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Original Article / *Özgün Makale*

Smartphone addiction negatively affects balance, attention, sleep quality, and quality of life

Akıllı telefon bağımlılığı denge, dikkat, uyku kalitesi ve yaşam kalitesini olumsuz etkiliyor

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ABSTRACT

Objectives: This study aims to investigate the effects of excessive smartphone use on attention, balance, sleep quality, and quality of life.

Patients and Methods: This prospective study was conducted with 77 individuals (59 females, 18 males; mean age: 21.4±5.4 years; range, 17 to 43 years) between September 2024 and January 2025. Participants were divided into two groups according to the Smartphone Addiction Scale (SAS): low smartphone use (LSU) and excessive smartphone use (ESU). One-leg standing test (OLST), functional reaching test (FRT), Stroop test (TBAG form), timed up and go (TUG) test, Pittsburgh Sleep Quality Index (PSQI), and the 36-item Short Form Health Survey (SF-36) were administered to both groups.

Results: The mean SAS score was 100.87±30.00 (range, 50 to 158). The mean SAS score of females was higher than those of males ($p<0.001$). There was no difference between the groups in terms of eyes open OLST, FRT, and TUG test ($p<0.05$). The eyes closed OLST score, the Stroop 4 score, the sleep quality, and all subscale scores of SF-36 were worse in the ESU group than in the LSU group ($p<0.05$).

Conclusion: Excessive smartphone use negatively affects balance, attention, sleep quality, and quality of life. Limiting smartphone use, particularly in children and teenagers, is essential to prevent these issues.

Keywords: Attention, balance, quality of life, smartphone.

ÖZ

Amaç: Bu çalışmada aşırı akıllı telefon kullanımının dikkat, denge, uyku kalitesi ve yaşam kalitesi üzerindeki etkileri araştırıldı.

Hastalar ve Yöntemler: Bu prospektif çalışma, Eylül 2024 - Ocak 2025 tarihleri arasında 77 kişi (59 kadın, 18 erkek; ort. yaş: 21.4±5.4 yıl; dağılım, 17-43 yıl) üzerinde yürütüldü. Katılımcılar Akıllı Telefon Bağımlılığı Ölçeği (ATBÖ) puanlarına göre iki gruba ayrıldı: az akıllı telefon kullanımı (AAK) ve aşırı akıllı telefon kullanımı (FAK). Her iki gruba da gözler açık ve kapalı tek ayak üzerinde durma testi (TADT), fonksiyonel uzanma testi (FUT), zamanlı kalk ve yürü testi (ZKYT), Stroop testi (TBAG) formu, Pittsburgh Uyku Kalitesi İndeksi (PUKİ) ve 36 maddelik Kısa Form Sağlık Anketi (SF-36) uygulanmıştır.

Bulgular: Ortalama ATBÖ skoru 100.87±30.00 (dağılım, 50-158) idi. Kadınların ATBÖ skoru erkeklerden daha yüksekti ($p<0.001$). Gruplar arasında gözler açık TADT, FUT ve ZKY testi açısından bir fark yoktu ($p<0.05$). Fazla akıllı telefon kullanımı grubunun gözler kapalı TADT, Stroop 4, uyku kalitesi ve SF-36'nın tüm alt ölçek skorları AAK grubuna kıyasla daha kötüydü ($p<0.05$).

Sonuç: Fazla akıllı telefon kullanımı denge, dikkat, uyku kalitesi ve yaşam kalitesini olumsuz etkilemektedir. Özellikle çocuklarda ve gençlerde akıllı telefon kullanımını sınırlamak, bu sorunların önlenmesi açısından önemlidir.

Anahtar sözcükler: Dikkat, denge, akıllı telefon, yaşam kalitesi.

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In the last decade, the use of smartphones has increased significantly, and smartphones have profoundly influenced our lives. Nowadays, smartphones are used not only for communication but also for obtaining information, taking photos, playing games, and surfing the internet. With these functions, smartphones make our lives significantly easier when used consciously. However, unconscious and excessive use of these functions causes some issues. The most prominent of these is smartphone addiction. Defining smartphone addiction, which is considered a behavioral addiction, is challenging because such addictions are related to physical, social, and psychological factors.[1] Furthermore, the absence of a standardized definition for smartphone addiction in the 11th revision of the International Classification of Diseases[2] and the Diagnostic and Statistical Manual of Mental Disorders 5[3] creates challenges in diagnosing this condition. As a result, the term excessive smartphone use (ESU) is frequently preferred.

Among university students, daily smartphone use can take up to 9 h.[4] Blurred vision, wrist and finger pain, neck pain, and decreased sleep quality may be observed in these individuals due to ESU.[5-7] Additionally, individuals' work, school success, and social lives may be affected. It can be easily predicted that these social problems and physical disorders may develop due to ESU. However, ESU can also affect individuals psychologically and cognitively. Moreover, unknown adverse effects may arise in the future. A study stated that depression and anxiety in university students may be related to excessive phone use.[7]

Balance, which includes static and dynamic skills, is achieved by processing vestibular, proprioceptive, and visual inputs in the central nervous system. In addition to these systems, attention and musculoskeletal systems are also important in preventing falls and ensuring coordination. It has been reported that the use of smartphones negatively affects the attention levels of high school students.[8] In addition, it is known that using a smartphone simultaneously with a task such as walking limits the cognitive capacity allocated to balance skills, and balance skills deteriorate in these individuals due to the dual-task effect.[10] However, there are a limited number of studies investigating balance skills in individuals who excessively use smartphones,[10-12] and it is not clear exactly how ESU affects the balance mechanism.

This study aimed to investigate the effects of ESU on attention, balance, sleep quality, and quality of life (QoL). We hypothesized that balance, attention, sleep quality, and QoL would be poorer in individuals who excessively use their smartphones than in individuals with low smartphone use (LSU).

PATIENTS AND METHODS

This prospective study was conducted on university students at the Karabük University, Vocational School of Health Services between September 2024 and January 2025. The study included 113 randomly selected students as candidate participants. Participants with systemic, neurological, and orthopedic disorders who did not use a smartphone and whose tests could not be completed were excluded from the study. According to these criteria, two students were excluded from the study because they had an orthopedic disorder, and 34 students were excluded because their tests could not be completed. As a result, 77 participants (59 females, 18 males; mean age: 21.4±5.4 years; range, 17 to 43 years) were included in the study. Written informed consent was obtained from all participants. The study protocol was approved by the Karabük University Non-Interventional Clinical Research Ethics Committee (Date: 22.02.2023, No: 2023/1250). The study adhered to the principles of the Declaration of Helsinki.

To assess the intensity of smartphone use, all participants completed the Smartphone Addiction Scale (SAS). Based on their median SAS scores, participants were categorized into two groups: LSU (SAS score <98) and ESU (SAS score ≥98). Both groups underwent functional balance tests, the Temel Bilimler Araştırma Grubu (TBAG) version of the Stroop test, the Pittsburgh Sleep Quality Index (PSQI), and the 36-item Short-Form Health Survey (SF-36).

The SAS, whose Turkish validity and reliability study was conducted by Demirci et al.,[14] consists of 33 questions. The Cronbach's alpha of the SAS is 0.947. Each question with 6-point Likert-type answers can be scored between 1 and 6. The total score is calculated out of 196. The score's magnitude indicates the severity of smartphone use, and a higher score suggests a greater risk of smartphone addiction. The scale does not have a cutoff score. Therefore, the median value is often used to assess the risk of smartphone addiction.[7]

For the evaluation of static balance, participants underwent the one-leg standing test (OLST), with both eyes open and closed. Dynamic balance was evaluated through the functional reach test (FRT) and the timed up-and-go (TUG) test. All three tests

Table 1
Overview of group characteristics

	LSU group (n=38)					ESU group (n=39)					
	n	%	Mean±SD	Median	Min-Max	n	%	Mean±SD	Median	Min-Max	*p*
Age (year)			22.5±6.5		18-43			20.2±3.6		17-38	0.077[a]
Sex											0.254[b]
Female	27	61.1				32	82.1				
Male	11	28.9				7	17.9				
SAS			73.29±10.13		50-95			127.74±14.11		98-158	
Smartphone usage time (years)				6	2-12				7	3-14	0.154[a]

LSU: Low smartphone use; ESU: Excessive smartphone use; SD: Standard deviation; SAS: Smartphone addiction scale; [a] Mann Whitney-U test; [b] Chi-squared test.

were applied in accordance with the instructions of Söylemez and Mujdeci.[15]

The Stroop test was evaluated with the TBAG form. The test consisted of five cards (Stroop 1, Stroop 2, Stroop 3, Stroop 4, and Stroop 5). The test instructions were explained to the participants, and the time it took for the participant to complete each card was measured with a stopwatch.

Sleep quality was assessed using the Turkish version of the PSQI,[16] and life quality was assessed using the Turkish version of the SF-36.[17]

Statistical analysis

The sample size for this prospective randomized controlled study was determined using G*Power version 3.1 (Heinrich-Heine Universität Düsseldorf, Düsseldorf, Germany). Based on an effect size of 0.7937418, a power of 95%, and a significance level of 0.05, a total sample size of 72 participants was necessary for the study.[13]

Statistical analyses were performed using IBM SPSS version 21.0 software (IBM Corp., Armonk, NY, USA). The Shapiro-Wilk test was applied to assess the normality of the data distribution. Variables that followed a normal distribution were presented as mean ± standard deviation, whereas those that did not conform to normal distribution were reported as median (min-max). Parametric tests were applied to normally distributed data, while nonparametric tests were used for nonnormally distributed data. The statistical analyses employed are detailed in each table. A p-value <0.05 was considered statistically significant.

RESULTS

The mean SAS score for females was 102.97±29.81 (range, 54 to 158), while the mean score for males was 94.00±30.45 (range, 50 to 154). Females' SAS scores were significantly higher than those of males (p<0.001). The mean SAS score of the 77 participants

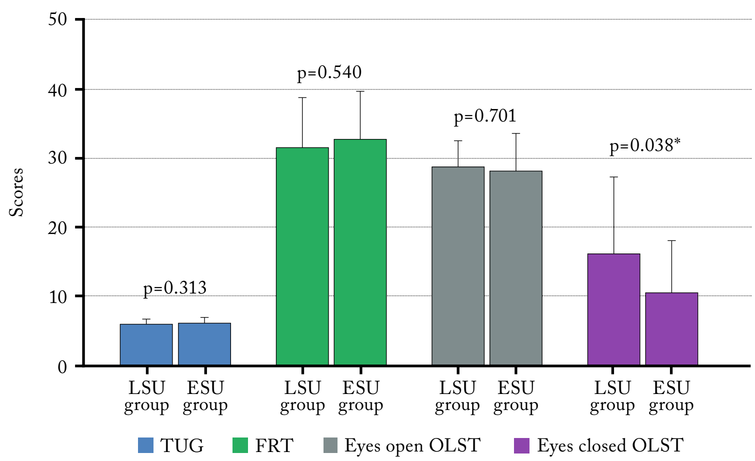

Figure 1. Functional balance test scores by groups.

LSU: Low smartphone use; ESU: Excessive smartphone use; TUG: Timed up-and-go; FRT: Functional reach test; OLST: One-leg standing test.

Table 2
The relationship between SAS and functional balance tests, Stroop test, sleep quality, and quality of life

				SAS	
	Mean±SD	Median	Min-Max	Correlation coefficient (r)	*p*
Time up and go test	5.93±0.72			0.074	0.210[a]
Functional reach test		32	21-49	0.153	0.184[b]
One leg standing test					
Open eyes		30	7.60-30.00	−0.004	0.974[b]
Closed eyes		10.92	1.34-30.00	−0.167	0.147[b]
Stroop 1		8.4	5.71-13.13	0.022	0.849[b]
Stroop 2	8.87±1.52			−0.001	0.705[a]
Stroop 3	11.23±1.67			0.102	0.095[a]
Stroop 4	14.16±2.46			0.265	0.010[a]
Stroop 5	20.47±4.38			0.033	0.951[a]
Pittsburgh Sleep Quality Index		7	1-20	0.415	<0.001[b]
Short Form-36					
Physical function		90	25-100	−0.309	0.006[b]
Physical role restriction		50	0-100	−0.318	0.005[b]
Emotional role		66.66	0-95	−0.297	0.009[b]
Energy/vitality		50		−0.420	<0.001[b]
Mental health	52.46±21.46			−0.437	<0.001[a]
Social functionality		62.5	0-100	−0.330	0.003[b]
Pain		67.5	0-100	−0.422	<0.001[b]
General health		55	0-100	−0.335	0.003[b]

SAS: Smartphone addiction scale, SD: Standard deviation; [a] Pearson correlation; [b] Spearman correlation.

in the study was 100.87±30.00 (range, 50 to 158). The median SAS score in the study was 98. Of the total participants, 38 (49.4%) were placed in the LSU group, while 39 (50.6%) were assigned to the ESU group. No significant differences were observed between the groups regarding age and sex ($p>0.05$). The detailed characteristics of the groups are shown in Table 1.

There was no difference between the groups in terms of open eyes OLST, FRT, and TUG test ($p>0.05$). However, closed eyes OLST scores of the ESU group were worse than the LSU group ($p<0.05$). Functional balance scores between the groups are presented in Figure 1. Additionally, there was no relationship between smartphone use severity and FRT, TUG test, and OLST ($p>0.05$; Table 2).

Table 3
Stroop test TBAG form scores according to groups

	LSU group (n=38)	ESU group (n=39)			
	Mean±SD	Mean±SD	Median	Min-Max	*p*
Stroop 1	8.50±1.47	8.62±1.27			0.713[a]
Stroop 2	8.80±1.51		8.48	6.40-13.93	0.992[b]
Stroop 3	10.97±1.74	11.49±1.58			0.177[a]
Stroop 4	13.40±1.96	14.90±2.69			0.007[a]
Stroop 5	20.15±4.61	20.77±4.18			0.541[a]

TBAG: Temel Bilimler Araştırma Grubu; LSU: Low smartphone use; ESU: Excessive smartphone use; SD: Standard deviation; [a] T-test; [b] Mann-Whitney U test.

Table 4
Sleep quality and quality of life according to groups

	LSU group (n=38)			ESU group (n=39)			
	Mean±SD	Median	Min-Max	Mean±SD	Median	Min-Max	*p*
PSQI		5	1-20	8.33±2.86			0.001[a]
Short Form-36							
Physical function		95	25-100		90	55-100	0.039[a]
Physical role restriction		75	0-100		50	0-100	0.027[a]
Emotional role		66.66	0-100		33.33	0-100	0.018[a]
Energy/vitality		65	10-95	40.00±22.59			0.001[a]
Mental health	61.26±18.81			43.89±20.59			<0.001[b]
Social functionality		75	0-100	58.97±21.64			0.004[a]
Pain		77.50	0-100		57.50	10-90	0.003[a]
General health		65	0-100	50.89±19.46			0.005[a]

LSU: Low smartphone use; ESU: Excessive smartphone use; SD: Standard deviation; PSQI: Pittsburgh Sleep Quality Index, [a] Mann-Whitney U test; [b] T-test.

There was no difference between the groups in terms of Stroop 1, Stroop 2, Stroop 3, and Stroop 5 scores ($p>0.05$). However, the Stroop 4 score of the ESU group was worse than the LSU group ($p<0.05$). Stroop test TBAG form scores of the groups are presented in Table 3. There was no relationship between smartphone use severity and Stroop 1, Stroop 2, Stroop 3, and Stroop 5 scores ($p>0.05$). There was a slight positive relationship between smartphone usage severity and Stroop 4 scores ($p<0.05$; Table 2).

The sleep quality of the ESU group was worse than the LSU group ($p<0.05$). When looking at the SF-36 scores between groups, all subscale scores of SF-36 were worse in the ESU group than in the LSU group ($p<0.05$). Sleep and QoL scores between the groups are presented in Table 4. There was a negative relationship between SAS and sleep quality and QoL ($p<0.05$; Table 2).

DISCUSSION

In recent years, the cost of smartphones has significantly decreased, making them more affordable and accessible to a wider population. This affordability has contributed to the widespread use of smartphones without discrimination or consideration of potential negative consequences. This study found that the balance, attention, sleep quality, and QoL of the ESU group were worse than the LSU group.

There are a limited number of studies investigating the effect of smartphone use on the balance system, and the mechanism of ESU's impact on the balance system is unclear.[10,11] Lee et al.[1] investigated the short-term effect of smartphone use on balance and dizziness. They had participants play smartphone games for 10 and 20 min and evaluated their balance before and after the smartphone game with a force plate. The authors reported that even 10 min of gaming affects the balance system (visual system) and that individuals who use smartphones for a long time should rest for a while to avoid the risk of falling. Azab et al.[11] divided 60 individuals into three groups (those who did not use smartphones, those who used them for less than 4 h, and those who used them for more than 4 h) and evaluated the balance of these individuals with the Biodex Stability System. The study stated that the balance skills of individuals using smartphones were worse than those who did not use them. The authors attributed this situation to pain and fatigue in the neck muscles due to smartphone use. Another study investigated static balance disorder in smartphone users with neck issues.[10] The researchers emphasized that the duration of daily smartphone use, the length of smartphone ownership, and the severity of neck disability could be indicators of static balance disorders. Hyong[9] examined individuals' balance abilities during smartphone use and observed that balance deteriorated when performing a dual task (during smartphone use) compared to a single task. The researchers emphasized that multitasking while using a smartphone could increase the risk of falls and injuries. Cognitive capacity sharing observed during dual tasking reduces attention and increases the risk of falling. Therefore, the increased risk of falling is not only related to phone use but also applies to all dual-task conditions. Unlike these studies, we evaluated the balance skills of individuals using smartphones with static and dynamic balance tests. The TUG test, one of the dynamic tests we applied, evaluates walking performance. Functional reaching test indicates how much the center of gravity can be shifted in the anterior plane. One-leg standing test can be performed with eyes open and closed. In this way, proprioceptive and visual systems, which are the primary systems for maintaining posture and balance, can be evaluated as a whole. Our study showed no difference between the ESU and LSU groups in terms of TUG test, FRT, and eyes-open OLST. However, the eyes-closed OLST performance was poorer in the ESU group compared to the LSU group. As Lee et al.[1] stated, long-term phone use may affect the visual system and cause imbalance. However, in our study, unlike Lee et al.'s study, we investigated the long-term effect of the smartphone, not the short-term effect. Additionally, in our study, there was no difference between the groups in terms of eyes-open OLST performance. In the eyes-closed OLST test, the visual system is disabled. Thus, vestibular and reduced-input proprioceptive systems are expected to maintain balance. Therefore, the possible reason for the worse eyes-closed OLST performance of individuals in the ESU group may be due to the vestibular or proprioceptive system.

Users of the smartphone must tilt their heads to view the phone screen. This condition, which puts excessive load on the neck and shoulders, can cause increased activity in the neck extensor muscles and muscle fatigue. Long-term phone use can affect the musculoskeletal system and cause pain, particularly in the neck area.[10] Therefore, proprioceptive input from the cervical region may be more abnormal in the ESU group. For this reason, individuals may have difficulty maintaining their posture when the visual system is disabled and proprioceptive input is reduced (eyes-closed OLST). On the other hand, ESU individuals tend to live sedentary lives and generally socialize only with virtual friends instead of the individuals next to them. A sedentary life negatively affects individuals' musculoskeletal and vestibular systems and causes imbalance/dizziness in individuals.[18] Therefore, individuals in the ESU group may have more maladaptive vestibular abilities due to a sedentary life, as well as abnormal cervical proprioceptive inputs. The poorer balance performance under challenging conditions in these individuals suggests that ESU should be considered a potential risk factor for falls, even during single-task situations.

In our study, we used the Stroop test TBAG form, one of the behavioral evaluations, to evaluate attention. The Stroop test presents the word and color to the individual in the same plane. Word and color recognition involve different cognitive processes. Word reading is always faster than color recognition. Therefore, cognitive processes occur at different speeds. When the words' colors and meanings are the same, it is simple to do the given task. However, when it is different, the reaction speed decreases, and errors occur. This situation is called the Stroop effect. Zhang et al.[13] investigated the effect of phone addiction on the Stroop test in university students. The authors reported that phone addiction impaired cognitive control ability. Tanrıverdi et al.[19] reported a significant positive correlation between the Stroop task errors and short-form SAS scores and a significant negative correlation between the number of words read in the Stroop task and short-form SAS scores. Based on these findings, the authors stated that there is a relationship between smartphone addiction and inhibitory control processes. Abramson et al.[20] investigated the relationship between mobile phone use and Stroop test performance in secondary school students. The authors reported that students whose number of voice calls and total text messages were higher had worse Stroop performance. Similarly, we used the Stroop test TBAG form in our study. The first part of the Stroop test TBAG form, which consists of five parts, is reading the color names in black. The sections become increasingly complex, and in the fifth section, color names are written in different colors. In this section, individuals should not read the color names written on the cards but instead state the color of the words. In our study, there was no difference between the groups in terms of Stroop 1, 2, 3, and 5. However, the ESU group had more difficulty in Stroop 4. Our study has shown that ESU individuals may be more easily impaired in their attention and inhibitory control processes. The faster attention deficit of ESU individuals may be related to excessive mobile phone use. In situations such as messaging, the message is written very quickly and carelessly. Therefore, the change in attention and cognitive skills may be due to impulsive reasons, not the radio frequency emitted by smartphones.[20] In other words, these behaviors may have been learned through frequent use of mobile phones.

Demirci et al.[7] investigated anxiety, depression, and sleep quality in individuals with ESU and reported that ESU causes anxiety and depression that can disrupt sleep quality. In their review, Cain and Gradisar[20] explained the relationship between electronic media (EM) use and sleep issues with four hypotheses: *(i)* EM use can replace sleep; *(ii)* cognitive, emotional, or physiological effects of EM use; *(iii)* the impact of the device's screen lights; *(iv)* received messages can wake individuals up. Another study reported that evening exposure to electromagnetic fields influences physiological factors such as sleep quality and melatonin rhythm, mainly by impacting the pineal gland.[22] Similarly, our study revealed that sleep quality was worse in individuals with ESU than in LSU. In addition, the QoL (physical function, physical role limitation, emotional role difficulty, energy/vitality, mental health, social functionality, pain, and general health) of individuals with ESU was also worse than LSU. It is known that ESU may cause wrist and neck pain.[6,10] Therefore, the physical effects of ESU may have affected individuals' subscale scores of QoL, such as pain, general health, and physical function. On the other hand, ESU causes anxiety and depression in individuals and decreases self-esteem.[7] Individuals with smartphone addiction prefer phone meetings or playing games instead of face-to-face meetings. Therefore, ESU may cause emotional issues in individuals and affect the emotional subdimensions of QoL.

One of the primary limitations of the present study is that the participants were university students, which naturally resulted in a relatively low mean age and a rather homogeneous sample in terms of lifestyle and physical activity level. Consequently, the findings may not be generalizable to the broader adult population. Furthermore, the balance assessments employed in this study were based on functional, device-free tests, which, although practical and clinically feasible, lack the precision and sensitivity of instrumented posturographic or sensor-based evaluations. Future studies should therefore include a more diverse and representative sample encompassing various age groups and employ objective, device-assisted balance measurement techniques such as force platform analysis or wearable motion sensors. Expanding the sample size and integrating advanced measurement technologies would enhance the external validity and reliability of the findings, providing a more comprehensive understanding of balance performance across the adult population.

In conclusion, this study evaluated the effects of smartphone addiction from a broad perspective and offered essential views on its mechanisms of action. As a result, ESU negatively affects balance, attention, sleep quality, and QoL. Excessive use of smartphones, which are increasingly used by individuals of all ages, may pose a significant public health problem. It is essential to develop conscious smartphone usage habits to reduce addiction. Limiting smartphone use, particularly in children and teenagers, is essential to prevent these problems. Training programs and awareness campaigns can increase awareness, leading to positive effects in the long term by encouraging the healthy and balanced use of smartphones.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea/concept, design, data collection and/or processing, analysis and/or interpretation, writing the article: E.S., M.D.; Control/supervision: S.E., Z.A.; Literature review: A.D.K., Z.A.; Critical review, references and fundings: A.D.K., Z.A., S.E.; Materials: E.S., M.D., S.E.

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