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RECEIVED 01 June 2024

ACCEPTED 30 August 2024

PUBLISHED 15 October 2024

## CITATION

Ko Y-M, Lee ES and Park S (2024) Prevalence, correlates, and comorbidities of internet gaming disorder and problematic game use: national mental health survey of Korea 2021. *Front. Psychiatry* 15:1442224. doi: 10.3389/fpsy.2024.1442224

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# Prevalence, correlates, and comorbidities of internet gaming disorder and problematic game use: national mental health survey of Korea 2021

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**Background:** This study investigated the prevalence, correlates, and comorbidities of Internet Gaming Disorder and problematic game use among the general population in Korea.

**Methods:** The data of 2,764 individuals aged 18 to 49 years who participated in the National Mental Health Survey of Korea 2021 were analyzed. The diagnostic assessments were based on the Structured Clinical Interview for Internet Gaming Disorder and the Composite International Diagnostic Interview. The Game Overuse Screening Questionnaire assessed problematic game use. Multiple logistic regression analyses were performed, and a complex sampling design analysis was applied.

**Results:** The 12-month prevalence rate of Internet gaming disorder (IGD) was 0.8% and the 1-month prevalence rate of problematic game use was 8.4%. IGD was higher in men, younger people, unemployed, and in those with low physical activity, dissatisfaction with their quality of life, and who perceived more loneliness and social isolation. While both alcohol use disorder (AUD) and Attention-Deficit/Hyperactivity Disorder (ADHD) were significantly associated with IGD, only ADHD was significantly associated with problematic game use.

**Conclusion:** IGD and problematic game use are relatively prevalent in the Korean adult population and are comorbid with AUD and ADHD. Therefore, a preventive strategy for IGD and problematic game use is needed for game users who are more likely to be addicted, such as younger male users. In addition, mental health screening and appropriate treatment for both game addiction and comorbid psychiatric disorders should be provided to individuals with IGD and problematic game use.

## KEYWORDS

internet gaming disorder, problematic game use, comorbidity, prevalence, attention-deficit/hyperactivity disorder

## 1 Introduction

In the current highly digitalized world, gaming represents not only a recreational activity, but also a potential threat when a game user loses with a sense of reality, substituting gaming for social, occupational, or other recreational activities (1). Internet gaming disorder (IGD), the repetitive use of Internet-based games that leads to significant impairment or distress, was deliberated in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) in Section III that was published in 2013, as a condition for further study (2). Gaming disorder was defined as a distinct nosological entity under the addictive disorders section of the 11<sup>th</sup> Revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-11) (3). However, the concept of IGD is still under debate as clinical data on symptoms of its ‘true’ addiction are lacking, negative consequences may be overemphasized, and Internet gaming could be related to inefficient strategies for dealing with life problems or other underlying mental health problems (4, 5).

Several studies have used instruments based on the DSM-5 to estimate the prevalence rates of problematic game use or game addiction. Rehbein et al. (6) reported a 1.2% prevalence rate in a school-aged population in Germany, and Lemmens et al. (7) found a 5.4% prevalence rate in a Dutch sample of adolescents and young adults. Using a web-based survey, Kim et al. (8) reported that 13.8% of the surveyed Korean adults aged 20–49 years met the DSM-5 criteria for IGD. More recently, Darvesh et al. (9) posited that the prevalence rates of IGD using the DSM-5 criteria varies from 0.21% to 57.5% in the general population. This wide gap between the prevalence rates might originate from differences in sample size, sample characteristics, and age range. For instance, the study using a large sample size of male adults among the general population indicated a low prevalence rate of IGD (10), while a small-scale observational study with online game players who were late teens and young adult males showed a higher prevalence rate (11). The prevalence rates of problematic game use ranged from 0.5 to 9.9%, with the variation attributed to the study population and the diagnostic instrument utilized (12). The prevalence rates of problematic game use in a large general population study varied among adolescents (7.6%), young adults (3.3%), and older adults (3.0%) (13).

Most studies have described a higher prevalence of IGD and problematic game use among young people than among the elderly, who are considered “age at risk” (14–16). Moreover, this prevalence is higher in males than females (14, 17, 18). Several psychological factors, personality traits, and psychological disorders are perceived to increase the risk of IGD (19). Impulsivity, poor self-control, and the pursuit of desired appetitive goals are psychological features associated with IGD (20). Gaming addiction has been reported to be significantly associated with loneliness (21) and low life satisfaction (22). IGD has been associated with loneliness, low self-worth, poor social skills, lack of social acceptance, dysfunctional coping, and psychopathology (23–25). Previous studies have also reported that psychological resilience reduces the effect of individual risk factors on addictive behaviors (26, 27).

A growing body of research suggests that gaming disorders are associated with several other mental health disorders, including

depression (28), anxiety (22, 29), problematic substance use (30), and personality disorders (31). Regarding psychiatric comorbidities, some studies have reported no differences in the prevalence of alcohol use disorder (AUD) between problematic game users and usual users; however, illicit drug use is prevalence in problematic game users (32, 33). Of the numerous psychiatric comorbidities of IGD, attention-deficit/hyperactivity disorder (ADHD) is considered the most frequent, due to its prevalence and conceptual overlap (5, 34–36). Yen et al. (36) identified the shared features of impulsivity and hostility in ADHD and IGD.

Because of the limited existing studies that use instruments that are based on the DSM-5 and representative samples, we investigated the prevalence of IGD and problematic game use and examined the correlates and comorbidities of a wide range of psychiatric disorders among a nationwide sample of Korean adults aged 18–49 years.

## 2 Methods

### 2.1 Sample

We examined the data from the National Mental Health Survey of Korea 2021 (NMHSK2021), which was conducted between June 19, 2021 and August 31, 2021. A nationally representative sample of non-institutionalized residents was selected. This study used a complex sample design, in which state(si)/province(do), *dong/eup/myeon*, and household type were used as stratification variables. The NMHSK2021 survey was used to measure the lifetime and 12-month prevalence of major psychiatric disorders and their association with sociodemographic characteristics and comorbidities among Korean adults according to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV). The survey encompassed participants aged between 18 and 79 years during the NMHSK 2021 study period, as per the Population and Housing Census. The interviews involved 13,530 households, with 5,511 participants completing the interviews (37). In this study, 2,764 participants who played internet/online games among people aged 18–49 years were used for the final analysis, following a prior study that indicated an increase in the prevalence of gaming disorder with young age (7, 8, 14, 22, 38–40).

This study was approved by the Institutional Review Board of the National Center for Mental Health (IRB No. 116271-2022-19).

### 2.2 Measurement

#### 2.2.1 Internet gaming disorder

The Structured Clinical Interview for DSM-5 Internet Gaming Disorder (SCI-IGD) tool was used to measure IGD. The SCI-IGD tool, consisting of 12 dichotomous questions, was developed by Koo, Han, Park, and Kwon (41) to diagnose IGD in accordance with DSM-5 diagnostic criteria and determine whether the 9-diagnostic criteria presented in DSM-5 are met. Cho et al. (42) verified the validity of the tool in adults. The diagnostic criteria of IGD in the DSM-5 comprises nine items: preoccupation, withdrawal, tolerance, unsuccessful attempts to control, loss of other interests, continued

excessive use despite psychosocial problems, deception during online gaming, escape, and functional impairment (41). Participants who responded “yes” to five or more of the criteria were considered positive (IGD) and others were classified as negative (normal internet game users) during the last year in the nine-diagnostic criteria.

### 2.2.2 Problematic game use

Problematic Game Use was assessed using the Game Overuse Screening Questionnaire (GOS-Q). The GOS-Q is a more comprehensive and definitive screening tool used to distinguish high-risk independent users associated with overuse of games (such as PC games, console games, smartphone games, internet/online games) from casual internet users. The GOS-Q comprises a 30-item questionnaire, and these 30 items are classified into six subscales (preoccupation, tolerance, impaired interpersonal domain, impairment in occupational or academic domain, loss of control, and loss of interest in other areas) (43). Respondents were asked to state the degree to which they had experienced symptoms in the past month through a 30 item-questionnaire (e.g., “I tried to reduce the amount of time I play games, but it is difficult”), using a four-point Likert scale (the four points were: not at all, sometimes, often, always) and with a total score ranging from 30 to 120 points. The Cronbach’s alpha of the GOS-Q was 0.96, and respondents who scored 38.5 points or more were considered high-risk indicators (43). This study classified participants who had not played any games within the last month or played games but scored less than 38.5 points in the GOS-Q as “negative” and those who scored 38.5 points or more as “positive”.

### 2.2.3 Psychiatric disorders

Psychiatric disorders were measured using the Korean version of the Composite International Diagnostic Interview 2.1 (CIDI) (44). The CIDI (45) is a fully structured diagnostic tool that diagnoses psychiatric disorders based on the DSM-IV (46). The lifetime and one-year prevalence of alcohol use, nicotine use, depression, and anxiety disorders were calculated and analyzed.

### 2.2.4 ADHD

We used the Adult ADHD Self-Report Scale-Version 1.1 (ASRS-v1.1) Screener (47) to screen adults with ADHD. The ASRS-v1.1 was developed by revising the WHO CIDI (48) for the WHO World Mental Health Survey Initiative (49). Each question in the ASRS-v1.1 Screener asks respondents to rate the frequency of a particular symptom of ADHD in the previous six months using a five-point Likert scale consisting of “never,” “rarely,” “sometimes,” “often,” and “very often.” The first three items were considered symptomatic if the respondents answered “sometimes,” “often,” or “very often,” and for the last three items, they were considered symptomatic if they answered “often” or “very often.” If respondents had symptoms for more than four of the six items, they were considered to have adult ADHD (50).

### 2.2.5 Socio-demographic characteristics

Self-reported questionnaires from the NMHSK 2021 were used to obtain information on socio-demographic characteristics. The

variables included gender (male/female), age (mean age), education (high school degree/lower/college degree/higher), employment (full-time/part-time/unemployed), and family income (below standard median income/above standard median income).

### 2.2.6 Physical activity

This study used the Korean version of the short form of the International Physical Activity Questionnaire (IPAQ), which measures health-related physical activity in populations (51). The reliability of the Korean version of the IPAQ was confirmed by the Spearman Rho coefficients 0.427 to 0.646 (median value 0.542) and the Kappa value 0.365 to 0.620 (median value 0.471) (52). Using this measure, this study assessed high-intensity activities, moderated activities, and walking hours, which were conducted for more than 10 minutes in the last 7 days, and the corresponding average duration in hours. Respondents’ activity levels were classified into three groups (low/intermediate/high).

### 2.2.7 Subjective and psychological characteristics

Quality of life was measured by asking, “How would you evaluate your quality of life?” Respondents answered “very bad,” “bad,” “not bad,” “good,” or “very good,” and classified the answer into “satisfaction” (not bad/good/very good) or “dissatisfaction” (very bad/bad).

Resilience was measured using the 10-item Connor-Davidson Resilience Scale (CD-RISC), which was extracted from the original 25-item CD-RISC (53). Reliability and validity of the 10-item Korean version of the CD-RISC were assessed, with the Cronbach’s alpha coefficient and test-retest reliability being 0.93 and 0.93, respectively (54). Each item was rated on a five-point Likert scale ranging from 0 (not true at all) to 4 (true nearly all the time). Total scores were obtained by summing all the responses and ranged from 0 to 40, with higher scores indicating greater resilience (55).

The Loneliness and Social Isolation Scale (LSIS) (56) was used to evaluate loneliness and social isolation. The scale consists of six self-reported items evaluated using three subscales: loneliness (two items), social support (two items), and social networks (two items) (56). Each item was rated on a four-point Likert scale ranging from 0 to 3. The greater the sum of each sub-factor, the more the loneliness, the less the social support, and the smaller the size of the social network perceived over the past month. Cronbach’s alpha for the LSIS was 0.774 (56).

## 2.3 Statistical analysis

A complex sample design was utilized for the statistical analyses. The Rao-Scott Chi-square test was performed to compare gender, educational status, employment status, family income, physical activity, and the quality of life among participants with IGD, problematic game users, and normal game users. A t-test was performed to compare the mean differences in age, resilience, and loneliness and social isolation among participants with IGD, problematic game users, and normal game users. Multivariate logistic regression analyses were performed to

calculate the odds ratios (ORs) and 95% confidence intervals (CIs) of the 12-month prevalence of psychiatric disorders and the 6-month prevalence of ADHD based on the presence of IGD and problematic game use. Moreover, adjusted ORs were calculated after correcting for sociodemographic, physical activity, and psychological variables that appeared significantly different among the groups (i.e., IGD vs. normal game users and problematic game users vs. normal game users). We used SPSS (version 26, SPSS; IBM Co., Armonk, NY, USA) to perform the statistical analyses, and a p-value less than 0.05 was considered significant.

### 3 Results

#### 3.1 Prevalence, correlates, and comorbidities of IGD

The estimated prevalence rate of IGD was 0.8% (22/2764). Participants with IGD were more likely male (p=0.003), had a lower mean age (p=0.001), were unemployed (p=0.018), had low physical activity (p<0.001), were dissatisfied with their quality of life

(p=0.002), and perceived more loneliness and social isolation (p=0.026) compared to the normal game users (Table 1).

AUD (OR 6.451, 95% CI 1.784–23.326), anxiety disorder (OR 3.533, 95% CI 1.038–12.022), and ADHD (OR 18.719, 95% CI 6.391–54.824) were significantly related to IGD. After adjusting for gender, age, employment, IPAQ, quality of life, and LSIS, AUD (OR 3.832, 95% CI 1.127–13.035) and ADHD (OR 12.320, 95% CI 2.583–58.757) were still significantly correlated with IGD, but there was no association between anxiety disorder and IGD (Table 2).

#### 3.2 Prevalence, correlates, and comorbidities of problematic game use

The estimated prevalence rate of problematic game use in the past month was 8.4% (232/2764). As shown in Table 3, the estimates for problematic game use were significantly higher among male participants (p<0.001), those who had a lower mean age (p<0.001), those who had a college degree or higher (p=0.002), the unemployed (p=0.001), those who had a higher family income (p=0.001), those with lower resilience (p=0.033), and those with perceived more loneliness and social isolation (p=0.037). AUD (OR

TABLE 1 Characteristics of subjects with and without IGD.

			IGD				
			Total (n=2,764) (n, weighted %)	Negative (n=2,742) (n, weighted %)	Positive (n=22) (n, weighted %)	Rao-Scott $\chi^2 / t$	p-value
Socio-demographic characteristics	Gender	Male	1,403 (51.6)	1,384 (51.3)	19 (85.7)	12.550	0.003
		Female	1,361 (48.4)	1,358 (48.7)	3 (14.3)		
	Age	Mean (S.E.)	34.64 (0.136)	34.70 (0.138)	28.23 (1.467)	3.435	0.001
	Education	High School degree or lower	977 (35.2)	968 (34.8)	9 (41.1)	0.411	0.591
		College degree or higher	1,787 (64.8)	1,774 (64.9)	13 (58.9)		
	Employment	Full-time	1,707 (61.2)	1,697 (61.4)	10 (37.8)	12.635	0.018
		Part-time	395 (13.3)	394 (13.3)	1 (6.8)		
		Unemployed	662 (25.5)	651 (25.2)	11 (55.3)		
	Family income	<Standard median income	1,069 (35.6)	1,061 (35.5)	8 (37.9)	0.063	0.834
		≥Standard median income	1,695 (64.4)	1,681 (64.5)	14 (62.1)		
Physical activity	IPAQ	Low	845 (29.6)	832 (29.2)	13 (69.4)	20.617	<0.001
		Intermediate	1,268 (47.8)	1,262 (48.0)	6 (23.4)		
		High	651 (22.6)	648 (22.8)	3 (7.2)		
Subjective & psychological characteristics	Quality of life	Dissatisfaction	850 (29.5)	837 (29.2)	13 (61.1)	12.970	0.002
		Satisfaction	1914 (70.5)	1905 (70.8)	9 (38.9)		
	Resilience	Mean (S.E.)	26.09 (0.222)	26.13 (0.223)	22.38 (1.474)	1.061	0.289
	LSIS	Mean (S.E.)	7.70 (0.092)	7.67 (0.091)	10.75 (1.236)	-2.231	0.026

IPAQ, International Physical Activity Questionnaire; LSIS, Loneliness and Social Isolation Scale.

2.020, 95% CI 1.077-3.790) and ADHD (OR 3.943, 95% CI 2.226-6.983) were significantly correlated with problematic game use. After adjusting for gender, age, education, employment, family income, resilience, and LSIS, ADHD was still significantly correlated with problematic game use (OR 5.546, 95% CI 2.828-10.876), but there was no association between AUD and problematic game use disappeared (Table 4).

## 4 Discussion

This study investigated the prevalence, correlates, and comorbidities of a wide range of psychiatric disorders of IGD and problematic game use in a nationally representative sample of Korean adults. We extended the findings of previous studies on IGD and problematic game use by using a nationwide sample of young adults and by applying the DSM-5 criteria for IGD and the GOS-Q.

The prevalence rate of IGD was 0.8% in our finding, which is like the rates reported in the United States and European countries (10). According to data from large international adult cohorts, the 6-month prevalence rates of IGD were estimated to be between 0.32% and 1.04% (10). On the other hand, the prevalence rate of 13.8% yielded by a previous Korean study (8) is much higher when compared to the rate from the current study. This variation may be due to the different sampling populations used in the two studies.

While our data were from a nationally representative sample that included the general population of Korean adults, Kim et al. (8) employed data from an online survey with inclusion criteria specifically targeting internet gamers in fact, a previous systematic review study has shown that the prevalence rate of IGD is higher among a sample of only gamers compared to a mixed sample of gamers and non-gamers (14). Additionally, the survey methods may also account for the differences in prevalence rates across studies (14). Online surveys tend to yield higher prevalence compared to other methods such as classroom, mail, or telephone surveys. Since the data used in our study was collected through face-to-face interviews as part of the NMHSK 2021, the prevalence rate in our study may be lower than those reported by Kim et al. (8).

Meanwhile, the prevalence rate of problematic game use was 8% in the current study, which is almost twice as low as the 2016 prevalence of 17.6% using the same measurement and cut-off point (38). This discrepancy in prevalence rates may be due to the different number of subjects (N=415) and age range (18–30 years old) in the previous research, as well as the gaming regulatory policies in Korea. In 2014, regulations were implemented for in-game purchases, particularly for online board games, to reduce overconsumption and prevent games from being used as a means of gambling (57). Given that the in-game purchases showed a significantly positive association with probable gaming disorder (58), it is plausible that consistent restriction of in-game purchases

TABLE 2 Odds ratios for psychiatric disorders among subjects with and without IGD.

		IGD								
		Total (n=2,764) (n, weighted %)	Negative (n=2,742) (n, weighted %)	Positive (n=22) (n, weighted %)	Unadjusted			Adjusted		
					OR	95% CI	p-value	OR	95% CI	p-value
Alcohol use disorder	Negative	2,678 (96.6)	2,659 (96.8)	19 (82.3)						
	Positive	86 (3.4)	83 (3.2)	3 (17.7)	6.451	1.784-23.326	0.005	3.832	1.127-13.035	0.032
Nicotine use disorder	Negative	2,680 (96.7)	2,660 (96.8)	20 (88.6)						
	Positive	84 (3.3)	82 (3.2)	2 (11.4)	3.932	0.884-17.497	0.072	1.863	0.474-7.317	0.373
Depressive disorder	Negative	2,722 (98.5)	2,702 (98.6)	20 (94.6)						
	Positive	42 (1.5)	40 (1.4)	2 (5.4)	3.926	0.640-24.081	0.139	1.431	0.239-8.551	0.694
Anxiety disorder	Negative	2,662 (96.5)	2,644 (96.6)	18 (89.0)						
	Positive	102 (3.5)	98 (3.4)	4 (11.0)	3.533	1.038-12.022	0.043	3.617	0.972-13.451	0.055
ADHD symptoms	Negative	2,702 (97.5)	2,686 (97.7)	16 (69.6)						
	Positive	62 (2.5)	56 (2.3)	6 (30.4)	18.719	6.391-54.824	<0.001	12.320	2.583-58.757	0.002

Adjusted OR adjusted for gender, age, employment, IPAQ, quality of life, and LSIS.

TABLE 3 Characteristics of subjects with and without problematic game use.

			Problematic Game Use				
			Total (n=2,764) (n, weighted %)	Negative (n=2,532) (n, weighted %)	Positive (n=232) (n, weighted %)	Rao- Scott $\chi^2 / t$	p-value
Socio- demographic characteristics	Gender	Male	1,403 (51.6)	1,224 (49.0)	179 (74.7)	66.796	<0.001
		Female	1,361 (48.4)	1,308 (51.0)	53 (25.3)		
	Age	Mean (S.E.)	34.64 (0.136)	35.35 (0.155)	28.38 (0.550)	9.840	<0.001
	Education	High School degree or lower	977 (35.2)	875 (34.0)	102 (45.7)	15.267	0.002
		College degree or higher	1,787 (64.8)	1,657 (66.0)	130 (54.3)		
	Employment	Full-time	1,707 (61.2)	1,568 (61.8)	139 (55.7)	20.768	0.001
		Part-time	395 (13.3)	372 (13.8)	23 (8.3)		
		Unemployed	662 (25.5)	592 (24.3)	70 (36.0)		
	Family income	<Standard median income	1,069 (35.6)	1,000 (36.7)	69 (25.9)	12.883	0.001
		≥Standard median income	1,695 (64.4)	1,532 (63.3)	163 (74.1)		
Physical activity	IPAQ	Low	845 (29.6)	755 (28.8)	90 (36.7)	7.761	0.078
		Intermediate	1,268 (47.8)	1,171 (48.2)	97 (43.9)		
		High	651 (22.6)	606 (23.0)	45 (19.5)		
Subjective & psychological characteristics	Quality of life	Dissatisfaction	850 (29.5)	778 (29.7)	72 (27.8)	0.440	0.606
		Satisfaction	1,914 (70.5)	1,754 (70.3)	160 (72.2)		
	Resilience	Mean (S.E.)	26.09 (0.222)	26.26 (0.227)	24.57 (0.570)	2.131	0.033
	LSIS	Mean (S.E.)	7.70 (0.092)	7.66 (0.095)	8.08 (0.256)	-2.094	0.037

IPAQ, International Physical Activity Questionnaire; LSIS, Loneliness and Social Isolation Scale.

may have contributed to the decrease in problematic game use prevalence.

Compared to normal use, IGD and problematic game use were more prevalent in males than in females (14, 17, 18). Darvesh et al. (9) reviewed 160 studies that used 35 different methods to diagnose IGD; these studies, conducted in general, clinical, and severe populations, highlighted prevalence rates of 0.21–57.5% for males in the general population who were not undergoing treatment for IGD. Most studies have described a higher prevalence of IGD and problematic game use among young people than among the elderly, with an “age at risk” (14–16). Consistent with prior findings, participants with IGD were more likely to be unemployed (59), have lower physical activity, and be dissatisfied with their quality of life (14, 22). Loneliness and social isolation were found to be higher with both IGD and problematic game use than in normal use (60–62); this phenomenon was particularly noticeable with IGD. In addition, problematic game users showed lower resilience than normal game users. This may be because socially isolated and less resilient people cope by indulging in games rather than social activities (63–65). Further, participants with problematic game use had higher education levels. These findings were inconsistent with those from earlier studies (39, 66). Another study found game addiction to be independent of educational background (21, 67) and

there were no significant differences (38). However, a medium or high education level showed a significant positive association with excessive computer game playing among Norwegian adults (68). Meanwhile, in this study, a group with high family income showed an association with problematic game use. In a systematic literature review study by Kuss et al. (69), high household income in the youth population group was related to internet addiction, and in a study by Ju et al. (70), the internet use index was significantly related to income level. The lower the income group, the lower the probability of accessing the internet at home, and the higher the probability of access at high income. Therefore, there is a gap in internet use according to income level. There is a paucity of up-to-date studies on problematic game use and socio-economic status based on young adults. More research is needed to identify the sociodemographic factors relevant to the risk of developing gaming disorder through longitudinal data.

Previous studies (4, 30, 71, 72) stated that IGD was associated with an increased prevalence of AUD. This association between IGD and AUD may be attributed to several shared psychological features, including dysfunctional impulsivity, limited capacity for self-control, excessive anxiety, and severe psychopathological impairment (30, 73). Evidence supports the co-occurrence of addiction for both substances and behaviors, in particular, the

TABLE 4 Odds ratios for psychiatric disorders among subjects with and without problematic game use.

		Problematic Game Use								
		Total (n=2,764) (n, weighted %)	Negative (n=2,532) (n, weighted %)	Positive (n=232) (n, weighted %)	Unadjusted			Adjusted		
					OR	95% CI	p-value	OR	95% CI	p-value
Alcohol use disorder	Negative	2,678(96.6)	2,461(96.9)	217(94.0)						
	Positive	86(3.4)	71(3.1)	15(6.0)	2.020	1.077-3.790	0.029	1.358	0.684-2.699	0.381
Nicotine use disorder	Negative	2,680(96.7)	2,458(96.9)	220(95.5)						
	Positive	84(3.3)	74(3.1)	10(4.5)	1.450	0.685-3.067	0.331	0.962	0.417-2.221	0.928
Depressive disorder	Negative	2,722(98.5)	2,497(98.6)	225(98.2)						
	Positive	42(1.5)	35(1.4)	7(1.8)	1.259	0.498-3.184	0.626	1.347	0.398-4.562	0.631
Anxiety disorder	Negative	2,662(96.5)	2,443(96.7)	219(95.3)						
	Positive	102(3.5)	89(3.3)	13(4.7)	1.425	0.720-2.822	0.309	1.641	0.740-3.642	0.223
ADHD symptoms	Negative	2,702(97.5)	2,487(98.0)	215(92.6)						
	Positive	62(2.5)	45(2.0)	17(7.4)	3.943	2.226-6.983	<0.001	5.546	2.828-10.876	<0.001

Adjusted OR adjusted for gender, age, education, employment, family income, resilience, and LSIS.

presence of a behavioral addiction increases the propensity for addiction to develop other behaviors (74). This may create a cycle of reciprocity, wherein mutual exacerbation occurs between two or more problematic behaviors (75, 76). Na et al. (30) surveyed South Korean adults (n=1,819) online and found that 21% experienced both problematic alcohol use and problematic game use. Our results revealed a significant association between AUD and IGD, a more severe condition than problematic game use.

The findings suggested that ADHD is the most frequent psychiatric comorbidity of IGD and problematic game use (5, 34–36). Recent cross-sectional studies with community samples found that ADHD symptoms were closely associated with IGD symptoms (77–80). Many studies have reported psychiatric comorbidities and a conceptual overlap between gaming disorder and ADHD in terms of clinical and biological aspects (34, 35, 81, 82). ADHD features such as impulsivity, low self-esteem, hyperactivity, and inattentiveness can contribute to the development of IGD (83). Several community-based longitudinal studies indicated that ADHD was a predictor of the development of IGD and problematic game use (84–86). Lee et al. (5) showed that ADHD comorbidity was associated with a more chronic course of IGD, with lower rates of recovery and higher rates of recurrence. In a longitudinal clinical cohort study, Han et al. (87) investigated 755 patients with IGD over five years and found that the comorbid condition of ADHD was one of the key predictive factors for long-

term recovery from IGD. In a three-year clinical cohort study, ADHD comorbidity predicted a poor clinical course of IGD, wherein changes in ADHD symptoms were associated with alterations in IGD symptoms (33). ADHD and IGD share similar biological features (81, 82, 88). Several resting-state functional magnetic resonance imaging (MRI) studies on the shared conditions between ADHD and IGD illustrated diminished functional connectivity within the attentional network and cortico-subcortical circuits (81, 82). Furthermore, Han et al. (88) conducted a one-year longitudinal study of IGD and ADHD subjects and reported similar changes in functional connectivity between the cortex and subcortex in response to treatment. Due to high comorbidity and the negative impact of ADHD symptoms on the course of IGD, patients with IGD and problematic game use require clinical attention as a high-risk group as well as extensive management for their mental difficulties.

The strengths of this study are as follows: This study is the first in Korea to measure the prevalence, correlation, and comorbidities by using DSM-5 internet game disorder diagnostic criteria and a tool to screen for game addiction among the adult general population via nationally representative data. Moreover, the data used in this study, well-trained interviewers collected through face-to-face interview with participants. The limitations of this study were as follows. First, due to its cross-sectional design, this study could not determine causality among variables. For instance, our

data could not explain how psychiatric comorbidities contributed to IGD and problematic game use or, conversely, how addictive symptoms affected the progression of other psychiatric symptoms. Second, our data focused on the Korean adult population, thereby excluding the adolescent population. Given that IGD and problematic game use are more prevalent and severe among adolescents (89), our results may not fully reflect the magnitude of the gaming addiction problem in Korea. Last, our results, obtained from a Korean sample, may have been influenced by social and cultural environment characteristics.

## 5 Conclusion

Our results revealed that IGD and problematic game use are relatively prevalent in the Korean adult population and are highly comorbid with AUD and ADHD. Therefore, a preventive strategy for IGD and problematic game use is needed for game users who are more likely to be addicted, such as being younger and male. In addition, mental health screening and appropriate treatment for both game addiction and comorbid psychiatric disorder are required for individuals with IGD and problematic game users.

## Data availability statement

The data analyzed in this study is subject to the following licenses/restrictions: Raw data were generated at National Center for Mental Health. Derived data supporting the findings of this study are available from the corresponding author SP on request.

## Ethics statement

The studies involving humans were approved by Institutional Review Board of the National Center for Mental Health (IRB No. 116271-2022-19). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

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Y-MK: Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. EL: Investigation, Methodology, Writing – review & editing. SP: Conceptualization, Data curation, Project administration, Supervision, Writing – original draft, Writing – review & editing.

## Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. This research was supported by National Center for Mental Health R&D Project, Republic of Korea (grant number: MHIR22A02).

## Acknowledgments

The authors would like to thank the interviewers and those who participated in the National Mental Health Survey of Korea 2021.

## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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