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Problematic smartphone use and risk behaviors in adolescents during the COVID-19 pandemic

Yeseul Lee¹, Hyeseon Choi^{2*} and Yedong Son^{3*}

Abstract

Background This study examined the association between problematic smartphone use (PSU) and risk behaviors among Korean adolescents during the COVID-19 pandemic. It also aimed to develop preventive measures for adolescent health promotion in the event of future pandemics.

Methods A secondary analysis of data from the 16th Korean Youth Risk Behavior Web-based Survey (2020) was conducted, which included 54,948 middle and high school students. Smartphone use, PSU, alcohol use, and smoking status were assessed via self-reported questionnaires. Complex samples descriptive statistics and logistic regression analyses were performed using SPSS 25.

Results Korean adolescents averaged 282.8 and 393.4 min of smartphone use across weekdays and on weekends, respectively, with a 25.5% prevalence of PSU. Female and high school students exhibited significantly higher PSU rates ($p < .001$). Current alcohol use and smoking increased PSU risk by 1.098- and 1.295-fold, respectively.

Conclusions The findings emphasize the need for intervention strategies targeting PSU and associated risk behaviors. Continuous monitoring in home and school settings, along with gender-specific and educational-level interventions, is recommended to promote healthy smartphone use among adolescents.

Keywords Adolescent, Smartphone use time, Drinking, Smoking, COVID-19

Introduction

The COVID-19 pandemic has profoundly reshaped adolescents' digital media consumption patterns, particularly in Korea [1] where digital infrastructure is highly developed [2]. As a pandemic response, Korea implemented stringent social distancing measures in 2020, restricting

in-person activities and necessitating a shift to online learning. Consequently, Korean adolescents experienced a substantial increase in smartphone use due to remote education and extended social isolation [3].

Adolescents use smartphones for self-expression in digital spaces and to maintain interpersonal relationships [4]. Social media exposes them to the behaviors of peers, celebrities, and influencers, which can influence their attitudes and actions [5]. Frequent exposure to high-risk content on social media platforms correlates with heightened curiosity and mimetic behavior, potentially encouraging risk taking [6]. The interaction between social media consumption and behavioral manifestations is particularly concerning during adolescence, a developmental

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stage marked by increased susceptibility to peer influences and a tendency toward risk-taking [7].

Examining smartphone use during the COVID-19 pandemic is crucial for understanding how global health crises affect adolescent behavior [3]. A key concern is the link between problematic smartphone use (PSU) and other risky behaviors, given that pandemic-induced anxiety and social isolation have been identified as contributors to an increased risk of smartphone addiction [4, 8]. Prior research suggests that psychological symptoms during the pandemic may drive PSU and other behavioral issues [9]. Heightened feelings of loneliness and a desire to escape reality are major risk factors for excessive smartphone use, especially during public health crises [10].

Adolescent risk behaviors encompass a spectrum of maladaptive activities, including alcohol consumption, current smoking, substance abuse, prostitution, truancy, and delinquency [11]. Underage drinking and smoking warrant particular attention, as behaviors that begin in adolescence often continue into adulthood, posing long-term health risks [12, 13]. The prevalence of these behaviors among adolescents remains a significant public health concern worldwide. Recent research analyzing national trends in Korean adolescent risk behaviors over the past decade found that while the prevalence of both alcohol consumption and smoking declined prior to the COVID-19 pandemic, both behaviors increased again during the pandemic period [14]. Previous studies have reported strong associations among adolescent smoking, drinking, and internet use [15, 16]. Given the rise in smartphone usage following the COVID-19 outbreak, further investigation is required to explore its potential impact on problematic behaviors, such as underage drinking and smoking [10].

The results of this study can inform targeted intervention strategies to promote adolescent health in preparation for future public health emergencies [3]. In recent years, studies have highlighted the negative consequences of excessive screen time during the pandemic, including an increase in mental health disorders and behavioral addictions among adolescents [7, 17]. As this study was conducted early on in the COVID-19 pandemic, it offers a valuable opportunity to gather evidence supporting early response strategies [18]. Importantly, research has demonstrated an escalation in smartphone addiction during the pandemic, adversely affecting both physical and mental well-being [10]. Developing a deeper understanding of these behavioral patterns is essential for formulating rapid intervention protocols for future public health crises, as early intervention is crucial for mitigating long-term impacts on adolescent behavioral health [3, 9]. Overall, the present study aimed to enhance current knowledge of adolescent digital health behaviors in

the context of a global health emergency while providing valuable insights to inform evidence-based public health policy development.

Materials and methods

Study design

This cross-sectional study involved secondary analysis of national data from the 16th Korean Youth Risk Behavior Web-based Survey (KYRBS, 2020), examining the associations between smartphone use and alcohol consumption and smoking risks among Korean adolescents [19]. The KYRBS is a nationally approved statistical survey jointly conducted by the Korea Disease Control and Prevention Agency (KDCA) and the Ministry of Education. It is conducted annually as an anonymous, self-administered, web-based survey to assess the current status of health behaviors among Korean adolescents.

Sample and participants

The study population comprised middle and high school students in Korea as of April 2020. A stratified multi-stage cluster sampling method was employed to ensure national representativeness. The sampling frame was stratified based on 39 regional strata derived from administrative divisions (cities/provinces) and urbanization levels (metropolitan, small/medium cities, rural areas). Additional stratification was applied according to school type and gender composition. Within each stratum, sample schools were selected using a permanent random number extraction method. The 16th KYRBS was designed to survey 57,925 students from 400 middle schools and 400 high schools (800 in total). Owing to COVID-19-related challenges, including teacher workload and limited access to computer labs, the final sample included 54,948 students from 398 middle schools and 395 high schools (793 in total), yielding a 94.9% participation rate. Students with extended absences, self-capable special education students, and those with reading disabilities were excluded from the survey [19].

Measurements

Weekday and weekend smartphone use

Weekday smartphone use was measured via participants' self-reported average hours and minutes of usage from Monday to Friday, obtained through an online, self-administered questionnaire [19]. Weekend smartphone use was measured in the same manner, but from Saturday to Sunday [19].

PSU

PSU was measured using the Korean Youth Smartphone Addiction Scale, a standardized 10-item tool developed by the National Information Society Agency of Korea [20]. The scale uses a 4-point Likert scale (1 = strongly

disagree to 4 = strongly agree) to assess three key dimensions: daily life disturbance, virtual life orientation, and withdrawal symptoms among adolescents. The total score ranged from 10 to 40, with scores categorized into general users (10–15), potential risk users (16–22), and high-risk users (≥ 23), with high-risk users considered problematic smartphone users [20].

Current alcohol use and smoking status

Current alcohol use was defined as the percentage of youths who reported consuming at least one alcoholic beverage during the preceding 30 days [19]. Current smoking prevalence was defined as the percentage who used traditional cigarettes or electronic nicotine delivery systems, including cigarette-type devices and liquid-form e-cigarettes, during the preceding 30 days [19].

Data collection and ethics

The sampling process involved three key phases: population stratification, sample allocation, and sample extraction. A stratified cluster sampling approach was employed, with schools as the primary sampling units and classes as secondary units. In 2020, in response to the COVID-19 pandemic, the 16th KYRBS was administered via mobile devices (tablet PCs and smartphones) under teacher supervision in computer labs or classrooms. Participants voluntarily accessed the survey platform using assigned participation numbers, following the instructions provided. They completed the survey anonymously after giving informed consent [19]. The Institutional Review Board (IRB) of Woosuk University approved this study (IRB no.: WS-2022-05).

Data analysis

Secondary analysis of the 16th KYRBS raw data was conducted after data cleaning (handling logical errors and outliers), weight generation, and stratum integration.

Table 1 Participants' general characteristics

			(n = 54,948)
Characteristics	Categories	n ¹	% ²
Gender	Male	28,353	51.9
	Female	26,595	48.1
School type	Middle school	28,961	49.6
	High school	25,987	50.4
Grade level*	1 st of middle school	10,005	17.9
	2nd of middle school	9,564	16.2
	3rd of middle school	9,392	15.6
	1 st of high school	8,907	16.9
	2nd of high school	8,907	17.0
	3rd of high school	8,173	16.5

¹n Unweighted number

²% weighted percentage

*Excluding missing values

All analyses were performed using SPSS 25.0, with two-tailed tests and a significance level set at $\alpha = 0.05$. The analysis accounted for the complex sampling design characteristics by applying integrated strata, weights, cluster variables, and finite population correction with equal probability sampling without replacement. These procedures are in accordance with KDCA guidelines [19]. Complex samples descriptive statistics were employed to analyze general characteristics, smartphone use, current alcohol use, and smoking status. Group differences were assessed using complex samples *t*-tests, and the risk of PSU associated with alcohol use and smoking status were analyzed using complex samples logistic regression models, with gender and school type as covariates.

Results

Participant characteristics

Table 1 presents the general characteristics of the study participants.

Adolescents' smartphone use, PSU, current alcohol use, and smoking status

On average, Korean adolescents used smartphones for 282.8 min (4.7 h) across weekdays and 393.4 min (6.6 h) on weekends, with a 25.5% prevalence of PSU. Among participants, 10.7% had consumed alcohol at least once in the past 30 days, and 4.8% reported smoking within this period. Table 2 provides a breakdown of smartphone use, PSU prevalence, alcohol use, and smoking status by gender and school type.

Differences in PSU scores according to gender, school type, current alcohol use, and smoking status

PSU scores varied by gender, school type, alcohol consumption, and smoking status. For instance, PSU scores were significantly higher in female students than in male students ($p < .001$), and high school students' scores were significantly higher than those of middle school students ($p < .001$). Additionally, the PSU scores of adolescents who reported drinking alcohol ($p < .001$) and smoking ($p < .001$) were significantly higher than those of nonusers (Table 3).

Risk of PSU associated with current alcohol use and smoking status

Table 4 presents the association between PSU and substance use. Adolescents who consumed alcohol had a 1.098-fold greater risk of PSU compared with nondrinkers ($p < .001$), and current smokers exhibited a 1.295-fold higher risk of PSU compared with nonsmokers ($p < .001$).

Table 2 Smartphone use, PSU, current alcohol use, and smoking status according to participants' characteristics

Characteristics	Categories	(n = 54,948)									
		Smartphone use across weekdays (min) ⁴		Smartphone use on weekends (min) ⁴		PSU ⁵		Current alcohol use		Current smoking status	
		M ^{1*}	SE ^{2*}	M ^{1*}	SE ^{2*}	% ³	SE ²	% ³	SE ²	% ³	SE ²
Total		282.8	1.8	393.4	2.4	25.5	0.3	10.7	0.2	4.8	0.2
Gender	Male	258.8	2.1	350.2	2.5	21.2	0.4	12.1	0.3	6.7	0.2
	Female	309.9	2.4	438.5	3.0	30.0	0.3	9.1	0.3	2.9	0.1
School type	Middle school	275.4	2.4	385.4	3.4	23.6	0.4	5.4	0.1	2.0	0.1
	High school	290.7	2.7	401.9	3.3	27.3	0.4	15.9	0.4	7.7	0.3
Grade level*	1 st of middle school	246.0	2.9	344.2	3.9	18.8	0.5	3.7	0.2	0.8	0.1
	2nd of middle school	279.5	3.0	398.2	4.0	24.6	0.5	4.9	0.2	1.8	0.1
	3rd of middle school	305.0	3.2	419.4	4.3	28.1	0.6	7.8	0.3	3.4	0.2
	1 st of high school	282.5	3.1	400.1	3.9	25.7	0.6	10.9	0.4	5.4	0.3
	2nd of high school	295.9	3.3	408.5	4.1	28.4	0.5	15.8	0.5	7.8	0.4
	3rd of high school	293.9	3.9	396.9	4.4	27.7	0.5	20.9	0.6	9.9	0.5

¹Weighted mean²Standard error³%; weighted percentage⁴average use in minutes⁵PSU: problematic smartphone use

*Excluding missing values

Table 3 Differences in PSU scores according to gender, school type, current alcohol use, and smoking status

Characteristics	Categories	M ¹	SE ²	Wald F	(n=54,948)
					p
Gender	Male	18.3	0.1	799.54	<0.001
	Female	20.3	0.1		
School type	Middle school	19.1	0.1	19.89	<0.001
	High school	19.4	0.1		
Current alcohol use	No	19.5	0.1	184.09	<0.001
	Yes	19.9	0.1		
Current smoking status	No	19.1	0.0	6.66	<0.001
	Yes	19.5	0.2		

¹Weighted mean²Standard error

Discussion

This study investigated the association between PSU and adolescent risk behaviors, including alcohol consumption and smoking, during the COVID-19 pandemic, providing

insights to inform future public health interventions. The investigation was timely, as the 16th KYRBS incorporated smartphone overdependence questionnaire items [19], enabling meaningful analysis of adolescent PSU in the context of the global health crisis.

Our findings indicate that Korean adolescents used smartphones for an average of 4.7 h across weekdays and 6.6 h on weekends, with a 25.5% prevalence of PSU. These results align with studies outside Korea, with similar patterns reported in China [21] and Italy [22]. The rise in smartphone use can be largely attributed to the shift to remote learning and reduced outdoor activities following the COVID-19 outbreak [3]. Although smartphone use is not inherently harmful to adolescents [23], excessive use can negatively impact health and social development, increasing the risk of social isolation or disconnection [24]. Importantly, unconscious smartphone use in daily life can escalate into addiction, particularly as smartphones have become integral to adolescent peer interactions [25].

Table 4 Risk of PSU associated with current alcohol use and smoking status

Variables	Categories	PSU OR ¹	B	SE ²	t	95% CI ³		p
						Lower	Upper	
Current alcohol use	No		0.358	0.025	0.308	0.408	14.130	<0.001
	Yes	1.098				1.023	1.179	
Current smoking status	No		−0.259	0.047	−0.351	−0.166	−5.479	<0.001
	Yes	1.295				1.181	1.421	

¹PSU OR problematic smartphone use odds ratio²SE standard error³95% CI: confidence interval

Gender analysis revealed that smartphone use and PSU rates were higher in female adolescents than in males, consistent with prior research highlighting females' susceptibility to overdependence on smartphone use [26]. This gender difference may be attributed to females' stronger tendency to maintain peer relationships through text messaging and photo and video sharing [27]. Similarly, findings in Spain indicate higher social networking service addiction in females [28].

Comparisons by academic level showed that smartphone use and PSU rates were higher among high school students than middle school students, supporting previous research indicating that high school students' smartphone dependency was 1.072-fold higher than that of middle school students [29]. This trend is likely driven by the heightened academic stress faced by Korean high school students [30, 31].

Our analysis of risk behaviors revealed that adolescents who consume alcohol have a 1.098-fold higher risk of PSU compared with nonusers, whereas current smokers exhibit a 1.295-fold higher risk. These findings align with previous research showing that adolescents who drink or smoke are more prone to smartphone-related issues [32]. Prior Korean studies have similarly reported that smoking and drinking may increase internet and smartphone dependency among adolescents [33]. Therefore, comprehensive intervention strategies for PSU among adolescents require addressing not only smartphone use but also associated risk behaviors such as alcohol consumption and smoking. While the overuse of smartphones, alcohol, and tobacco may present distinct symptoms depending on the specific behavior, the underlying mechanisms and characteristics of overuse are often similar [34]. It is therefore important to take an integrated approach to prevent, cope with, and regulate these problems by enhancing self-control [35].

Within this integrated framework, smartphone-specific interventions should not focus solely on reducing screen time. Rather than imposing strict restrictions, educational strategies should help adolescents understand and self-manage the risks of smartphone overdependence [36]. Continuous monitoring in both home [37] and school [38] environments is critical for promoting healthy smartphone use and preventing problematic behaviors. Educational interventions should emphasize cyber safety and mindful internet use, equipping adolescents with self-regulation skills [39]. Furthermore, tailored interventions such as gender-specific education programs and digital literacy curricula aligned with middle and high school curricula, are recommended to promote healthy smartphone use among adolescents. These findings highlight the importance of implementing comprehensive, developmentally appropriate interventions

that simultaneously address multiple risk behaviors to effectively support adolescent health.

Limitations and strengths

This study has some limitations. As a secondary analysis of KYRBS data, this study is limited by the item scope, which constrains detailed assessment of smartphone use, alcohol consumption, and smoking behaviors. Due to its cross-sectional design and reliance on self-reported data, there is a potential for recall and social desirability biases. Future research should explore longitudinal changes in adolescent smartphone use patterns and their relationship with risk behaviors. Additionally, the development of gender-specific and educational level-appropriate intervention strategies warrants further investigation.

Despite these limitations, the study has several notable strengths. First, it analyzed a large-scale, nationally representative dataset, enhancing the generalizability of the findings to Korean adolescents. Furthermore, by incorporating newly introduced smartphone overdependence measures from the 16th KYRBS [19], the study provides timely insights into the association PSU and adolescent risk behaviors during the COVID-19 pandemic. Overall, this research contributes to our understanding of post-pandemic youth behavior trends and provides evidence-based insights to guide interventions promoting healthy smartphone use among adolescents.

Conclusions

This study revealed that Korean adolescents spent an average of 4.7 h on smartphones across weekdays and 6.6 h on weekends with 25.5% classified as having PSU. Gender and school type differences were notable, with female students and high school students exhibiting higher PSU rates. Moreover, current alcohol use and smoking increased the risk of PSU by 1.098- and 1.295-fold, respectively. These findings underscore the need for comprehensive intervention strategies addressing PSU and associated risk behaviors. Rather than simply restricting smartphone use, educational approaches should focus on fostering self-management skills. Continuous monitoring in home and school environments, along with targeted interventions tailored to gender and educational level, is recommended. Future longitudinal research is necessary to examine the causal relationships between PSU and risk behaviors and to evaluate the effectiveness of intervention strategies.

Authors' contributions

HS analyzed and interpreted data regarding associations between PSU and risk behaviors, while making substantial contributions to manuscript development. YS conducted preliminary analyses and authored the literature review section, with YD providing significant input. YD contributed to manuscript revision and editing. All authors reviewed and approved the final manuscript.

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Data availability

All data used in this research are accessible through the Korea Youth Risk Behavior Web-based Survey database (<http://www.kdca.go.kr/yhs>).

Declarations**Ethics approval and consent to participate**

This study was conducted in accordance with relevant guidelines and regulations. Furthermore, the Institutional Review Board (IRB) of Woosuk University approved the survey (IRB No. WS-2022-05).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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