



Mediating Effect of Loneliness on Anxiety and Smartphone Overdependence among Korean Adolescents: Based on the 16th Korea Youth Risk Behavior Survey

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Abstract

Background: This study aimed to determine the mediating role of loneliness in the relationship between anxiety and smartphone overdependence among Korean adolescents.

Methods: This national cross-sectional secondary study used data from the 16th (2020) Korea Youth Risk Behavior Survey. The sample comprised 54,948 adolescents in middle and high schools. The mediating effects were analyzed using the procedure of Baron and Kenny and the Sobel test.

Results: Anxiety impacted both loneliness and smartphone overdependence ($P < 0.001$). Additionally, loneliness was identified as a factor influencing smartphone overdependence ($P < 0.001$). Loneliness demonstrated a statistically significant mediating effect in the relationship between anxiety and smartphone overdependence ($P < 0.001$).

Conclusions: It was concluded that smartphone overdependence increases with the heightened maladaptive emotions of adolescents, such as anxiety and loneliness. These findings confirmed the mediating role of loneliness in the relationship between anxiety and smartphone overdependence.

Keywords: Loneliness, Anxiety, Internet addiction disorder, Adolescent health, Problem behavior

INTRODUCTION

Background

South Korea had a very high smartphone penetration rate in 2023, with 95.7% of Korean adolescents owning smartphones [1]. Adolescents have low control and high impulsivity, making them vulnerable to addiction, and their risk of smartphone overdependence is 40.1%, higher than that of adults and children [2].

Smartphone overdependence poses more severe problems in adolescents than in adults. Using smartphones for a long time in poor postures leads to unbalanced physical growth [3]. Furthermore, it affects brain development, causing distractions, lack of attention, and impulsive behavior [4]. There is also a high risk of exposure to harmful stimuli such as pornography and dangerous situations such as cyberbullying [5]. Individuals with addiction are more likely to be addicted to another behavior if they are addicted to one behavior [6,7].

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Anxiety is highly associated with overdependence and addiction [8,9]. Studies have shown that individuals with high levels of anxiety use smartphones to check social media feeds more frequently and that the emotional state of adolescents is a risk factor for smartphone addiction [5,10]. Thus, it can be expected that individuals with high anxiety levels are using smartphones excessively to alleviate anxiety, unlike those with low anxiety levels [11]. Therefore, gaining a comprehensive understanding of the variables affecting smartphone overdependence and identifying various ways to prevent smartphone overdependence of adolescents with high anxiety are possible by investigating the mediators between anxiety and smartphone overdependence.

Loneliness is an emotion that most individuals experience as a lack of belonging in social relationships [12]. However, as with anxiety, anyone experiencing more loneliness is likely to be dependent on or addicted to something [13]. In the life cycle, adolescence is a period in which there is a very high need for belonging and intimacy [14], which are not all fulfilled; therefore, one experiences much loneliness [15]. Because one can interact with others anytime and anywhere using smartphones, adolescents use smartphones to build and maintain social relationships [16]. Therefore, it can be assumed that adolescents use smartphones as a medium to overcome loneliness, and loneliness can be expected to amplify smartphone overdependence even more.

However, in prior studies that explored loneliness, anxiety, and smartphone overdependence among adolescents, only connections among these variables were recognized. Finding studies that systematically examined the mediating role of loneliness in the relationship between anxiety and smartphone overdependence is difficult [8-11,16]. Therefore, this study aimed to contribute to the conception of specific and expanded prevention and intervention strategies for smartphone addiction in adolescents by examining the effect of anxiety on smartphone overdependence through loneliness as a mediator.

Conceptual framework of the research

Based on the mediating effect model [17], the conceptual framework of this study was developed with the assumption that anxiety in adolescents affects their smartphone overdependence through the mediating role of loneliness (Fig. 1).

METHODS

Research design

This descriptive analysis used secondary data from the 16th (2020) Korea Youth Risk Behavior Survey (KYRBS) [18] to examine the mediating effects of loneliness on the association between anxiety and smartphone overdependence among Korean adolescents.

Participants

The KYRBS is an anonymous, self-administered online survey conducted among middle to high school students to gain insights into the health behavior of Korean youth. This government-approved statistical survey (approval number: 117058) has been conducted annually since 2005. The 16th KYRBS [18] was conducted involving students from 400 middle schools and 400 high schools. In total, 54,948 students from 793 schools (398 middle schools and 395 high schools) were surveyed (response rate=94.9%). Among the sample students, long-term absences, children with special needs who could not participate in the survey independently, and students with text-reading disabilities were excluded. The data collection period was from August 2020 to November 2020.

Measures

Smartphone overdependence

The smartphone overdependence scale was used to assess the degree of smartphone overdependence among the adolescent

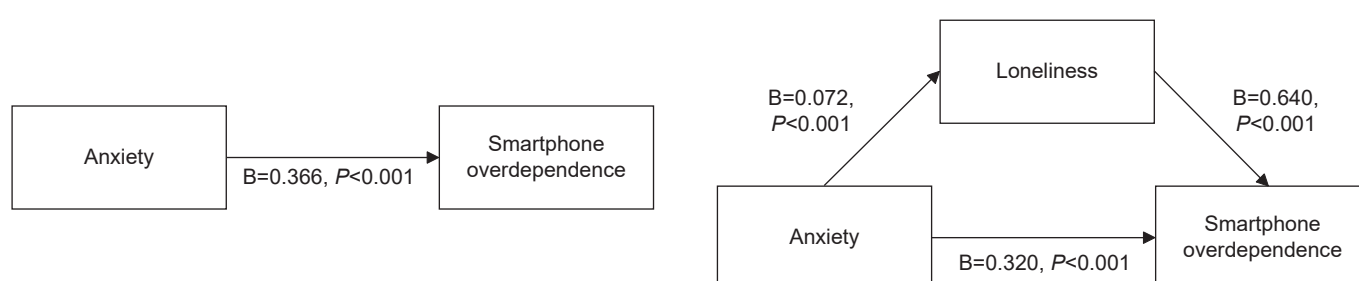


Fig. 1. Mediation model for anxiety, loneliness, and smartphone overdependence in Korean adolescents.

participants. A questionnaire was developed to measure smartphone overdependence among South Korean youth, adults, and seniors [19-21]. The questionnaire comprises 10 items. Responses are based on a 4-point scale: 1="strongly disagree" to 4="strongly agree." The total scores ranged from 10 to 40. The higher the score, the more severe the overdependence on smartphones [19]. Cronbach's α during survey development was 0.84 [21], and 0.92 in this study.

Anxiety

The Generalized Anxiety Disorder-7 (GAD-7) comprises a self-report questionnaire that allows for the rapid detection of GAD [22]. The subjects were asked whether they were bothered by anxiety-related problems over the past 2 weeks by answering seven items on a 4-point scale. The total scores ranged from 0 to 21 [22]. Cronbach's α was 0.92 in the previous study [22] and 0.90 in this study.

Loneliness

The question "How often have you felt lonely during the last 12 months?" was answered on a 5-point scale (5=always feeling lonely to 1=not feeling lonely at all).

Covariates

Twelve covariates were included in the analysis, including socioeconomic status, problem behavior, and mental health variables [23-27].

- 1) Socioeconomic variables included sex, age, perceived economic status, perceived academic performance, and body mass index (BMI) (kg/m^2).
- 2) Problem behavior variables included drug, drinking, and smoking experiences.
- 3) Mental health variables included perceived stress, sleep satisfaction, depressive symptoms, and suicidal ideation.

Data analysis

The KYRBS comprises complex data, which were analyzed based on complex sampling design and strata, cluster, weight, and finite population correction provided by the Korea Disease Control and Prevention Agency (KDCA) [18]. The analysis was performed using IBM SPSS Statistics 25.0 (IBM Corp.). *P*-values <0.05 were used to denote statistical significance.

Data were analyzed according to the following steps. First, anxiety, loneliness, and smartphone overdependence were an-

alyzed using complex sample descriptive statistics. Second, the relationship among the respondents' anxiety, loneliness, and smartphone overdependence was analyzed using the complex sample general linear model. Third, the mediating effects of loneliness on the relationship between anxiety and smartphone overdependence were analyzed using the three-step mediated effect validation procedure of Baron and Kenny [28] and the Sobel test [29] with the complex sample general linear model. The analysis was adjusted for covariate variables.

Ethical considerations

The KYRBS is a government-approved statistical survey conducted annually in Korea since 2005 (approval no. 117058) [18]. This study obtained data from the survey website (<https://www.cdc.go.kr/yhs>) according to the regulations of the KDCA. This study involved secondary data analysis and, therefore, was exempt from institutional review board approval.

RESULTS

General characteristics

Table 1 shows the general characteristics of the study participants included in this study. The study included 51.9% males and 48.1% females, with a mean age of 15.19 years. The mean BMI was $21.50 \text{ kg}/\text{m}^2$. Regarding economic status, 47.5% were medium. Regarding subjective academic performance, 30.1% were medium. Furthermore, 0.8% of the students had drug experience, 33.4% had drinking experience, and 10.2% had smoking experience. Depressive symptoms were reported by 25.2% of the respondents, and suicidal ideation was reported by 10.9%. Regarding sleep satisfaction, 33.7% were medium, and regarding perceived stress, 44.4% were medium.

Anxiety, loneliness, and smartphone overdependence

The anxiety score was 3.94, the loneliness score was 2.41, and the smartphone overdependence score was 18.60. The risk of anxiety was 11.2%. The risk of smartphone overdependence was 25.5% (Table 2).

Relationship between anxiety, loneliness, and smartphone overdependence

Anxiety showed a significant association with loneliness ($B=0.13$, $P<0.001$); loneliness ($B=1.52$, $P<0.001$) and anxiety ($B=0.45$, $P<0.001$) both affected smartphone overdependence (Table 3).

Table 1. General characteristics in Korean adolescents (N=54,948)

Variable	Category	Subject (n)	Weighted %	Mean	SE
Sex	Males	28,353	51.9	15.19	0.023
	Females	26,595	48.1		
Age (yr) (n=54,809)				21.50	0.029
Body mass index (kg/m ²) (n=53,534)					
Perceived economic status	Very high	6,039	11.3	28.6	47.5
	High	15,300	28.6		
	Middle	26,397	47.5		
	Low	5,937	10.4		
	Very low	1,275	2.2		
Subjective academic performance	Very high	6,736	12.2	24.7	30.1
	High	13,410	24.7		
	Middle	16,585	30.1		
	Low	12,684	23.0		
	Very low	5,533	10.0		
Drug experience	No	54,543	99.2	66.6	33.4
	Yes	405	0.8		
Drinking experience	No	36,591	66.6	89.8	10.2
	Yes	18,357	33.4		
Smoking experience	No	49,318	89.8	74.8	25.2
	Yes	5,630	10.2		
Depressive symptoms	No	41,108	74.8	89.1	10.9
	Yes	13,840	25.2		
Suicidal ideation	No	48,969	89.1	33.7	24.8
	Yes	5,979	10.9		
Sleep satisfaction	Very satisfied	5,582	9.9	11.2	8.3
	Satisfied	11,242	20.4		
	Neutral	18,656	33.7		
	Dissatisfied	13,481	24.8		
	Very dissatisfied enough	5,987	11.2		
Perceived stress	Very low	2,018	3.6	44.4	25.9
	Low	9,889	17.8		
	Middle	24,379	44.4		
	High	14,059	25.9		
	Very high	4,603	8.3		

SE, standard error.

Table 2. Anxiety, loneliness, and smartphone overdependence in Korean adolescents (N=54,948)

Variable	Category (score)	n (weighted %)	Mean	SE	Range
Anxiety	Risk group (10–21)	6,099 (11.2)	3.94	0.031	0–21
	Low risk group (0–9)	48,849 (88.8)			
Loneliness			2.41	0.007	1–5
Smartphone overdependence	Overdependence group (23–40)	13,775 (25.5)	18.60	0.043	10–40
	Normal group (0–22)	41,173 (74.5)			

SE, standard error.

Mediating effect of loneliness on the relationship between anxiety and smartphone overdependence

In this study, the independent variable was anxiety, the mediator was loneliness, and the dependent variable was smartphone

overdependence. Twelve control variables were used to adjust for differences in smartphone overdependence according to the respondents' general characteristics (Table 4, Fig. 1).

The assumption of the regression analysis was verified by

Table 3. Relationship between anxiety, loneliness, and smartphone overdependence in Korean adolescents (N=54,948)

Variable		R ²	Wald F (P)	B	SE	t (P ^a)
Independent	Dependent					
Anxiety	Loneliness	0.282	12,433.10 (<0.001)	0.13	0.001	111.50 (<0.001)
Loneliness	Smartphone overdependence	0.067	3,292.42 (<0.001)	1.52	0.027	57.38 (<0.001)
Anxiety	Smartphone overdependence	0.096	3,986.59 (<0.001)	0.45	0.007	63.14 (<0.001)

SE, standard error.

^aComplex sample general linear model.**Table 4.** Mediating effect of loneliness on the relationship between anxiety and smartphone overdependence (N=54,948)

Variable	B	SE	t (P ^a)	R ²	Wald F (P)
Step 1. Anxiety → loneliness	0.072	0.001	54.89 (<0.001)	0.371	1,913.07 (<0.001)
Step 2. Anxiety → smartphone overdependence	0.366	0.009	41.16 (<0.001)	0.124	464.66 (<0.001)
Step 3. Anxiety, loneliness → smartphone overdependence					
1) Anxiety → smartphone overdependence	0.320	0.009	35.58 (<0.001)	0.131	458.44 (<0.001)
2) Loneliness → smartphone overdependence	0.640	0.032	19.98 (<0.001)		
Sobel test			Z=19.270, P<0.001		

SE, standard error.

^aComplex sample general linear model with the following covariates: sex, age, perceived economic status, perceived academic performance, body mass index, drug/drinking/smoking experiences, perceived stress, sleep satisfaction, depressive symptoms, suicidal ideation.

multiple regression before verifying the mediating effect, and the effect of the independent variable, parameter, and control variables on smartphone overdependence was analyzed.

The first step of the analysis showed that anxiety had a significant effect on loneliness (B=0.072, $P<0.001$). The results of the second step showed that anxiety had a significant effect on smartphone overdependence (B=0.366, $P<0.001$). The third step showed that loneliness had a significant effect on smartphone overdependence (B=0.640, $P<0.001$). Furthermore, anxiety had a significant mediating effect on smartphone overdependence (B=0.320, $P<0.001$), with a partial mediating effect. Moreover, the Sobel test had a statistically significant result ($Z=19.270$, $P<0.001$).

DISCUSSION

This study established and verified the relationship between anxiety and smartphone overdependence mediated by loneliness as a theoretical model.

Anxiety and loneliness affected smartphone overdependence. These findings are consistent with those of previous research, which found that various emotions experienced during adolescence, such as anxiety and loneliness, affect the problematic use of media such as smartphones. Individuals with psychological issues, such as anxiety or loneliness, overuse cyber media or technological devices such as smartphones [30,31]. These ad-

dictions to media and technology cause other problems, such as physical injury or cognitive impairment, leading to dangerous health consequences, such as suicidal ideation [31,32]. In several studies, users with high smartphone dependence showed increased anxiety, nervousness, and depression when separated from smartphones [30,33]. Thus, if adolescents' maladaptive emotions are not resolved and lead to smartphone overdependence, it could result in a vicious cycle that leads to other health problems and increased maladaptive emotions such as anxiety and restlessness. Therefore, a system that can closely monitor the emotional state of adolescents should be established.

During the COVID-19 (coronavirus disease-19) pandemic, psychological and emotional problems, including anxiety, loneliness, and depression caused by COVID-19, increased among adolescents [34]. Negative emotions, such as anxiety and loneliness, may have persisted for many years because of social distancing, which may have further increased smartphone dependence. Therefore, identifying the potential risk group expected to have a high degree of anxiety and loneliness is necessary. Smartphone overdependence risk groups should also be screened. In South Korea, diagnostic tests are currently being performed for the early detection of mental health problems in children and adolescents. However, the tests are conducted only in some mental health centers and mainly for individuals suspected to be at a high risk, which is hardly considered a comprehensive solution [35]. Therefore, accessible school-wide

screenings must be established to identify potential risk groups for mental health issues and smartphone use among adolescents.

In this study, adolescents' anxiety affected smartphone overdependence through the mediation of loneliness. In particular, the higher the anxiety, the greater the loneliness, and the higher the level of smartphone overdependence. This result suggests that when assisting adolescents suffering from anxiety, closely examining their loneliness levels and exploring the effects of the degree of loneliness on smartphone overdependence are necessary. Anxiety is a psychological response that protects an individual against danger and threat and a personality trait that forms over many years from the beginning of life [36,37]. During adolescence, anxiety is frequent because of sudden physical changes and development, and decreasing anxiety levels in adolescents through short-term intervention or counseling is challenging [36-38]. In contrast, loneliness is relatively easier to manage through emotional reflection and counseling relationships than anxiety [39]. Improving unstable family or peer relationships and reducing the loneliness of adolescents during the time in life when one is most dependent on peers are possible [40].

The results of this study suggest that if adolescents complaining of smartphone overdependence experience anxiety, seeking specific interventions and solutions that can alleviate loneliness along with measures to intervene for anxiety is practical. The findings indicate that managing anxiety in adolescents with smartphone overdependence necessitates specific interventions directed at alleviating both loneliness and anxiety. This comprehensive approach can guide practical solutions for adolescents dealing with smartphone overdependence.

This study has limitations and suggests directions for future research. First, the cross-sectional nature of the data prevents the establishment of clear causal relationships between variables [41]. Longitudinal analyses in subsequent studies are essential to determine significant causal directions. Second, breaking down maladaptive emotions for a more detailed examination is recommended. Anxiety [42] and loneliness [43] can manifest in various forms. Therefore, future studies should perform a nuanced evaluation of emotions to identify specific aspects of anxiety and loneliness associated with smartphone addiction.

Despite its limitations, this study can help establish a psychological framework to predict smartphone overdependence among adolescents. This study offers insights into the risk factors associated with smartphone overdependence in this age

group. This study confirmed that the maladaptive emotions of adolescents, such as anxiety and loneliness, are associated with smartphone overdependence. Furthermore, because loneliness mediates anxiety in adolescents, it was established that loneliness should be mediated together when intervening in smartphone overdependence of adolescents with high anxiety levels in the future.

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AUTHOR CONTRIBUTIONS

Dr. Jaeyoung LEE had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. The author reviewed this manuscript and agreed to individual contributions.

Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Writing—original draft, Writing—review & editing: JL.

CONFLICTS OF INTEREST

No existing or potential conflict of interest relevant to this article was reported.

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DATA AVAILABILITY

The data presented in this study are available upon reasonable request from the corresponding author.

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