

Dependency on Smartphone Use and Its Association with Anxiety in Korea

KYUNG EUN LEE, MD^a
SI-HEON KIM, MD^a
TAE-YANG HA, MD^a
YOUNG-MYONG YOO, MD^a
JAI-JUN HAN, MD^a
JAE-HYUK JUNG, MD^a
JAE-YEON JANG, PhD^a

ABSTRACT

Objective. South Korea has the highest rate of smartphone ownership worldwide, which is a potential concern given that smartphone dependency may have deleterious effects on health. We investigated the relationship between smartphone dependency and anxiety.

Methods. Participants included 1,236 smartphone-using students (725 men and 511 women) from six universities in Suwon, South Korea. Participants completed measures of smartphone use, smartphone dependency, anxiety, and general characteristics (i.e., demographic, health-related, and socioeconomic characteristics). To measure smartphone dependency and anxiety, we used questionnaires of Yang's test developed from Young's Internet Addiction Test and Zung's Self-Rating Anxiety Scale. We used multiple logistic regression to determine the association between smartphone dependency and anxiety after adjusting for relevant factors.

Results. On a scale from 25 to 100, with higher scores on the smartphone dependency test indicating greater dependency, women were significantly more dependent on smartphones than were men (mean smartphone dependency score: 50.7 vs. 56.0 for men and women, respectively, $p < 0.001$). However, the amount of time spent using smartphones and the purpose of smartphone use affected smartphone dependency in both men and women. Particularly, when daily use time increased, smartphone dependency showed an increasing trend. Compared with times of use < 2 hours vs. ≥ 6 hours, men scored 46.2 and 56.0 on the smartphone dependency test, while women scored 48.0 and 60.4, respectively ($p < 0.001$). Finally, for both men and women, increases in smartphone dependency were associated with increased anxiety scores. With each one-point increase in smartphone dependency score, the risk of abnormal anxiety in men and women increased by 10.1% and 9.2%, respectively ($p < 0.001$).

Conclusion. Among this group of university students in South Korea, smartphone dependency appeared to be associated with increased anxiety. Standards for smartphone use might help prevent deleterious health effects.

^aAjou University School of Medicine, Department of Preventive Medicine and Public Health, Suwon, Republic of Korea

Address correspondence to: Jae-Yeon Jang, PhD, Ajou University School of Medicine, Department of Preventive Medicine and Public Health, 164 Worldcup-ro, Yeongtong-Gu, Suwon, Gyeonggi-do, 16499, Republic of Korea; tel. +82-31-219-5293; fax +82-31-219-5293; e-mail <free5293@gmail.com>.

©2016 Association of Schools and Programs of Public Health

Smartphones (mobile telephones that run on portable operating systems) are more advanced than regular mobile telephones because they have advanced capabilities, such as wireless Internet access.¹ Smartphone sales have increased rapidly worldwide, with an estimated 300 million smartphones being purchased annually after 2010.^{2,3} South Korea has the highest rate of smartphone ownership worldwide, with 58% of adults and 84% of college students reportedly using smartphones in 2012. Moreover, the number of smartphone users continues to increase.^{4,5}

Because smartphones afford greater access to media, their use may lead to unexpected health problems, such as Internet addiction.^{6,7} Although addiction is considered to be a pathologic condition characterized by persistent use and excessive dependency,⁸ studies on the health effects of smartphone use (e.g., psychological effects, smartphone dependency risk) are scarce. Hwang et al. found a positive correlation between smartphone overuse and upper extremity pain, while several case reports and studies noted increased addictive and depressive symptoms as a function of smartphone use.⁹⁻¹² Im et al. reported positive correlations of smartphone addiction level with scores measuring psychotic depression and obsessive-compulsive disorder.¹¹ However, most studies were limited in their sampling techniques (e.g., small sample sizes, convenience samples)^{7,11,13} or did not control for confounding factors. Assessing compulsive and dependent symptoms as confounding factors would help address the effects of potential comorbidities on smartphone addiction.^{10,14}

Given that smartphones are portable, provide convenient Internet access, and have functions that allow for multitasking, they could promote dependence to a greater degree than regular mobile telephones or Internet accessed from a computer.^{1,15} Increased smartphone dependency is a putative risk factor for industrial injuries or automobile accidents (via disrupted concentration), muscular pain, and anxiety.^{7,9,15} Increased use of smartphones also relates to mental health problems, such as increasing depression and anxiety.^{5,10,11} Anxiety disorders, which are among the most prevalent mental disorders, may be particularly exacerbated by smartphone use because they are related to substance addiction and dependency.^{16,17} Notably, the relationship between smartphone overuse and negative psychological adaptation is moderated by demographic characteristics, smartphone use preferences, and inappropriate use.¹⁸⁻²⁰ However, research studies identifying the health effects from smartphone overuse considering those factors are rare.

Apparent differences by sex exist in the perceptions of social contact, motivation for technology

use, and compulsive use of media and substances.^{19,21} For example, men are at greater risk for addiction to alcohol, smoking, and computer games, whereas^{19,22,23} women are more likely to immerse themselves in online social networking.^{1,21} Hwang et al. reported that men's smartphone use was driven by the desire to show off new technologies and entertainment media, while women's smartphone use was motivated by the desire to communicate.¹⁴ Thus, sex may affect smartphone dependency.^{20,24}

We examined health-related, demographic, and socioeconomic factors as potential influences on smartphone dependency. Additionally, we investigated the relationship between smartphone dependency and anxiety by sex.

METHODS

Participants

Participants were students in large, open-lecture classrooms of six universities located in Suwon, South Korea, recruited via cluster sampling. First, we selected all universities (four institutions with four-year curriculums and two institutions with two-year curriculums) in Suwon and investigated summer lecture schedules. Then, we selected classes in each university in which the registration was not limited by major or grade.

Of the 1,296 open-lecture students, a total of 1,261 (97.3%) consented to participate. The survey was conducted in July and August 2013 via a closed-ended questionnaire. Five trained investigators visited classes in six universities and performed face-to-face interviews for anxiety and smartphone dependency. Participants self-reported demographic characteristics and behavioral characteristics on smartphone use in questionnaires. Data collected from researchers and participants were electronically entered and checked for accuracy by research staff members.

Data collection instruments and variables

The survey assessed smartphone use patterns (including total use time), situations in which smartphones are frequently used, average daily use (in hours), and purpose of use. Situations were described as activities they frequently perform while using smartphones, such as commuting or traveling, transportation or walking, working or attending a lecture, and before sleeping. We included the activity of spending a break time using mobile telephones for participants who use their smartphones during break time or do nothing else when using their smartphones. We defined smartphone dependency as persistent smartphone use despite problems related to that use. We measured

smartphone dependency using Yang's questionnaire on mobile telephone dependency, which was based on Young's Internet Addiction Test.^{25,26} We modified the items in Yang's questionnaire to assess smartphone dependency.

The questionnaire has established validity^{15,25–28} and comprises 25 items in four subscales (obsession, withdrawal, reliance, and disturbances in daily life). Obsession indicates persistent use of smartphones (e.g., "How often do you use a smartphone longer than you intended?"). Withdrawal indicates experiencing nervous symptoms or repetitive illusions of ringing when not using a smartphone. Reliance, characterized as excessive psychological attachment, indicates attaching great importance to smartphones. We measured reliance in terms of the frequency of experiencing a deep sense of loss when unable to use smartphones (e.g., "How often do you fear that life without your smartphone would be boring, empty, and joyless?"). Disturbances in daily life indicates a significant distress and impairment of social, occupational, and role functioning due to excessive use of smartphones. We

measured disturbances in daily life with questions such as, "How often do you lose sleep due to late-night use of a smartphone?" (Table 1).

Total scores ranged from 25 to 100, with higher scores indicating greater smartphone dependency. Cronbach's α for the total score in the present study was 0.90 (range: 0.87–0.89 for the subscales in previous studies),^{26,28} which is considered reliable.

We assessed anxiety, defined as uncontrollably excessive and persistent worrying that causes exacerbated distress, with an adapted version of Zung's Self-Rating Anxiety Scale. This scale comprises 20 items in four subscales. Total scores range from 20 to 80, with a normal level of anxiety defined as ≤ 44 . Cronbach's α for the scale was 0.96.²⁹

We assessed demographic, socioeconomic, and health-related characteristics, including sex, age, economic status, academic achievement, self-rated health, smoking patterns, amount of alcohol consumed, presence of physical or mental illness, and family history of mental illness. For smoking patterns, participants reported whether or not they had smoked during the

Table 1. Questionnaire assessing problematic use of mobile telephones by Yanga for a study of smartphone use among students at six universities in Suwon, South Korea, July–August 2013^a

<i>Subscale</i>	<i>Questions about mobile telephone use</i>
Obsession	How often do you use your mobile telephone longer than you intended? How often do others in your life complain to you about your excessive mobile telephone use? How often do you find yourself saying "just a few more minutes" when using your mobile telephone? How often do you try to cut down the amount of time you use your mobile telephone but fail? How often do you feel that you cannot help buying yourself a new mobile telephone whenever a new model is launched?
Withdrawal	How often do you prefer the excitement of mobile telephone use to intimacy with a partner or friends? How often do you check your mobile telephone before something else that you need to do? How often are you nervous about missing a call or message when you cannot use a mobile telephone? How often do you snap, yell, or act annoyed if someone bothers you while you use a mobile telephone? How often do you think that your mobile telephone is ringing even when you do not have it? How often do you use a mobile telephone during school hours? How often do you think that spending time with your mobile telephone is the most enjoyable way to spend time? How often do you feel nervous when you are not allowed to use your mobile telephone?
Reliance	How often do you spend time with your mobile telephone to avoid troublesome tasks? How often do you feel that life without your mobile telephone would be boring, empty, and joyless? How often do you feel depressed, moody, or nervous when you cannot use your mobile telephone, which goes away once you can use it? How often do you find yourself anticipating when you will use your mobile telephone again? How often do you think using your mobile telephone is the most important activity in your daily schedule? How often do you block out disturbing thoughts about your life with soothing thoughts of your mobile telephone?
Disturbances in daily life	How often do you neglect household chores to spend time using your mobile telephone? How often do your family and friends complain about the amount of time you use your mobile telephone? How often do your grades or schoolwork suffer because of the amount of time you use your mobile telephone? How often do you find yourself using your mobile telephone unconsciously? How often do you have a lack of concentration while studying due to mobile telephone use? How often do you lose sleep due to late-night use of your mobile telephone?

^aScoring on each item was 1 to 4 based on participants' answers, with 1 = rarely, 2 = occasionally, 3 = often, and 4 = always. Total scores ranged from 25 to 100, with higher scores indicating greater smartphone dependency. Adapted with permission from: Yang SY. Studies for mobile phone addiction in high school students. Sejong-si (South Korea): Korea National Youth Policy Institute; 2002.

past six months; for alcohol consumption, participants rated the number of times they had consumed alcohol in the past month (i.e., >60 grams of pure alcohol each time for men, >40 grams of pure alcohol each time for women). Those who consumed alcohol more than once per week were classified as high risk. We also collected data on physical and mental illness diagnoses (including anxiety) during the past three years. Physical illnesses (e.g., arrhythmia and thyroid disease) included those assessed by Flint³⁰ and mental illnesses (e.g., depression, schizophrenia, and bipolar disorder) includes those assessed by Alloy et al.³¹

Statistical analysis

We stratified all data by sex and excluded missing values from the analysis. We used the Mann-Whitney U-test and Pearson's χ^2 test to compare smartphone dependency scores by participants' characteristics and smartphone use patterns. We used analysis of covariance to compare smartphone dependency scores by sex while controlling for general characteristics and smartphone use patterns. Finally, we computed the association between smartphone dependency and incidence of anxiety using odds ratios (ORs) via multiple logistic regression. We used SPSS[®] version 19.0 for all analyses.³²

RESULTS

Of the 1,261 participants, 15 (1.2%) did not use smartphones and 10 (0.8%) did not answer all of the questions; as such, their data were excluded. Thus, the final sample comprised 1,236 participants (725 men and 511 women).

Participants' mean age differed significantly ($p<0.001$) between men (23.6 years) and women (21.5 years). Additionally, compared with women, men reported significantly higher rates of smoking (38.8% vs. 27.8%) and high-risk alcohol consumption (28.4% vs. 6.7%) ($p<0.001$). Compared with men, women reported significantly worse subjective health ($p<0.001$) and higher prevalence rates of physical illness (31.6% vs. 22.8%, $p=0.001$) and family history of mental illness (6.5% vs. 3.4%, $p=0.019$). The rate of abnormal anxiety, which was >44 according to Zung's scale, was reported by 20.1% of women and 8.9% of men ($p<0.001$) (Table 2).

Smartphone use patterns differed by sex. More women than men reported owning a smartphone for more than two years (61.6% vs. 46.3%, $p<0.001$) and using a smartphone in bed before sleeping (33.7% vs. 24.3%, $p<0.001$). We found a significant difference by sex in usage situations: 40.7% of women and 24.8%

of men reported using smartphones frequently during break time, 31.5% of men and 37.2% of women reported using smartphones frequently while commuting or traveling between places, and 3.5% of men and 4.3% of women reported using smartphones frequently during work or class ($p<0.001$) (Table 3).

We also found significant differences by sex in average daily smartphone use ($p<0.001$). Twice the percentage of women as men (22.9% vs. 10.8%) used smartphones for ≥ 6 hours per day, a greater percentage of women than men used their smartphones for 4–<6 hours per day (31.1% vs. 18.6%), and a greater percentage of men than women used their smartphones for <2 hours per day (29.2% vs. 12.5%) (Table 3).

The purpose of smartphone use differed by sex ($p<0.001$). The most common purpose of smartphone use was social networking services for both men and women, but women reported using social networking services more frequently than did men (51.7% vs. 39.2%). After social networking services, the next most frequent use of smartphones by men and women was to search the Internet (20.5% of women and 23.7% of men) and for entertainment (18.2% of women and 23.9% of men). Overall, women were significantly more dependent on smartphones than were men (mean dependency score: 56.0 vs. 50.8, $p<0.001$) (Table 3).

Men and women also differed significantly when we examined smartphone dependency score by average daily use time and purpose of smartphone use, with higher scores on a scale from 25 to 100 indicating greater smartphone dependency. For <2 hours, ≥ 2 –<4 hours, ≥ 4 –<6 hours, and ≥ 6 hours of daily use time, men scored 46.2, 51.4, 53.4, and 56.0, respectively, while women scored 48.0, 54.8, 57.3, and 60.4, respectively ($p<0.001$). Thus, smartphone dependency showed an increasing trend as daily use time increased (Table 4). Those who most frequently used their smartphones for entertainment, searching the Internet, and social networking services had significantly greater smartphone dependency than did those who most frequently used their smartphones for calling/miscellaneous functions ($p<0.001$).

With each one-point increase in smartphone dependency score, the odds of having abnormal anxiety in men and women increased by 10.6% and 9.2%, respectively ($p<0.001$) (Table 5). After adjusting for known risk factors for anxiety disorders (e.g., age, health, presence of physical and mental illness, and economic status), the odds of having abnormal anxiety in men and women increased by 7% and 9%, respectively ($p<0.001$), for every one-point increase in smartphone dependency score.

Table 2. Demographic characteristics and anxiety scores, by sex, of students who use smartphones at six universities, Suwon, South Korea, July–August 2013

Characteristic	Number of male students (percent) ^a	Number of female students (percent) ^a	P-value ^b
Total	725 (100.0)	511 (100.0)	
Age in years: mean (SD)	23.6 (2.7)	21.5 (2.7)	<0.001
Economic status ^c			0.309
High income	207 (28.6)	130 (25.5)	
Middle income	375 (51.7)	287 (56.1)	
Low income	143 (19.7)	94 (18.4)	
Academic achievement ^c			0.419
High grades	223 (30.7)	139 (27.2)	
Middle grades	294 (40.6)	217 (42.5)	
Low grades	208 (28.7)	155 (30.3)	
Health status ^c			<0.001
Excellent or good	459 (63.3)	238 (46.6)	
Fair	199 (27.4)	209 (40.9)	
Poor	67 (9.2)	64 (12.5)	
Drinking pattern ^d			<0.001
>1 time per week	206 (28.4)	34 (6.7)	
≤1 time per week	519 (71.6)	477 (93.3)	
Cigarette smoking			<0.001
Smoker ^e	281 (38.8)	142 (27.8)	
Nonsmoker	444 (61.2)	369 (72.2)	
Physical illness ^c	165 (22.8)	161 (31.6)	0.001
Mental illness ^f	36 (5.0)	18 (3.5)	0.259
Family history of mental illness ^f	25 (3.4)	33 (6.5)	0.019
Anxiety score ^g			<0.001
Normal (≤44)	660 (91.1)	408 (79.9)	
Anxiety (>44)	65 (8.9)	103 (20.1)	

^aPercentages may not total to 100 because of rounding.

^bMann Whitney U-test and Pearson's χ^2 test

^cSelf-reports were recorded for economic status, academic achievement, health status, and physical illness. The levels of high, middle, and low income were determined by participants' subjective opinion of their relative state compared with their surroundings.

^dAverage alcohol consumption in the past month (>60 grams of pure alcohol each time for men and >40 grams of pure alcohol each time for women)

^eParticipants who reported that they had smoked during the past six months

^fMental illnesses were based on self-report of diagnosed illness from a doctor within the past two years.

^gTotal scores range from 20 to 80, with a normal level of anxiety defined as ≤44. Adapted from: Zung WW. A rating instrument for anxiety disorders. *Psychosomatics* 1971;12:371-9.

SD = standard deviation

DISCUSSION

Women had higher smartphone dependency scores than men, suggesting that women might be more vulnerable to smartphone addiction. This finding supports previous research. For example, Kim et al. noted that the risk of mobile telephone addiction may be higher in female adolescents than in male adolescents because females regard interpersonal interaction more highly.³³ Recently, mobile telephones have come to be perceived as a medium for interpersonal interaction and quick communication, which may explain why women tend to use their smartphones for longer periods of time.^{21,33} Considering that smartphones have strengthened interpersonal interaction by online access (e.g., social

networking), according to a study by Kim et al., the risk of smartphone addiction in women may be higher than the increase in mobile telephone addiction.¹

Average daily use time and purpose of smartphone use also accounted for significant differences in smartphone dependency and differences by sex. More than half of all sampled women, compared with one-third of men, used smartphones for >4 hours per day. Furthermore, more than twice the percentage of women as men used their smartphones for ≥6 hours per day. Notably, Young explained that the more individuals experience a sense of immersion in the Internet, the more they will become further immersed.²⁷ Thus, continuous, excessive Internet use can lead to dependence.

It is possible that the same principle applies to smartphone use. Namely, women who are dependent on smartphones may use their smartphones for longer periods of time, which may, in turn, increase their dependence on smartphones. However, further study is needed to provide evidence for this explanation.

Regarding purpose of use, smartphone dependency was higher among participants who used smartphones for social networking services, Internet searches, and media-based entertainment than among participants who used smartphones for mobile telephone-related functions. For example, both male and female social networking services users had high smartphone dependency scores; however, 51.7% of women, compared with 39.2% of men, were social networking services users. Social networking services use might have led to women having higher dependency scores than men. Specifically, more women appeared to believe that interpersonal relationships can be fostered via the Internet, which is consistent with women's preferences for social networking services.³⁴ Additionally, women tend to believe that media are useful in the

development and maintenance of relationships, which coincides with their greater media use.³⁵ For example, in a longitudinal study of Japanese texting behavior, women communicated with more people using text messages than did men.¹ Furthermore, compared with men, women used smartphones to communicate with others more often, which may contribute to greater smartphone dependency among women. Although not shown in the tables, the interaction between women's preferences for social networking services and total smartphone use was not significant. However, smartphone dependency scores differed significantly by average daily use and purpose of use; thus, the main purpose of smartphone use and average daily use may independently affect smartphone dependency.

Smartphone dependency scores were also high among students who mainly used smartphones' entertainment functions compared with students using smartphones as conventional mobile telephones. This result coincides with previous results showing that mobile telephone addiction was highly associated with entertainment-based use.³⁶ Additionally, Park and Shin

Table 3. Smartphone use patterns and mean smartphone dependency scores, by sex, of students at six universities, Suwon, South Korea, July–August 2013

Smartphone use patterns	Number of male students (percent)	Number of female students (percent)	P-value ^a
Total	725 (100.0)	511 (100.0)	
Total length of smartphone ownership			<0.001
<6 months	50 (6.9)	20 (3.9)	
≥6–<12 months	91 (12.5)	31 (6.1)	
≥1–<2 years	248 (34.3)	145 (28.4)	
≥2 years	336 (46.3)	315 (61.6)	
Situations in which smartphone is frequently used ^b			<0.001
Commuting or traveling between places	229 (31.5)	190 (37.2)	
Working or attending a lecture	25 (3.5)	22 (4.3)	
During a break	295 (40.7)	127 (24.8)	
Before or while in bed	176 (24.3)	172 (33.7)	
Average daily use time, in hours			<0.001
<2	212 (29.2)	64 (12.5)	
≥2–<4	300 (41.4)	171 (33.5)	
≥4–<6	135 (18.6)	159 (31.1)	
≥6	78 (10.8)	117 (22.9)	
Purpose of use ^b			<0.001
Calling/miscellaneous functions	96 (13.2)	49 (9.6)	
Social networking services	284 (39.2)	264 (51.7)	
Searching/researching the Internet	172 (23.7)	105 (20.5)	
Entertainment ^c	173 (23.9)	93 (18.2)	
Mean smartphone dependency score (SD) ^d	50.8 (10.2)	56.0 (10.4)	<0.001

^aSex differences were compared using Mann-Whitney's U-test in dependency score and Pearson's chi-squared test in smartphone use patterns.

^bRespondents were asked to choose only one answer that most applied to themselves from the list in each question.

^cMedia-based entertainment functions includes digital multimedia broadcasting, MP3, video player, camera, and games.

^dTotal scores ranged from 25 to 100, with higher scores indicating greater smartphone dependency. Adapted from: Yang SY. Studies for mobile phone addiction in high school students. Sejong-si (Korea): Korea National Youth Policy Institute; 2002.

SD = standard deviation

Table 4. Smartphone dependency scores,^a by sex, according to use patterns of students at six universities, Suwon, South Korea, July–August 2013

Smartphone use patterns	Male students				Female students				
	Smartphone dependency score		Adjusted smartphone dependency score ^b		Smartphone dependency score		Adjusted smartphone dependency score ^b		
	Mean (95% CI)	P-value ^c	Mean (95% CI)	P-value ^c	Mean (95% CI)	P-value ^c	Mean (95% CI)	P-value ^c	
Total length of smartphone ownership									
<6 months	51.4 (48.6, 54.3)	0.198	50.9 (48.0, 53.7)	0.260	57.8 (53.3, 62.2)	0.438	55.0 (50.7, 59.4)	0.506	
≥6–<12 months	50.4 (48.3, 52.5)		50.8 (48.7, 52.9)		55.4 (51.8, 59.0)		55.9 (52.5, 59.4)		
≥1–<2 years	49.7 (48.4, 51.0)		50.2 (48.6, 51.7)		55.0 (53.3, 56.6)		54.5 (52.6, 56.4)		
≥2 years	51.5 (50.4, 52.6)		51.8 (50.4, 53.1)		56.4 (55.3, 57.6)		55.9 (54.4, 57.4)		
Situations in which smartphones is frequently used									
Commuting or traveling between places	50.2 (48.9, 51.5)	0.458	50.5 (49.0, 52.0)	0.795	54.6 (45.7, 50.3)	0.005	53.4 (51.4, 55.3)	0.078	
Working or attending a lecture	53.1 (49.1, 57.1)		51.0 (47.2, 54.8)		61.2 (57.0, 65.4)		58.1 (54.0, 62.2)		
During a break	50.6 (49.4, 51.8)		50.7 (47.2, 54.8)		55.5 (53.7, 57.2)		54.9 (52.8, 57.1)		
Before or while in bed	51.4 (49.9, 52.9)		51.4 (49.8, 53.0)		57.3 (55.8, 58.8)		55.0 (53.0, 57.0)		
Average daily use time (in hours)									
<2	46.2 (44.9, 47.5)	<0.001	45.7 (44.0, 47.4)	<0.001	48.0 (45.7, 50.3)	<0.001	49.3 (46.4, 52.2)	<0.001	
≥2–<4	51.4 (50.3, 52.5)		50.4 (48.9, 52.0)		54.8 (53.4, 56.3)		55.1 (53.0, 57.2)		
≥4–<6	53.4 (51.8, 55.1)		52.3 (50.3, 54.3)		57.3 (55.8, 58.8)		57.2 (55.0, 59.3)		
≥6	56.0 (53.8, 58.2)		55.1 (52.9, 57.3)		60.4 (58.7, 62.2)		59.9 (57.6, 62.1)		
Purpose of use									
Calling/miscellaneous functions	45.6 (43.5, 47.6)	<0.001	47.0 (44.0, 47.4)	<0.001	50.6 (47.8, 53.4)	<0.001	51.6 (48.6, 54.7)	0.005	
Social networking services	52.2 (51.0, 53.3)		52.8 (51.2, 54.3)		57.0 (55.8, 58.2)		56.8 (55.0, 58.6)		
Searching/researching the Internet	51.5 (50.0, 53.0)		52.7 (50.9, 54.4)		55.5 (53.5, 57.4)		56.1 (53.7, 58.5)		
Entertainment ^d	50.5 (49.0, 52.0)		51.1 (49.3, 52.8)		56.7 (54.7, 58.7)		56.8 (54.4, 59.2)		

^aTotal scores ranged from 25 to 100, with higher scores indicating greater smartphone dependency. Adapted from: Yang SY. Studies for mobile phone addiction in high school students. Sejong-si (Korea): Korea National Youth Policy Institute; 2002.

^bAll variables of behavioral patterns of smartphone use and other variables that contributed to significant differences in dependency (e.g., academic achievement in men and academic achievement and alcohol consumption in women) were adjusted.

^cAn analysis of covariance was used to compare the mean of smartphone dependency scores between groups of use patterns.

^dMedia-based entertainment function including digital media broadcasting, MP3, video player, camera, and games

CI = confidence interval

Table 5. Association between smartphone dependency score and anxiety score,^a by sex, in students at six universities, Suwon, South Korea, July–August 2013

Dependency score	Male students		Female students	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Unadjusted model	1.11 (1.08, 1.15)	<0.001	1.09 (1.06, 1.12)	<0.001
Adjusted model ^b	1.07 (1.04, 1.11)	<0.001	1.09 (1.06, 1.12)	<0.001

^aTotal scores ranged from 20 to 80, with a normal level of anxiety defined as ≤ 44 . Adapted from: Zung WW. A rating instrument for anxiety disorders. *Psychosomatics* 1971;12:371-9.

^bUsing multiple logistic regression adjusting for known risk factors (i.e., age, health status, physical and mental illness, and economic status)

OR = odds ratio

CI = confidence interval

noted that smartphone dependency increased when users' need for fun was satisfied via playing games or watching videos with the device.⁸ The fact that smartphone dependency increased by playing games can be partially explained as an effect of video game addiction. According to a study of Hong Kong adolescents, video game addiction was significantly higher among those who preferred multiplayer online games than among those who preferred other games. Wang et al. assumed that multiplayer online games increased enjoyment and interaction with other players, which might result in prolonged gaming sessions.³⁷ Because the smartphone is optimized for portable online access, people who use it to play games could end up using it more persistently. Thus, our results may show a positive correlation between Internet and video game addiction, although it should be directly confirmed in future studies.

Men and women also differed by situations in which they used smartphones. Although men used smartphones frequently when resting, women used them frequently when commuting or traveling or just before sleeping. Smartphone dependency did not differ significantly by usage situation among men, but dependency scores were significantly higher among women who used smartphones during work or just before sleeping. However, the increase in dependency scores was non-significant after controlling for smartphone use and confounding variables. Importantly, smartphone dependency was significantly related to anxiety, the most prevalent mental disease, in both men and women; this finding suggests that dependency is not a habit but, rather, a potential public health issue for smartphone use.

When the smartphone dependency score increased by one point, the odds of having anxiety rose by 7% in men and 9% in women after adjusting for anxiety disorder risk factors. This finding supports work by Yun et al.,¹⁰ who reported that 62.6% of smartphone-addicted users complained of anxiety.¹³ University

students in Turkey demonstrated increased anxiety among heavy users of smartphones, which the researchers proposed was mediated by sleep disturbances.³⁸ Furthermore, Hwang et al. researched the relationship between psychological characteristics and mobile telephone addiction among female university students and found that social extraversion and anxiety positively influenced addiction.¹⁴

Limitations

This study was subject to several limitations. First, because the study was cross-sectional, causal relationships between smartphone dependency and anxiety could not be inferred. Second, the sample was limited to Suwon and a specific age group. As such, the results are not necessarily representative of Korea because socioeconomic status and environmental conditions affecting smartphone use (e.g., population growth rate and social infrastructure for accessing the Internet) differ among regions.

CONCLUSION

Our study identified significant differences in smartphone use and dependency for several different use factors, such as average daily use time and purpose of use. Our study also found an association between smartphone dependency and abnormal anxiety. These findings add to the current knowledge base concerning dependency on smartphone use and abnormal anxiety that might be related to smartphone use and dependency.

The average amount of time spent using a smartphone is rising yearly in Korea (from 124 minutes per day in 2011 to 134 minutes per day in 2012), and use is concentrated heavily among young people. More than 77.1% of all smartphone users are aged 20–39 years, with a smartphone distribution rate in this age range of approximately 98%.³⁴ These young people are at a time

in life when they must begin managing their behaviors to preserve health in later years. Together with other published studies and studies to come, our results may help form a stepping-stone toward recommendations for the use of smartphones to prevent dependency and its associated health effects.

The study protocol was approved by the Ethical Committee of the Institutional Review Board of Ajou University Hospital.

REFERENCES

- Kim H-J, Kim J-H, Jeong S-H. Predictors of smartphone addiction and behavioral patterns. *J Cybercomm Acad Soc* 2012;29:55-93.
- Verkasalo H, López-Nicolás C, Molina-Castillo FJ, Bouwman H. Analysis of users and non-users of smartphone applications. *Telematics and Informatics* 2010;27:242-55.
- Verkasalo H. Analysis of smartphone user behavior. Abstract presented at the Mobile Business and 2010 Ninth Global Mobility Roundtable (ICMB-GMR), 2010 Ninth International Conference; 2010 Jun 13-15; Athens, Greece.
- Korea Internet and Security Agency. Report on smartphone adoption and usage in 2011. Seoul (Korea): Korea Internet and Security Agency; 2011.
- Park N, Lee H. Social implications of smartphone use: Korean college students' smartphone use and psychological well-being. *Cyberpsychol Behav Soc Netw* 2012;15:491-7.
- Young KS. Internet addiction: the emergence of a new clinical disorder. *CyberPsychol Behav* 1998;1:237-44.
- Lee Y-K, Chang C-T, Lin Y, Cheng Z-H. The dark side of smartphone usage: psychological traits, compulsive behavior and technostress. *Comput Human Behav* 2014;31:373-83.
- Park I-K, Shin D-H. Using the uses and gratifications theory to understand the usage and the gratifications of smartphones. *J Commun Sci* 2010;10:192-225.
- Hwang K-H, Yoo Y-S, Cho O-H. Smartphone overuse and upper extremity pain, anxiety, depression, and interpersonal relationships among college students. *J Korea Contents Assoc* 2012;12:365-75.
- Yun JY, Moon JS, Kim MJ, Kim YJ, Kim H, Huh B, et al. Smart phone addiction and health problems in university students. *J Korean Assoc Crisis Emerg Manag* 2011;3:92-104.
- Im K-G, Hwang S-J, Choi M-I, Seo N-R, Byun J-N. The correlation between smartphone addiction and psychiatric symptoms in college students. *J Korean Soc School Health* 2013;26:124-31.
- Shim J-M. The effect of carpal tunnel changes on smartphone users. *J Phys Ther Sci* 2012;24:1251-3.
- Ko K-S, Lee M-J, Kim Y-E. Research on addictive use of smartphones by university students. *J Digital Contents Soc* 2012;13:501-16.
- Hwang HS, Sohn S, Choi YJ. Exploring factors affecting smart-phone addiction: characteristics of users and functional attribute. *Korean J Broadcasting and Telecomm Stud* 2011;25:277-313.
- Kwon M, Lee JY, Won WY, Park JW, Min JA, Hahn C, et al. Development and validation of a smartphone addiction scale (SAS). *PLoS One* 2013;8:e56936.
- Hinton DE, Park L, Hsia C, Hofmann S, Pollack MH. Anxiety disorder presentations in Asian populations: a review. *CNS Neurosci Ther* 2009;15:295-303.
- Kessler RC, Berglund P, Demler O, Jin R, Merikangas KR, Walters EE. Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication [published erratum appears in *Arch Gen Psychiatry* 2005;62:768]. *Arch Gen Psychiatry* 2005;62:593-602.
- Poulin C, Hand D, Boudreau B, Santor D. Gender differences in the association between substance use and elevated depressive symptoms in a general adolescent population. *Addiction* 2005;100:525-35.
- Nysveen H, Pedersen PE, Thorbjørnsen H. Explaining intention to use mobile chat services: moderating effects of gender. *J Consumer Marketing* 2005;22:247-56.
- Lane W, Manner C. The impact of personality traits on smartphone ownership and use. *Int J Business Soc Sci* 2011;2:22-8.
- Igarashi T, Takai J, Yoshida T. Gender differences in social network development via mobile phone text messages: a longitudinal study. *J Soc Personal Relationships* 2005;22:691-713.
- Chou C, Tsai MJ. Gender differences in Taiwan high school students' computer game playing. *Comput Human Behav* 2007;23:812-24.
- Lev-Ran S, Le Strat Y, Imtiaz S, Rehm J, Le Foll B. Gender differences in prevalence of substance use disorders among individuals with lifetime exposure to substances: results from a large representative sample. *Am J Addict* 2013;22:7-13.
- Suki NM, Suki NM. Dependency on smartphones: an analysis of structural equation modelling. *Jurnal Teknologi (Sciences and Engineering)* 2013;62:49-55.
- Jang HJ. The psychological characteristics of adolescents addictive using cellular phone. Seoul: Graduate School of Sungshin Women's University; 2002.
- Yang S-Y. Studies for mobile phone addiction in high school students. Sejong-si, Korea National Youth Policy Institute; 2002.
- Young KS. Caught in the net: how to recognize the signs of Internet addiction—and a winning strategy for recovery. New York: John Wiley & Sons; 1998.
- Kim YS. A study on the relationship between the mobile phone addiction and psychological maturity of high school students. Incheon (Korea): Inha University Graduate School of Education; 2004.
- Guy W. ECDEU assessment manual for psychopharmacology. Rockville (MD): Department of Health, Education, and Welfare (US), Public Health Service, Alcohol, Drug Abuse, and Mental Health Administration; 1976.
- Flint AJ. Epidemiology and comorbidity of anxiety disorders in the elderly. *Am J Psychiatry* 1994;151:640-9.
- Alloy LB, Kelly KA, Mineka S, Clements CM. Comorbidity of anxiety and depressive disorders: a helplessness-hopelessness perspective. In: Maser JD, Cloninger CR, editors. *Comorbidity of mood and anxiety disorders*. Washington: American Psychiatric Press; 1990. p. 499-544.
- IBM Corp. SPSS®: Version 19.0 for Windows. Armonk (NY): IBM Corp.; 2010.
- Kim S-N, Jung H-W. A study on teenagers' mobile phone addiction. *Korean J Broadcasting and Telecommunication Studies* 2004;18:88-116.
- Korea Internet and Security Agency. 2013 use of mobile Internet survey. Seoul (Korea): Korea Internet and Security Agency; 2013.
- Kim B, Ko E, Choi H. A study on factors affecting smart-phone addiction in university students: a focus on differences in classifying risk groups. *Studies on Korean Youth* 2013;24:67-98.
- Sung DK, Cho YK. The difference of using pattern according to the mobile phone user groups' characters. *Korean J Journalism & Communication Studies* 2002;46:153-90.
- Wang CW, Chan CLW, Mak KK, Ho SY, Wong PWC, Ho RTH. Prevalence and correlates of video and Internet gaming addiction among Hong Kong adolescents: a pilot study. *Sci World J* 2014;2014:874648.
- Demirci K, Akgonul M, Akpınar A. Relationship of smartphone use severity with sleep quality, depression, and anxiety in university students. *J Behav Addict* 2015;4:85-92.