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ORIGINAL ARTICLE

Addictive smartphone use in the elderly: relationship with depression, anxiety and sleep quality

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Key words: *addictive smartphone use, anxiety, depression, elderly adults, sleep quality.*

Abstract

Background: The aim of the present study was to explore the relationship between addictive smartphone use (ASU) and depressive symptoms, anxiety and sleep quality in elderly adults.

Methods: The study sample included smartphone users over the age of 65 years. The research data were obtained from social networking sites via a Google survey link. In addition to filling out a sociodemographic data form, the participants were also assessed with Smartphone Addiction Scale (SAS), Geriatric Depression Scale, Beck Anxiety Inventory and Pittsburgh Sleep Quality Index tools.

Results: The correlation analysis revealed the SAS score to be positively correlated with depression and anxiety, and negatively correlated with sleep quality. In the regression analysis, depressive symptoms, anxiety level and sleep quality were all found to have an effect on the SAS total score. Furthermore, the SAS score was found to have an effect on depressive symptoms, anxiety and sleep quality.

Conclusions: Our findings reveal a bidirectional relationship between ASU and depressive, anxiety symptoms and impaired sleep quality in elderly adults. It is important to question smartphone use patterns in people with sleep problems, symptoms of depression or anxiety.

INTRODUCTION

The development of mobile technologies and the ever-increasing access to the Internet has gradually increased the use of smart phones. According to the Digital 2021 October Global Statshot Report, more than two-thirds of the world's population uses smartphones, and the rapidly increasing number of global users reached 5.29 billion in October 2021.[1] According to a study conducted in 2021, 61% of people over the age of 65 years in the United States use a smartphone, while a further study reported that 75% of smartphone users feel dependent on their smartphone, 58% are unable to withstand not having their smartphone with them, 73% are unable to withstand having a dead phone battery and 36% check their mobile phone mid-sleep.[2,3]

Although smartphone addiction is similar to Internet addiction in many ways, there are differences, such as the portability and easy and direct communication offered by smartphones.[4,5] There is as yet no official diagnostic criteria for smartphone addiction, but based on the definition of Internet addiction, smartphone addiction can be defined as excessive use of smartphones to the point that the daily lives of users are disrupted.[5] Impaired control, as in other addictions, is considered one of the core symptoms of smartphone addiction. The concepts of 'addictive smartphone use' (ASU) or 'problematic smartphone use' are also widely used in place of smartphone addiction, since there is a lack of consensus on the conceptualisation and diagnostic criteria.[6,7] Problematic smartphone use has been shown to be strongly associated with depressive symptoms and also associated with anxiety, and it has been suggested that smartphones are used to escape negative life experiences.[8] Studies have shown that the relationship of

smartphone addiction with depression and anxiety may be bidirectional.[9,10] Also a relationship has been reported between smartphone addiction and high levels of loneliness which is not rare among the elderly.[11] There has been no study to date exploring smartphone addiction in the elderly, although it has been reported that depressive symptoms are associated with the addictive use of social media in this population.[12]

To the best of our knowledge, there has been no study to date exploring the relationship between ASU and depressive symptoms, anxiety, and sleep quality in the elderly. The aim of the present study was to investigate the relationship between ASU and depressive symptoms, anxiety and sleep quality in elderly adults.

METHOD

Participants and procedure

The research sample comprised 392 people over 65 years of age who actively used social media. After obtaining the approval of the Istanbul Gelişim University ethics committee (26.11.2021/2021-36), the data were collected in December 2021 after making an announcement on Facebook and providing a Google survey link. To identify potential participants for the study, Turkish Facebook groups with members over the age of 65 were searched using Facebook and the Google search engine. The survey link was posted in the selected Facebook groups with the permission of the group administrators. A sample was thus created using a snowball technique and through the gathering of participants via the survey link. Before starting the survey, participants were provided with a link to the project information form that explained the purpose of the study, the structure of the survey, the estimated completion time and the assurance of confidentiality. Participants were only able to take the survey after filling out an online informed consent form expressing their willingness to participate. The questionnaire was created in a way that the respondent was obliged to answer each question to proceed to the following one. Participants excluded from the study were those with any cognitive impairment preventing them from understanding or answering the questions, and those who were unwilling to participate in the study. A total of 402 participants completed the survey, although the data of nine participants were not included in the analysis due to inconsistencies in their answers to the questions, along with the data of one participant who was 60 years old. The participants received no remuneration for participating in our research project.

Data collection tools

Sociodemographic information form

This is a brief information form which was prepared by the researchers that includes questions about sociodemographic information, such as gender, age, marital status, economic status, education level and employment status, and about their smart phone use patterns such as the frequency or duration of use.

Smartphone Addiction Scale (SAS)

The SAS was developed by Kwon *et al*., and the reliability and validity study of the Turkish version of the scale was conducted by Demirci *et al*.[5,13] It is a six-point self-report Likert-type scale (1 = strongly disagree, 6 = strongly agree) consisting of 33 items. A factor analysis reveals a composition of seven subdimensions: disturbing daily life and tolerance, withdrawal symptoms, positive anticipation, cyberspace-oriented relationships, overuse, social network dependence and physical symptoms. The original study of the scale did not report a cut-off score, but the higher the score, the higher the risk of smartphone addiction.

Geriatric Depression Scale (GDS)

This was developed by Yesavage *et al*. for the measurement of depressive symptoms in geriatric populations.[14] The scale consists of 30 yes–no questions that are easy to answer by elderly participants. The minimum and maximum scores on a GDS are zero and 30, respectively. A total score of 0–10 indicates no depression, 11–13 indicates possible depression, and a score of 14 and above indicates definite depression. The cut-off point for the depression scale was determined to be 14 for the present study. The validity and reliability study of the Turkish version of the scale recorded an internal consistency coefficient of 0.91 and a test–retest reliability of 0.74.[15]

Beck Anxiety Inventory (BAI)

This self-rated scale developed by Beck *et al*. aims to determine the frequency of anxiety symptoms experienced by individuals.[16] It is a Likert-type scale comprising 21 items scored between zero and three. The scores of the scale are classified based on the cut-off value, with scores of 0–7 indicating minimal anxiety, 8–15 indicating mild anxiety, 16–25 indicating moderate anxiety, and 30–63 indicating severe anxiety. The validity and reliability study of the Turkish version of the scale was conducted by Ulusoy *et al*.[17]

Pittsburgh Sleep Quality Index (PSQI)

This scale was developed by Buysse *et al*. and the validity and reliability of the Turkish version of the scale was conducted by Ağargün *et al*.[18,19] The PSQI is a 19-item self-reported scale which assesses sleep quality and disturbances over a 1-month time interval. Each item in the questionnaire is scored equally between zero and three. The scale consists of seven components that assess subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction. The scores from these seven components are then summed to produce a total score in the 0–21 range. A total PSQI score greater than five indicates inadequate sleep quality with 89.6% sensitivity and 86.5% specificity, suggesting severe impairment in at least two of the abovementioned components or moderate impairment in three of them.

Statistical analysis

SPSS Statistics Version 25.0. (IBM, Armonk, NY, USA) was used for the analysis of the study data. The mean scale scores were expressed as mean and standard deviation. A Kurtosis-Skewness Test was used to test the normality of the means of the study scales, revealing a normal distribution in the scales (between -2 and $+2$). The data were subsequently analyzed with parametric tests. A *t*-test was used to determine the difference between the paired groups, a one-way analysis of variance (ANOVA) was used to determine the difference between three or more groups, and a hierarchical regression (stepwise) analysis was conducted to determine the predictors of the total SAS score. Tukey's analysis was carried out to identify the origin of the difference between the groups in the variables in which a significant difference was found in the ANOVA. Multiple regression (stepwise) models were created including the SAS score as the dependent variable, and gender, GDS total score, BAI total score, and PSQI total score as the independent variables in the analysis. A *P*-value of < 0.05 was considered statistically significant in all statistical analyses.

RESULTS

Descriptive statistics

Our research was carried out with 392 participants with a mean age of 65.62 ± 0.938 years. The sociodemographic characteristics of the participants are presented in Table 1, and the mean scores obtained from the study scales are given in Table 2.

Comparison of SAS scores according to sociodemographic variables, depression and anxiety cut-off scores

A comparison of the total SAS scores among the categories created based on the sociodemographic characteristics, details of smartphone use, and depression and anxiety cut-off scores is presented in Table 1.

The total SAS scores of the female respondents were significantly higher than those of the male respondents ($P < 0.01$), and the total SAS scores of the single respondents was higher than that of the married respondents ($P < 0.01$). The total SAS score of the unemployed participants was found to be higher than that of the retired ($P < 0.01$) and employed ($P < 0.01$) participants, while the total score of retired participants was found to be significantly higher than that of the employed participants ($P < 0.01$). Those with daily smartphone use durations in excess of 6 h were found to have higher total SAS scores than those with smartphone use durations of 3–6 and 1–3 h ($P < 0.01$), and those with a daily use duration of 3–6 h were found to have a higher total SAS score than those with a smartphone use duration of 1–3 h ($P < 0.01$). Those who had used smartphones for 7 years and above were found to have higher total SAS scores than those who had used smartphones for 3–6 years ($P < 0.05$), 1–3 years ($P < 0.01$) and less than 1 year ($P < 0.01$), while those with a total smartphone usage time of 1–3 years were

Table 1 Comparison of SAS scores according to sociodemographic characteristics, GDS and BAI cut-off scores

			SAS		
	n	%	$\bar{x} \pm$ SD	Test (T/F)	*P*
Gender					
Female	89	22.7	110.90 ± 47.73	5.952[†]	< 0.01
Male	303	77.3	77.01 ± 45.43		
Marital status					
Married	223	56.9	67.53 ± 37.70	−8.554[†]	< 0.01
Single[§]	169	43.1	107.37 ± 50.86		
Monthly income					
< 1000 TL	7	1.8	150.43 ± 14.29	34.932[‡]	< 0.01
1000–2000 TL	55	14	121.40 ± 43.63		
2000–3000 TL	101	25.8	102.37 ± 49.01		
3000–4000 TL	115	29.3	76.37 ± 44.22		
≥ 5000 TL	114	29.1	55.73 ± 29.15		
Education					
Primary	115	29.3	115.19 ± 48.41	36.986[‡]	< 0.01
Secondary	56	14.3	105.61 ± 51.43		
High school	111	28.3	72.66 ± 40.44		
University	105	26.8	54.98 ± 24.06		
Master degree and higher	5	1.3	41.20 ± 8.04		
Working status					
Employed	110	28.1	53.36 ± 19.44	58.13[‡]	< 0.01
Unemployed	76	19.4	120.45 ± 45.59		
Retired	206	52.6	88.26 ± 49.28		
Daily smartphone use duration (h)					
1–3	219	55.9	51.83 ± 19.15	339.17[‡]	< 0.01
3–6	108	27.6	114.94 ± 44.89		
≥ 6	65	16.6	145.26 ± 22.84		
Smartphone usage time (years)					
< 1	24	6.1	48.75 ± 20.21	50.381[‡]	< 0.01
1–3	144	36.7	58.11 ± 27.79		
3–6	180	45.9	100.77 ± 49.85		
≥ 7	44	11.2	125.66 ± 44.46		
Depression					
Yes (GDS ≥ 14)	179	45.7	114.32 ± 48.64	23.46[‡]	< 0.01
No (GDS < 14)	213	54.3	59.82 ± 30.16		
Anxiety					
Minimal (BAI 0–7)	188	48	60.25 ± 30.83	125.09[‡]	< 0.01
Mild (BAI 8–15)	67	17.1	61.07 ± 31.28		
Moderate (BAI 16–25)	50	12.8	115.96 ± 45.64		
Severe (BAI 26–63)	87	22.2	137.79 ± 36.48		

[†] Independent-samples *t*-test. [‡] One-way analysis of variance. [§] Single: never married, divorced, separated, or widowed. Abbreviation: BAI, Beck Anxiety Inventory; GDS, Geriatric Depression Scale; SAS, Smartphone Addiction Scale; TL, Turkish lira.

found to have higher total SAS scores than those with a total smartphone usage time of less than 1 year ($P < 0.01$). Those with a monthly income below 1000 TRY were found to have higher SAS scores than those with a monthly income of 2000–3000 TRY ($P < 0.01$), 3000–4000 TRY ($P < 0.01$) and 5000 TRY and above ($P < 0.01$). Those with a monthly income of 1000–2000 TRY were found to have higher SAS scores than those with a monthly income of 2000–3000 TRY ($P < 0.05$), 3000–4000 TRY ($P < 0.01$) and 5000 TRY and above ($P < 0.01$). Those with a monthly income of 2000–3000 TRY were found to have higher SAS scores than those with a monthly incomes of 3000–4000 TRY ($P < 0.01$) and 5000 TRY and above ($P < 0.01$). Those with a monthly income of 3000–4000 TRY were found to have a higher SAS score than those with a monthly income of 5000 TRY and above ($P < 0.05$). Those with a primary school education were found to have a higher SAS score than those with a high school ($P < 0.01$), Bachelor's degree ($P < 0.01$) and Master's degree and above ($P < 0.05$). Those with a secondary school education were found to have higher SAS scores than those with a high school ($P < 0.01$), Bachelor's degree

($P < 0.01$) and Master's degree and above ($P < 0.05$). Those with a high school education were found to have a higher SAS score than those with a Bachelor's degree ($P < 0.05$).

Based on the BAI cut-off point, those with severe anxiety were found to have higher total SAS scores than those with moderate ($P < 0.05$), mild ($P < 0.01$) and minimal anxiety ($P < 0.01$), while those with moderate anxiety levels were found to have higher total SAS scores than those with mild ($P < 0.01$) and minimal anxiety ($P < 0.01$). It was found that the participants who were considered depressed according to the GDS cut-off point had a higher total SAS score than those who were not depressed ($P < 0.01$).

Correlation analysis

A Pearson correlation analysis was conducted to identify the relationship between the participants' SAS total score and subscale scores, and the GDS, BAI and PSQI scores (Table 2).

The findings revealed a significant correlation between SAS total score and GDS score ($r = 0.590$, $P < 0.01$), BAI score ($r = 0.649$, $P < 0.01$) and PSQI score ($r = 0.575$, $P < 0.01$); between SAS disturbing daily life and tolerance score and GDS score ($r = 0.567$, $P < 0.01$), BAI score ($r = 0.626$, $P < 0.01$) and PSQI score ($r = 0.555$, $P < 0.01$); between SAS withdrawal symptoms score and GDS score ($r = 0.566$, $P < 0.01$), BAI score ($r = 0.626$, $P < 0.01$) and PSQI score ($r = 0.542$, $P < 0.01$); between the SAS positive anticipation score and GDS score ($r = 0.506$, $P < 0.01$), BAI score ($r = 0.553$, $P < 0.01$) and PSQI score ($r = 0.498$, $P < 0.01$); between SAS cyberspace-oriented relationships score and GDS score ($r = 0.558$, $P < 0.01$), BAI score ($r = 0.604$, $P < 0.01$) and PSQI score ($r = 0.528$, $P < 0.01$); between SAS overuse score and GDS score ($r = 0.553$, $P < 0.01$), BAI score ($r = 0.612$, $P < 0.01$) and PSQI score ($r = 0.557$, $P < 0.01$); between SAS physical symptoms score and GDS score ($r = 0.502$, $P < 0.01$), BAI score ($r = 0.540$, $P < 0.01$) and PSQI score ($r = 0.476$, $P < 0.01$); and between SAS social network dependence score and GDS score ($r = 0.494$, $P < 0.01$), BAI score ($r = 0.560$, $P < 0.01$) and PSQI score ($r = 0.505$, $P < 0.01$). GDS score had a significant correlation with BAI score ($r = 0.747$, $P < 0.01$) and PSQI score ($r = 0.722$, $P < 0.01$). Also, BAI score had a significant correlation with PSQI score ($r = 0.707$, $P < 0.01$).

Table 2 Correlation between GDS total, BAI total, PSQI total, SAS total and subscale scores

	$\bar{x} \pm$ SD	1	2	3	4	5	6	7	8	9	10	11
1.SAS Total	84.71 ± 48.05											
2.GDS	13.61 ± 8.21	0.590**										
3.BAI	13.96 ± 13.13	0.649**	0.747**									
4.PSQI	6.65 ± 5.06	0.575**	0.722**	0.707**								
5.SAS DDT	20.1 ± 11.67	0.942**	0.567**	0.626**	0.555**							
6.SAS WS	16.36 ± 11.17	0.962**	0.566**	0.626**	0.542**	0.869**						
7.SAS PA	14.08 ± 7.83	0.923**	0.506**	0.553**	0.498**	0.819**	0.879**					
8.SAS COR	8.74 ± 6.34	0.899**	0.558**	0.604**	0.528**	0.811**	0.873**	0.792**				
9.SAS OU	10.72 ± 7.04	0.953**	0.553**	0.612**	0.557**	0.866**	0.913**	0.870**	0.837**			
10.SAS PS	6.01 ± 3.76	0.807**	0.502**	0.540**	0.476**	0.763**	0.726**	0.710**	0.652**	0.747**		
11.SAS SND	8.69 ± 4.28	0.861**	0.494**	0.560**	0.505**	0.787**	0.797**	0.785**	0.732**	0.832**	0.670**	

** $P < 0.01$. Abbreviation: SAS, Smartphone Addiction Scale; BAI, Beck Anxiety Inventory; GDS, Geriatric Depression Scale; PSQI, Pittsburgh Sleep Quality Index; TS, total score; DDT, disturbing daily life and tolerance; WS, withdrawal symptoms; PA, positive anticipation; COR; cyberspace-oriented relationships; OU, over use; PS, physical symptoms; SND, social network dependence.

Regression analysis

The results of the linear (stepwise) regression analysis performed to evaluate the effects of age and gender as potential confounding factors, as well as of the GDS, BAI and PSQI scores on the total SAS score, are shown in Table 3, where it can be seen that BAI score ($\beta = 0.392$, $t = 6.621$; $P < 0.001$), gender ($\beta = 0.157$, $t = -4.179$, $P < 0.001$), GDS score ($\beta = 0.167$, $t = 2.757$, $P < 0.001$) and PSQI score ($\beta = 0.143$, $t = 2.495$; $P < 0.05$) all had an effect on the SAS total score.

Table 3 Factors predicting SAS total score (stepwise regression)

	B	SE	*β*	*t*	*P*
(Constant)	74.318	8.875		8.374	< 0.01
BAI total	1.435	0.217	0.392	6.621	< 0.01
Gender	−18.013	4.311	−0.157	−4.179	< 0.01
GDS total	0.976	0.354	0.167	2.757	0.006
PSQI total	1.356	0.543	0.143	2.495	0.013

Abbreviation: SAS, Smartphone Addiction Scale; BAI, Beck Anxiety Inventory; GDS, Geriatric Depression Scale; PSQI, Pittsburgh Sleep Quality Index.

In addition, hierarchical regression models were created to determine whether the total SAS score, GDS score and BAI score have a significant effect on sleep quality, whether the total SAS score and PSQI score have a significant effect on depression, and whether the total SAS score and PSQI score have a significant effect on anxiety (Table 4). In the first model, it was found that the total SAS score, which had been included in the analysis in the initial stage, predicted sleep quality ($\beta = 0.575$, $F = 192.855$, $P < 0.01$). The GDS score ($\beta = 0.587$, $F = 243.162$, $P < 0.01$) which was included in the model at the second stage, and the BAI total score ($\beta = 0.319$, $F = 189.140$, $P < 0.01$) which was included in the model at the third stage were found to be significant predictors of sleep quality. In the second model, the total SAS score ($\beta = 0.590$, $F = 207.824$, $P < 0.01$) which was included in the model in the initial stage and the PSQI score ($\beta = 0.572$, $F = 254.402$, $P < 0.01$) which was included in the model at the second stage, were found to be predictors of the GDS

Table 4 Predictors of GDS total, BAI total and PSQI total scores

	Standardised coefficients (*β*)	*t*	*P*	R^2	R^2 ch	*F*	Model *P*
Model I: PSQI							
Step 1				0.33	0.33	192.86	*P* < 0.01
(Constant)		3.598	< 0.01				
SAS total	0.575	13.89	< 0.01				
Step 2				0.56	0.23	243.16	*P* < 0.01
(Constant)		−0.838	0.403				
SAS total	0.229	5.477	< 0.01				
GDS total	0.587	14.03	< 0.01				
Step 3				0.59	0.04	189.14	*P* < 0.01
(Constant)		1.017	0.310				
SAS total	0.127	2.926	0.004				
GDS total	0.409	8.217	< 0.01				
BAI total	0.319	6.049	< 0.01				
Model II: GDS total							
Step 1				0.35	0.35	207.82	*P* < 0.01
(Constant)		7.469	< 0.01				
SAS total	0.590	14.42	< 0.01				
Step 2				0.57	0.22	254.4	*P* < 0.01
(Constant)		6.491	< 0.01				
SAS total	0.260	6.384	< 0.01				
PSQI total	0.572	14.03	< 0.01				
Model III: BAI total							
Step 1				0.42	0.42	283.43	*P* < 0.01
(Constant)		−1.037	0.300				
SAS total	0.649	16.84	< 0.01				
Step 2				0.59	0.17	276.85	*P* < 0.01
(Constant)		−3.453	0.001				
SAS total	0.362	9.087	< 0.01				
PSQI total	0.499	12.53	< 0.01				

Abbreviation: SAS, Smartphone Addiction Scale; BAI, Beck Anxiety Inventory; GDS, Geriatric Depression Scale; PSQI, Pittsburgh Sleep Quality Index.

score. In the third model, the total SAS score ($\beta = 0.649$, $F = 283.430$, $P < 0.01$) which was included in the model in the initial stage, and the PSQI score ($\beta = 0.499$, $F = 276.847$, $P < 0.01$) which was included in the model at the second stage, were found to be predictors of the BAI score.

DISCUSSION

Our study reveals depressive symptoms, anxiety levels and sleep quality to be associated with ASU in elderly adults. To the best of our knowledge, this is the first study in the literature to show the relationship of ASU with sociodemographic characteristics, depressive symptoms, anxiety and sleep quality in the elderly.

We found smartphone use to be higher in the elderly with high depression scores than in those with low depression scores. Moreover, a regression analysis showed depressive symptoms to be associated with ASU. These findings are consistent with the results of studies conducted on the young population in the literature.[13,20,21] A study by Kim *et al*. involving university students found aggression and impulsivity, which are closely linked to depressive symptoms, especially in young individuals, to be associated with ASU.[20] As depressive symptoms increase feelings of loneliness and isolation, they may be the cause of excessive smartphone use.[11,22] Furthermore, elderly adults with depressive symptoms may engage in more frequent smartphone use to avoid focusing on negative emotions and to increase their social interaction. The fact that the excessive use of smartphones may also cause depressive symptoms in adults may exacerbate this cycle of smartphone use and depressive symptoms.[23]

Stanković *et al*. identified a bidirectional correlation between smartphone use and depression, and claimed that this correlation was mediated by stress.[24] Our findings also reveal a bidirectional correlation between depression and smartphone use in the elderly. Elderly people may gravitate toward the use of smartphones to compensate for the stresses of depression and to increase their social interaction. Individuals with depression symptoms are more likely to seek social support. Smartphone use may be a way of seeking social support for elderly people with depression symptoms. On the other hand, the addictive use of smartphones may increase symptoms of depression, either directly (by increasing isolation or causing feelings of worthlessness through social comparison) or through sleep disturbance.

In the present study, we found the use of smartphones to be higher in elderly people with moderate and high levels of anxiety when compared to those with mild and minimal anxiety. Moreover, a regression analysis revealed symptoms of anxiety to be associated with ASU. Further, a regression analysis also revealed ASU predicted anxiety levels. In their study, Demirci *et al*. reported high anxiety levels to be associated with excessive smartphone use, while Stanković *et al*. reported the level of anxiety in university students to be associated with smartphone use.[13,24] Hawi and Samaha reported smartphone addiction to be associated with high anxiety in university students, and that problems in family relationships led to anxiety, resulting in an increased risk of smartphone addiction.[25] Matar Boumosleh and Jaalouk found anxiety level, like depression, to be an independent predictor of smartphone addiction in university students.[21] Lee *et al*. reported that anxiety may make adults prone to smartphone addiction, along with depression, obsessive–compulsive disorder and impulsivity.[26] High levels of anxiety have been found to be associated with smartphone addiction not only in adolescents and university students, but also in adults.[4,26,27] Elderly people may gravitate toward smartphone use as a means of coping with anxiety, just like young adults and those of middle age. In addition to social interaction, the use of smartphones for stimuli through games and other interests can temporarily distract attention from the source of anxiety. Elderly people may use smartphones as a means of coping with anxiety thanks to their temporary anxiety-easing functions. However, our findings show that the correlation between anxiety and ASU, like depression, may be bidirectional. The addictive use of smartphones may lead to symptoms of increased anxiety, either directly or through disturbed sleep. On the other hand, anxiety may also lead to ASU directly or through decreased sleep time.

A bidirectional correlation has been documented between depression and anxiety and sleep disturbance.[28,29] Our study showed that ASU may have a role in this relationship. As such, the excessive use of smartphones to cope with anxiety and depression may directly disrupt sleep, while ASU can result in anxiety and depression by impairing sleep quality.

Demirci *et al*. reported that smartphone use led to sleep problems and this relationship is linked to depression and anxiety among university students. The same study also suggested that sleep problems lead to ASU.[13] In a recent study, Stanković *et al*. reported that smartphone use led to impaired sleep quality in university students and our findings concur with this, revealing a bidirectional relationship between smartphone use and sleep problems also in elderly people.[24] Smartphone use can directly become addictive when used as a leisure activity, especially during the late sleepless hours. Moreover, sleep problems may lead to symptoms of depression and anxiety, resulting in increased smartphone use. Further, smartphone use, especially late at night, has been reported to increase the symptoms of depression and anxiety, resulting in sleep problems.[30,31] Smartphone use late at night can increase cognitive, emotional or physiological stimulation through games or social interaction, and this stimulation can make falling asleep difficult.[31,32] In addition, exposure to bright light from screens can suppress melatonin, and consequently delay the circadian rhythm, leading to sleep problems.[32–34]

Our findings revealed that women have higher SAS scores than men. Furthermore, female gender has a greater effect on the SAS score, according to the results of the regression analysis. Numerous studies have reported that smartphone use among women is more problematic, although this effect may be due to women's higher levels of anxiety and depression.[35,36] Women may use smartphones for enhanced social communication. The fact that ASU is more prevalent among single people than married people may be explained by the correlation between loneliness and ASU.[37] SAS scores were found to be higher in those with a low income than those with a high income, and also higher in those with low educational level than those with high educational level. Different studies have shown that ASU may be associated with high and low income levels.[38,39] A low level of income and low educational attainment may lead to higher smartphone use, as they are limited in their social interactions in daily life. It was observed that the SAS scores of the non-working and retired were higher than those of the employed respondents, which may be because those who do not work or who are retired have more free time than those who are employed. There have been many research findings suggesting that boredom mediates the relationship of depression and anxiety with problematic smartphone use.[8,40,41] The average SAS score is noted to increase as the duration of smartphone use in years increases in our study, which suggests that the duration of smartphone ownership may in itself pose a risk of increased addictive use.

Prensky defined students born after 1980 as digital natives, and the previous generations as digital immigrants, and stated that the technology use habits of these two generations may differ.[42] Indeed, the prevalence of ASU and the predisposing factors for ASU among digital natives and digital immigrants may differ.[43] However, this should not give the illusion that ASU is unique to digital natives and is not to be found in elderly people who have migrated from digital culture to the most remote distances.

One of the limitations of our study is that the assessment of ASU, depression and anxiety symptoms, and sleep quality are based on self-reported scales. The relationship between these variables may be investigated through studies based on clinical interviews in future studies. Self-reported data and logged data on phone use frequency, duration and time may differ from each other, so supporting the data with 'logged data' may yield sounder results.[44] The number of female participants is less than one-third of the male participants in our study, thus our results may underrepresent ASU for female gender. The cross-sectional nature of our study prevented the establishment of a cause-effect relationship between the variables that may affect each other, which is another important limitation of the study. Prospective follow-up studies of elderly people would be useful in clarifying the nature of the relationship between smartphone use and the other symptoms. It is also a limitation that cognitive functions were not evaluated because the data were collected with an online questionnaire. Since this study assesses only the addictive use of smartphones, the fact that the purpose of smartphone use is not included in the analysis can be considered another limitation.

In conclusion, the present study reveals the presence of a bidirectional relationship between symptoms of depression and anxiety, poor sleep quality, and ASU in elderly people. When evaluating elderly individuals with symptoms of depression, anxiety and

poor sleep quality, it is important to evaluate their smartphone use pattern, both for the treatment of these symptoms and for the diagnosis and treatment of smartphone addiction.

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DATA AVAILABILITY STATEMENT

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

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