy in the literature regarding the postural effects of smartphone use [50–52].

In the present study, no significant differences were found in cervical and thoracic translation and angulation values in relation to smartphone usage time. This finding may be attributed to several factors. First, the participants in our study reported higher average daily use of other technological devices (e.g., computers, tablets), which may have masked the specific effects of smartphone use on posture.

Additionally, differences in the number of participants engaged in regular combined exercise could have influenced the postural outcomes, as exercise is known to have a protective effect on musculoskeletal health and posture [53, 54]. Regular exercise training is a well-established factor in promoting musculoskeletal health and preventing postural deterioration. Therefore, it may have acted as a confounding variable in our analysis.

Another possible explanation for the absence of significant findings lies in the measurement method employed. The posture assessment system used in this study analyses postural translations and angulations that may result from complex compensatory mechanisms throughout the kinetic chain, rather than isolated segmental misalignments. Consequently, subtle postural deviations associated specifically with smartphone use may not have been detected.

Although smartphone usage duration was hypothesised to influence postural alignment, the present study did not reveal any statistically significant group differences in the objectively assessed postural parameters. Additionally, all effect sizes were small, indicating negligible practical differences. These findings may be attributed to several factors, including the young and healthy status of the participants, the musculoskeletal system's adaptive capacity, and potentially unmeasured ergonomic behaviours.

Interestingly, while postural outcomes did not differ significantly, certain independent variables, such as physical activity levels and exercise duration, did show meaningful group differences. This suggests that posture may be shaped by a multifactorial interaction of broader lifestyle factors, including engagement in physical activity and overall screen-based behaviours beyond smartphone use alone.

Future research should adopt longitudinal designs with repeated objective posture assessments, integrate continuous smartphone usage monitoring via built-in tracking tools, and systematically evaluate ergonomic behaviours such as static posture duration and multi-device use, to more precisely clarify the dynamic and multifactorial relationship between smartphone use and postural health.

We conducted secondary analyses due to the significant difference in the type of regular exercise between groups and the identified additional significant differences. Among the exercise groups, participants who engaged in resistive exercise – primarily involving bodybuilding training – had significantly higher mean body mass indexes, longer weekly regular exercise durations, and lower pain scores on the Visual Analogue Scale (VAS).

The higher BMI observed in this group is most plausibly explained by increased lean body mass resulting from the resistance training, rather than by excess adipose tissue. Moreover, the lower perceived pain levels in the resistive exercise group may be linked to their significantly longer total weekly exercise durations, as exercise dose is known to mediate analgesic effects.

These results are supported by previous literature. A meta-regression study indicated that, when accounting for dose-response relationships, resistive exercise – alongside motor control and mindfulness-based approaches – was among the most effective modalities for managing chronic nonspecific neck pain [55]. Similarly, a systematic review and meta-analysis examining the efficacy of resistive exercise in patients with fibromyalgia concluded that it was superior to other exercise types in terms of pain reduction [56].

Taken together, our secondary analyses suggest that both the type and amount of exercise may have meaningful impacts on physical health outcomes such as BMI and pain perception.

Limitations and future directions

Several limitations should be acknowledged in interpreting the findings of this study.

– The sample consisted solely of university students aged 18–25 years, which may limit the generalisability of the results to broader populations with different age ranges, occupational backgrounds, or lifestyle factors.

– The reclassification of groups into only two categories (≤ 4 hours and > 4 hours) due to the low number of participants reporting ≤ 2 hours of daily use reduced the granularity of analysis and may have limited the detection of dose-dependent effects of smartphone use on outcomes.

– Data obtained through subjective self-reports and open-ended questions may be subject to bias, thereby limiting the overall objectivity and reliability of the findings.

– The posture assessment method used, which analyses cervical and thoracic translations and angulations, may not detect subtle or segment-specific postural deviations related exclusively to smartphone use. Compensatory mechanisms along the kinetic chain may have masked localised postural deviations, reducing the sensitivity of our posture analysis. Employing complementary postural assessment techniques with higher spatial resolution or dynamic analysis might improve detection.

– Although our study considered multiple confounding variables, including other technological device use and exercise type, residual confounding cannot be ruled out. The complexity of lifestyle factors, psychosocial influences, and individual variability in pain perception and musculoskeletal health presents challenges in isolating the independent effect of smartphone usage.

Conclusions

This study examined the relationship between smartphone usage time and key health outcomes – posture, pain, disability, mental state, and quality of life – among young adults. While no significant differences in postural parameters or pain intensity were found between groups stratified by smartphone use, significant variations in physical activity levels and exercise types emerged. Participants with lower smartphone use reported higher overall physical activity and longer exercise durations, whereas those with higher use were more likely to engage in combined exercise regimens. Secondary analyses underscored the positive effects of resistive exercise on body composition and pain perception. Overall, the musculoskeletal impact of smartphone use appears to be less direct than commonly assumed and is likely shaped by broader lifestyle patterns such as exercise behaviour and overall screen exposure.

To better understand these complex relationships, future research should adopt a multidimensional perspective by incorporating longitudinal follow-up designs, objective device usage tracking, and comprehensive ergonomic behaviour assessments. Additionally, stratifying participants based on exercise habits and including detailed evaluations of exercise intensity and adherence may help clarify the independent and interactive effects of physical activity and smartphone use on health outcomes. These findings highlight the clinical importance of promoting physical activity and ergonomic awareness in young adults with high smartphone usage, even in the absence of reported symptoms.

Data availability statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical approval

The research related to human use complied with all the relevant national regulations and institutional policies, followed the tenets of the Declaration of Helsinki, and was approved by the Afyonkarahisar Health Sciences University Clinical Research Ethics Committee (approval No.: 2011-KAEK-2; 15.02.22&2022/5).

Informed consent

Informed consent was obtained from all individuals included in this study.

Conflict of interest

The authors state no conflict of interest.

Disclosure statement

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