Associations between game use and mental health in early adulthood: A nationwide study in Korea

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ABSTRACT

Background: : The number of digital game users is increasing, and so is attention to digital gaming's effects on mental health. We aimed to reveal if risky (game addiction) and usual game use (non-risky) are associated with mental health in early adulthood.

Methods: : Using data from the nationwide cross-sectional Korean Epidemic Catchment Area study for psychiatric disorders, 415 participants aged 18–30 years were divided into "non-game," "usual game," and "risky game" user groups based on the previous month's game use and cut-off value of game overuse screening questionnaire. Multiple linear and logistic regressions revealed the association between game use groups, perceived mental health, and lifetime prevalence of clinical mental disorders including suicidal ideation.

Results: : Among the 415 participants, 167 were non-game users, 175, usual game users, and 73, risky game users. Risky game users self-reported decreased satisfaction and happiness, and a significantly higher lifetime prevalence of major depressive disorder, alcohol dependence, and suicidal ideation. Usual game users were significantly associated with higher lifetime prevalence of alcohol dependence and suicidal ideation. Self-reported happiness partially mediated between game use and lifetime suicidal ideation in risky, but not usual game users.

Limitations: : This study is a cross-sectional observational study which was not possible to define the temporal relationship.

Conclusions: : Both risky and usual game use are associated with mental health problems in early adulthood, indicating the need for careful mental health screening on not only risky game users but also usual game users.

1. Introduction

As the Internet and mobile environments proliferated worldwide, the use of the Internet, smartphones or console games increased rapidly in adolescents and young adults (Gentile, 2009). In previous studies, games based on new technology were collectively referred to as "digital games." Further, "digital game addiction" was defined as "excessive and compulsive use of computers or video games resulting in social and/or emotional problems; despite these problems, the gamer is unable to control this excessive use" (Lemmens et al., 2009). Digital game addiction has different operational definitions and research methods, but it was reported to be 0.6–15% in adolescents and young adults (Desai

et al., 2010; Gentile, 2009; Poli and Agrimi, 2012; Van Rooij et al., 2011). Significant associations of digital game addiction were reported with loneliness (Wack and Tantleff-Dunn, 2009), low life satisfaction (Mentzoni et al., 2011), depression (Mentzoni et al., 2011), aggressive behavior (Anderson and Carnagey, 2009), anxiety (Mentzoni et al., 2011), violent tendency (Williams et al., 2011), decreased positive social behavior (Greitemeyer and Mügge, 2014), and attention deficit (Gentile, 2009). Accordingly, the importance of screening and early intervention of digital game addiction is increasing in terms of public mental health promotion (Saunders et al., 2017). However, limited engagement in digital game use has benefits such as emotional discharge and relief (Green and Bavelier, 2003; Prot et al., 2014). Additionally, some previous studies showed that digital game use increased self-confidence and was helpful in problem solving (Green and Bavelier, 2003; Griffiths, 2005). Previous results reported that the use of digital games was not significantly related to school grades (Wack and Tantleff-Dunn, 2009). Therefore, evaluation of mental health outcomes by dividing digital game users into "addiction risk users" and "non-addiction risk users" is needed.

The aim of this study was to investigate the relationship between the digital game use and subjective perceived mental health, clinically diagnosed mental illness, and suicidal ideation in early adulthood using the results of a national psychiatric epidemiologic study conducted in Korea in 2016.

2. Materials and methods

2.1. Participants

The Korean Epidemic Catchment Area study for psychiatric disorders (KECA)−2016, a nationally representative survey on psychiatric disorders in Korea, was conducted from April–November 2016. We employed the following stratified multistage cluster sampling method to select respondents, based on the 2010 census of population and housing data in Korea: (1) A total of 21 community catchment areas based on municipalities (Si/Gun/Gu in Korean) were selected as primary sampling units (PSUs) according to the population size of each division and accessibility to research centers, (2) The representative secondary sampling units (SSUs) were selected from the PSUs based on administrative regions (Eup/Myeon/Dong in Korean), (3) 645 representative clusters of tertiary sampling units (TSUs), which were about one-thirtieth (1/30) of the size of Eup/Myeon/Dong were chosen according to population census in 2010, (4) Two "chunks" (quarter sampling units, QSUs) composed of 24 households were randomly selected from each TSUs, and (5) Finally, a segment (the ultimate sampling units, USUs) including four households was chosen from each chunk via random sampling. Based on these samples, one person per household was randomly selected and interviewed (Lee et al., 2020; Park et al., 2020; Woo et al., 2019). Target sample size was determined after reflecting on the prevalence rates of major psychiatric disorders in previous KECA studies (Cho et al., 2007; Park et al., 2015). Ultimately, a total of 5102 respondents aged 18 or above completed face-to-face interviews. Among them, young adults aged 18–30 years, an age range with more prevalent game use than other age groups, were selected as final participants for this study. A total of 415 participants responded to whether they used games during last month and completed the game overuse screening questionnaire.

2.2. Assessment of sociodemographic variables

We collected data on the following sociodemographic variables via interview: age (years), gender, years of education, area of residence (urban/rural), monthly household income (under 3000 thousand won/ over 3000 thousand won), and the presence of at least one comorbid disorders (diabetes mellitus, hypertension, hyperlipidemia, stroke, cardiac disease, and cancer).

2.3. Ethics statement

All procedures of the study protocol were approved by the Institutional Review Board of Samsung Seoul Hospital permitted this study (approval No. 2016–05–014). All participants were fully informed of the study objectives and written consent was obtained from them.

2.4. Assessment of game use (Game overuse screening questionnaire, GOS-Q)

In this study, the game overuse screening questionnaire (GSO-Q) was used to define the risk group for digital game addiction. The GOS-Q is a 30 item-questionnaire, with 1, 2, 3, and 4 points per question (not at all, sometimes, frequently, and always) with a total score ranging from 30 to 120 points. The Cronbach alpha of questionnaire was 0.96 which is considered as "excellent," and the item-total correlations (r) were good, in the range of 0.47–0.82. Taking the ROC analysis as the gold standard, clinical diagnoses were confirmed by two clinical psychologists and one psychiatrist considering the symptoms related to addiction (tolerance, withdrawal, control failure, impairment of daily life functions, conflict with others related to use, usage, health problems, subjective discomfort, etc.). The area under the curve (AUC) value was 0.945. The high-risk addiction group was effectively characterized with a sensitivity of 0.828 and specificity of 0.82 at the cut-off point of 38.5 (Baek et al., 2020).

This study classified participants who did not play games at all in the past month as "non-users," those who played games but scored less than 38.5 points in the GSO-Q as "usual users," and those who scored 38.5 points or more as "risky game users."

2.5. Assessment of perceived satisfaction and happiness

Twelve questions used in the Gallup World poll (Gallup Inc,2008) and European Social survey (European Social Survey, 2012), were applied to evaluate the subjective perceived satisfaction and happiness (Questions: 1–12). Question 1, 2 and 3 range from 0 (extremely dissatisfied) to 10 points (extremely satisfied). Question 1 is "Considering overall satisfaction with life, from zero to ten, where do you personally feel at this time, assuming that the higher score the better you feel about your life, and the lower score the worse you feel about it?", Question 2 is "Are you satisfied with the freedom to choose what you do with your life?", and Question 3 is "Are you satisfied with your personal health?". Question 4′s a), b), and c) ask about the level of life now, 5 years ago, and 5 years later respectively, with this statement "Please imagine a ladder with steps numbered from 0 at the bottom to 10 at the top. The top of the ladder represents the best possible life for you and the bottom, the worst possible life for you. (a) On which step of the ladder would you say you personally feel you stand at this time?; (b) On which step do you think you stood about five years ago?; and (c) On which step do you think you will stand about five years from now?". Question 5 is rated from No days (0 points) to 7 days (7 points) as the question asks, "how many of the last 7 days you were physically active continuously for 20 min or longer?". Question 6 is, "How often do you meet socially with friends, relatives, and work colleagues?" and is rated from never (1 point) to every day (7 points). Question 7 is rated as Not at all (0 points) to completely (6 points) to the question "To what extent do you provide help and support to people you are close to when they need it?". Question 8 is rated as "To what extent do you learn new things in your life?", with not at all (0 points) to a great deal (6 points). Question 9 asks, "On a typical day, how often do you take notice of and appreciate your surroundings?" and is rated as never (0 points) to always (10 points). Question 10 is rated as extremely unhappy (0 points) to extremely happy (10 points) to the question, "Taking all things together, how happy would you say you are?". Question 11 is rated from not at all (0 points) to completely (10 points) to the question, "To what extent do you receive emotional help and support from people you are close to when

you need it?". Question 12 is rated from not at all (0 points) to completely (10 points) to the question, "To what extent do you receive material help and support from people you are close to when you need it?"

2.6. Assessment of clinical psychiatric disorders and suicidal ideation

We defined clinical diagnoses of psychiatric disorders according to the DSM-IV criteria (American Psychiatric Association, 1994). The Korean version of the Composite International Diagnostic Interview 2.1 (K-CIDI) was used as diagnostic interview in the KECA-2016. The K-CIDI is a structured and standardized diagnostic tool translated into Korean in accordance with the WHO guidelines. The K-CIDI has shown high reliability and validity in a previous study (Cho et al., 2002). Clinical psychiatric disorders were diagnosed and grouped as psychotic disorders (delusional disorder, brief psychotic disorder, schizoaffective disorder, schizophreniform disorder, and schizophrenia), mood disorders (bipolar disorder, dysthymic disorder, and major depressive disorder), nicotine use disorders (nicotine withdrawal and nicotine dependence), anxiety disorders (post-traumatic stress disorder, generalized anxiety disorder, specific phobia, agoraphobia, panic disorder, social phobia, and obsessive-compulsive disorder), and alcohol use disorders (alcohol dependence and alcohol abuse). Lifetime and 1-year prevalence of abovementioned disorders were evaluated

We also assessed information about suicidal ideation, behavior, and attempt using the modified Suicide Prevention Multisite Intervention Study on Suicidal Behaviors, developed by the WHO (Bertolote et al., 2005). All participants were asked three main questions to evaluate suicidality: (1) "Have you ever seriously thought about committing suicide?" (lifetime suicidal ideation); (2) "Have you ever made a plan for committing suicide?" (lifetime suicide plan); (3) "Have you ever attempted suicide?" (lifetime suicide attempt).

We used the lifetime prevalence of major depressive disorder (MDD), alcohol dependence, and suicidal ideation as the main dependent variables.

2.7. Statistical analysis

Age, education years, GOS-Q score, and DS 1–12 questionnaire scores were continuous variables; the means of each game use group were compared by one-way ANOVA tests and were followed by post hoc analyses with Bonferroni correction. Sex, monthly income, comorbidity, region, lifetime MDD prevalence, lifetime alcohol dependence prevalence, and lifetime suicidal ideation were categorical variables, whose proportions in each game use group were compared by the Chi-square test; post hoc analyses with Bonferroni correction were also performed.

Next, in order to study the association between game users and perceived satisfaction and happiness (DS 1–12), the groups (non-users, usual users, risky users) were dummy transformed with "non-users" as a reference. Then, the groups were inserted as independent variables, and linear regression analyses were performed using DS 1–12 as dependent variables, respectively. At each regression analysis, time, sex, age, education, region, comorbidity, and income were adjusted. After that, to see the association between the game use group (dummy transformed) and the lifetime prevalence of MDD, alcohol dependence, and suicidal ideation, logistic regression analyses were performed using the latter as dependent variables, respectively. Sex, age, education, region, comorbidity, and income were also used as correction variables for each regression analysis.

When the game use group was divided by 38.5 as cut-off point, the risky game group was 17.6% (74/415), which was relatively higher than the general prevalence of game addiction, that is, is, 0.6–15% (Desai et al., 2010; Gentile, 2009; Poli and Agrimi, 2012; Van Rooij et al., 2011), as suggested in previous epidemiological studies. Therefore, by applying 46 points corresponding to upper 5.2 percentile as a new cut-off point, sensitivity analyses were performed, repeating the abovementioned

procedure by dividing participants into "addicted game users" (46 points or more) and "non-addicted game users" (less than 46 points). From the results of regression analyses, both usual and risky game users were associated with a high prevalence of suicidal ideation, whereas DS 10 (perceived happiness) had a significant association only with risky game users. Hence, a mediation analysis was performed to determine whether DS 10 mediated between the game use group and suicidal ideation, and if so, whether the mediation effect differs between usual game users and risky game users.

Statistical analysis was conducted using IBM SPSS Statistics for Windows, Version 24.0 (Armonk, NY: IBM Corp.) except mediation analysis, which was performed using R Statistical Software (version 4.0.4; R Foundation for Statistical Computing, Vienna, Austria).

3. Results

3.1. Demographic and clinical characteristics

The demographic and clinical variables of non-game users, usual game users, and risky game users are presented in Table 1. Among the three groups, no significant differences in age, education, comorbidity, and region were found, but there were significant differences in gender (male percentage: risky game user > usual game user > non-game user) and low-income percentage (non-game user < usual game user, non-game user < risky game user). There were significant differences in the lifetime prevalence of MDD (risky game user > non-game user), alcohol dependence (risky game user > non-game user, usual game user > non-game user), and suicidal ideation (risky game user > non-game user, usual game user > non-game user). Among the self-report questionnaire scores of DS 1–12, significant differences were seen in freedom satisfaction (usual game user > risky game user), happiness (non-game user > risky game user, usual game user > risky game user), emotional support (usual game user > risky game user), and life support (no significant differences in post hoc analysis).

3.2. Associations between gaming habits and perceived mental health

In an analysis to observe the effect of the difference between the groups divided according to GSO-Q score on perceived mental health, risky game users were significantly lower than non-users in freedom satisfaction ($\beta=-0.017$, $p = 0.042$), health satisfaction ($\beta=-0.117$, $p = 0.042$), current life stage ($\beta=-0.131$, $p = 0.021$), life stage after 5 years ($\beta=-0.126$, $p = 0.025$), physical activity ($\beta=-0.116$, $p = 0.045$), and happiness ($\beta=-0.147$, $p = 0.010$). On the other hand, usual game users did not report significantly low scores on perceived mental health compared to non-game users. However, actual life support item scores was higher in both usual ($\beta=0.129$, $p = 0.020$) and risky game users ($\beta=0.134$, $p = 0.017$) than in non-game users (Table 2).

3.3. Associations between game use group and clinical mental disorders

Comparison of lifetime prevalence of clinical diagnosis (MDD, alcohol dependence) and suicidal ideation according to the game use group showed that the prevalence of risky users was significantly higher than that of non-game users in MDD (OR=4.150 [1.433–12.022], $p = 0.009$), alcohol dependence (OR=3.151 [1.181–8.042], $p = 0.022$), and suicidal ideation (OR=2.551 [1.166–5.579], $p = 0.019$). In usual game users, the prevalence of MDD (OR=2.403 [0.953–6.056], $p = 0.063$) was not significantly higher than that of non-users, but the prevalence of alcohol dependence (OR=2.879 [1.232–6.729], $p = 0.015$) and suicidal ideation (OR=2.501 [1.338–4.675], $p = 0.004$) was significantly higher than that of non-game users (Table 3).

Table 1

Demographic and clinical characteristics of participants.

Variables	All (n = 415)	non game user (n = 165)	Usual game user (n = 177)	Risky game user (n = 73)	p value
Age (years): Mean ± SD (18–30)	23.95 ± 3.315	24.28 ± 3.444	23.81 ± 3.321	23.52 ± 2.954	0.208
Sex: Male, n(%)	205 (49.4%)	48 (29.1%)	102 (57.6%)	55 (75.3%)	<0.001
Education (years): Mean ± SD	14.49 ± 2.129	14.37 ± 2.511	14.62 ± 1.771	14.47 ± 1.987	0.562
Monthly Income: <3000 thousands won, n(%)	208 (50.2%)	65 (39.4%)	99 (47.6%)	44 (60.3%)	0.001
Comorbidity Positive, n(%)	21 (5.1%)	6 (3.6%)	10 (5.6%)	5 (6.8%)	0.519
Region: Urban, n (%)	345 (83.3%)	139 (84.8%)	143 (80.8%)	63 (86.3%)	0.466
GOS-Q score	36.69 ± 7.793	–	32.85 ± 2.646	45.95 ± 8.318	<0.001
MDD whole life, n (%)	37 (9.0%)	8 (4.9%)	18 (10.2%)	11 (15.1%)	0.030
Alcohol dependence whole life, n(%)	53 (12.9%)	8 (4.9%)	30 (17.1%)	15 (20.5%)	<0.001
Suicidal idea whole life, n(%)	81 (19.6%)	19 (11.7%)	44 (24.9%)	18 (24.7%)	0.004
Q 1 (satisfaction of life): Mean ± SD	6.54 ± 1.776	6.55 ± 1.819	6.62 ± 1.790	6.32 ± 1.640	0.473
Q 2 (satisfaction of freedom): Mean ± SD	6.88 ± 2.061	6.77 ± 2.114	7.20 ± 1.960	6.38 ± 2.079	0.011
Q 3 (satisfaction of health): Mean ± SD	6.80 ± 2.049	6.95 ± 1.914	6.80 ± 2.138	6.48 ± 2.115	0.271
Q 4 (level of life): Current Mean ± SD	6.39 ± 1.731	6.51 ± 1.755	6.45 ± 1.722	5.99 ± 1.662	0.083
5 years ago	6.02 ± 2.137	6.22 ± 2.028	6.01 ± 2.173	5.62 ± 2.252	0.127
5 years after	7.78 ± 1.744	7.94 ± 1.706	7.77 ± 1.820	7.42 ± 1.607	0.110
Q 5 (physical activity): Mean ± SD	3.37 ± 2.406	3.50 ± 2.475	3.34 ± 2.350	3.18 ± 2.400	0.623
Q 6 (social activity): Mean ± SD	5.03 ± 1.422	4.82 ± 1.431	5.15 ± 1.339	5.22 ± 1.548	0.050
Q 7 (the tendency to help others): Mean ± SD	4.71 ± 1.056	4.84 ± 1.035	4.86 ± 1.068	4.55 ± 1.055	0.105
Q 8 (interests about learning): Mean ± SD	4.43 ± 1.259	4.50 ± 1.132	4.43 ± 1.387	4.29 ± 1.215	0.506
Q 9 (feeling of gratitude): Mean ± SD	7.52 ± 1.850	7.60 ± 1.859	7.57 ± 1.747	7.21 ± 2.055	0.283
Q 10 (happiness): Mean ± SD	7.09 ± 1.684	7.18 ± 1.745	7.22 ± 1.584	6.56 ± 1.700	0.012
Q 11 (emotional support): Mean ± SD	6.95 ± 1.989	6.92 ± 2.045	7.18 ± 1.960	6.48 ± 1.864	0.038
Q 12 (life support): Mean ± SD	6.73 ± 2.232	6.38 ± 2.364	6.92 ± 2.160	7.04 ± 2.017	0.033

*Footnote: continuous variables were represented as Mean ± SD, while categorical variables were represented as number (%).
Abbreviations: GOS-Q (Game overuse screening questionnaire).

3.4. Mediation effect of perceived happiness between game use group and suicidal ideation

Results indicated that risky game users had significantly lower happiness and higher suicide prevalence, whereas usual game users did not have significantly lower happiness, but had higher suicide prevalence. Therefore, mediation analysis was conducted to check for a difference in the mediation effect, in that the decrease in happiness level mediates suicide prevalence in the two groups. As a result, in risky game

Table 2

Association between game use group and perceived mental health.

Dependent variables	Independent variables	B	β	p value
Q 1: satisfaction of life	Usual game user	−0.112	−0.031	0.577
	Risky game user	−0.481	−0.103	0.069
Q 2: satisfaction of freedom	Usual game user	0.255	0.061	0.279
	Risky game user	−0.632	−0.117	0.042
Q 3: satisfaction of health	Usual game user	−0.315	−0.076	0.176
	Risky game user	−0.706	−0.131	0.021
Q 4: level of life Current	Usual game user	−0.125	−0.036	0.519
	Risky game user	−0.570	−0.126	0.025
5 years ago	Usual game user	−0.264	−0.061	0.273
	Risky game user	−0.585	−0.105	0.065
5 years after	Usual game user	−0.188	−0.053	0.349
	Risky game user	−0.522	−0.114	0.049
Q 5: physical activity	Usual game user	−0.420	−0.086	0.129
	Risky game user	−0.728	−0.116	0.045
Q 6: social activity	Usual game user	0.060	0.021	0.699
	Risky game user	0.005	0.001	0.981
Q 7: the tendency to help others	Usual game user	−0.202	−0.095	0.100
	Risky game user	−0.309	−0.112	0.055
Q 8: interests about learning	Usual game user	−0.047	−0.018	0.750
	Risky game user	−0.197	0.060	0.309
Q 9: feeling of gratitude	Usual game user	−0.086	−0.023	0.687
	Risky game user	−0.455	−0.094	0.106
Q 10: happiness	Usual game user	0.002	0.001	0.992
	Risky game user	−0.647	−0.147	0.010
Q 11: emotional support	Usual game user	0.300	0.075	0.186
	Risky game user	−0.312	−0.060	0.295
Q 12: life support	Usual game user	0.582	0.129	0.020
	Risky game user	0.786	0.134	0.017

*Foot note: 3 Game use groups were added as dummy independent variable putting 'non game user' as reference group.
'B' means unstandardized regression coefficient, while 'β' means standardized regression coefficient.
Adjusted by Sex, Age, Education, Region, Comorbidity and Income.

Table 3

Association between game use group and clinical mental outcomes.

Dependent variables	Independent variables	B	OR(95% CI)	p value
Lifetime prevalence of MDD	Usual game user	0.877	2.403 (0.953—6.056)	0.063
	Risky game user	1.423	4.150 (1.433—12.022)	0.009
Life time prevalence of Alcohol dependence	Usual game user	1.058	2.879 (1.232—6.729)	0.015
	Risky game user	1.148	3.151 (1.181—8.042)	0.022
Life time prevalence of Suicidal idea	Usual game user	0.917	2.501 (1.338—4.675)	0.004
	Risky game user	0.936	2.551 (1.166—5.579)	0.019

*Foot note: 3 Game use groups were added as dummy independent variable putting 'non game user' as reference group.
Adjusted by Sex, Age, Education, Region, Comorbidity and Income.
Abbreviations: MDD (Major depressive disorder).

users, perceived happiness mediated between game user group and suicidal ideation ($p = 0.002$), while in usual group, it did not ($p = 0.162$). (Table 4)

3.5. Associations between mental health (perceived mental health & clinical outcome) and addicted game users (Sensitivity analysis)

In the sensitivity analysis that defined the addicted game users (the upper 5.2 percentile of the game habit questionnaire scores) by the new cut-off score (46 points), the addicted game users scored significantly lower than non-users in health satisfaction (β=−0.148, $p = 0.004$), current life stage (β=−0.107, $p = 0.036$), life stage after 5 years

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Table 4
Mediation effect of perceived happiness between game use group and life time prevalence of suicidal idea.

Group	Pathway	B	p	OR (95% CI)	p
Usual game user	Direct effect	0.091	0.016	1.095 (1.021–1.175)	0.016
	Indirect effect	−0.012	0.162	0.988 (0.969–1.001)	0.162
	Total effect	0.078	0.034	1.081 (1.004–1.165)	0.034
Risky game user	Direct effect	0.019	0.804	1.019 (0.923–1.125)	0.804
	Indirect effect	0.032	0.002	1.032 (1.010–1.056)	0.002
	Total effect	0.051	0.406	1.052 (0.947–1.169)	0.406

* Direct effect: Game use group → Lifetime suicide prevalence.
* Indirect effect: Game use group → Perceived happiness → Lifetime suicide prevalence.
* Adjusted by Sex, Age, Education, Region, Comorbidity and Income.

(β=−0.150, p = 0.004), and happiness level (β=−0.148, p = 0.005) Further, the newly defined non-addicted game users scored significantly lower in health satisfaction (β=−0.108, p = 0.045) and physical activity (β=−0.107, p = 0.050) than non-game users, while their life support was higher. (β=0.136, p = 0.010) (Table 5)

Additionally, the lifetime prevalence of MDD (OR=7.702 [2.125—27.911], p = 0.002), alcohol dependence (OR=3.853 [1.043—14.227], p = 0.043), and suicidal ideation (OR=6.610 [2.156—17.598], p = 0.001) in addicted game users were higher than in non-game users; and this trend was also observed for the non-addicted game users. When comparing the effect size (odds ratio) of the two (addicted vs non addicted) groups, the differences in MDD (2.622 versus 7.702) and suicidal ideation (2.475 versus 6.610) scores were more pronounced than that in the alcohol dependence scores (3.076 versus 3.853) (Table 6).

4. Discussion

In this study, risky game users had significantly lower subjective satisfaction and happiness compared to non-game users. Moreover, risky game users had a significantly higher prevalence of MDD, alcohol dependence, and suicidal ideation. Usual game users, unlike risky game users, did not have significantly lower subjective satisfaction and happiness compared to non-game users. However, the prevalence of MDD and suicidal ideation in this group was significantly higher. Mediation analysis showed that subjective happiness mediated suicidal ideation in risky game users, but not in usual game users.

Previous studies mainly focused on the side effects of excessive engagement in digital games with respect to "game addiction" (Charlton and Danforth, 2007; Desai et al., 2010; Lemmens et al., 2009). Results reported that proper digital game use relieves stress and has beneficial effects (Green and Bavelier, 2003; Prot et al., 2014). Contrastingly, in this study, "usual game users" who did not exceed the cut-off in the game overuse screening scale also showed higher alcohol dependence and suicidal ideations than non-game users. We can hypothesize on why alcohol dependence and suicidal ideation are higher in usual game users than non-game users. Although subjective unhappiness or clinical depression of usual game users may not be evident, they might be more impulsive or have more prominent obsessive tendencies, a trait vulnerable to addiction and suicide. To prove this, mediation analysis showed that in risky game users, perceived happiness mediated suicidal ideation, while in usual game users, it did not. This means that factors other than subjective happiness are more important to suicidal ideation in usual game users. Previous studies suggested that digital games related to violent content worsen aggressive behavior (Anderson and Carnagey, 2009; Anderson et al., 2008; Bartholow et al., 2005), and

Table 5
Association between perceived mental health and addictive game user defined as upper 5.2 percentile in game overuse screening questionnaire score (n = 46). (Sensitivity analysis).

Dependent variables		Independent variables	B	β	p value
Q 1: satisfaction of life		Non addicted game user	−0.206	−0.058	0.280
		Addicted game user	−0.676	−0.085	0.099
Q 2: satisfaction of freedom		Non addicted game user	9951	0.012	0.822
		Addicted game user	−0.688	−0.075	0.155
Q 3: satisfaction of health		Non addicted game user	−0.443	−0.108	0.045
		Addicted game user	−1.358	−0.148	0.004
Q 4: level of life	Current	Non addicted game user	−0.214	−0.062	0.244
		Addicted game user	−0.830	−0.107	0.036
	5 years ago	Non addicted game user	−0.328	−0.077	0.152
		Addicted game user	−0.621	−0.065	0.206
	5 years after	Non addicted game user	−0.227	−0.065	0.233
		Addicted game user	−1.169	−0.150	0.004
Q 5: physical activity		Non addicted game user	−0.518	−0.107	0.050
		Addicted game user	−0.654	−0.061	0.246
Q 6: social activity		Non addicted game user	0.055	0.019	0.713
		Addicted game user	0.077	0.012	0.809
Q 7: the tendency to help others		Non addicted game user	−0.218	−0.103	0.062
		Addicted game user	−0.300	−0.064	0.229
Q 8: interests about learning		Non addicted game user	−0.094	−0.037	0.498
		Addicted game user	−0.448	−0.078	0.140
Q 9: feeling of gratitude		Non addicted game user	−0.165	−0.045	0.416
		Addicted game user	−0.710	−0.086	0.102
Q 10: happiness		Non addicted game user	−0.112	−0.033	0.538
		Addicted game user	−1.112	−0.148	0.005
Q 11: emotional support		Non addicted game user	0.160	0.040	0.457
		Addicted game user	−0.853	−0.096	0.066
Q 12: life support		Non addicted game user	0.610	0.136	0.010
		Addicted game user	0.189	0.019	0.711

*Foot note: 3 Game use groups were added as dummy independent variable putting 'non game user' as reference group.
'B' means unstandardized regression coefficient, while 'β' means standardized regression coefficient.
Adjusted by Sex, Age, Education, Region, Comorbidity and Income.

also suggested that groups with impaired dopamine reward circuit are relatively more engaged in digital games (Hoeft et al., 2008). Therefore, combining the results of previous study and this study, we can assume that the group using games in a non-addition risky style was more impulsive than the group of non-game users, and that this impulse can make them vulnerable to alcohol dependence and suicide.

The level of satisfaction and happiness of excessive digital game users (risky users) was significantly lower, and the prevalence of clinical depression was significantly higher. This is consistent with the results of previous studies that state that digital game addiction increased depression, anxiety, and suicidal ideation (Mentzoni et al., 2011; Messias et al., 2011). Unlike usual game users, the perceived happiness of risky game users partially mediated suicidal ideation, suggesting that clinical risk in addicted risky game users further increases due to negative perceptions and emotions in addition to the underlying impulsive trait. Sensitivity analyses results also support this assumption, which defined addicted game users as the top 5.2 percentile of the GSO-Q scores. The OR difference in MDD was significantly greater than that in alcohol dependence between addicted and non-addicted game

Table 6
Association between clinical outcomes and addicted game user defined as upper 5.2 percentile in game overuse screening questionnaire score ($n = 46$). (Sensitivity analysis).

Dependent variables	Independent variables	B	OR(95% CI)	p value
Lifetime prevalence of MDD	Non addicted game user	0.964	2.622 (1.066–6.540)	0.036
	Addicted game user	2.042	7.702 (2.125–27.911)	0.002
Life time prevalence of Alcohol dependence	Non addicted game user	1.123	3.076 (1.342–7.047)	0.008
	Addicted game user	1.349	3.853 (1.043–14.227)	0.043
Life time prevalence of Suicidal idea	Non addicted game user	0.906	2.475 (1.343–4.563)	0.004
	Addicted game user	1.818	6.160 (2.156–17.598)	0.001

*Foot note: 3 Game use groups were added as dummy independent variable putting 'non game user' as reference group.
Adjusted by Sex, Age, Education, Region, Comorbidity and Income.
Abbreviations: MDD (Major depressive disorder).

users. From this result, we can infer that main cause of negative mental health outcome in non-addicted game users is the impulsive predisposition that makes them prone to digital game use, or the increase in impulsiveness due to hazardous digital game use, whereas main cause in addicted game users is subjective negative perception and emotion.

Since the results of this study were adjusted by age, gender, education level, residential area, coexistence disease, and income, the effect of game use groups on mental health could be independently evaluated. Additionally, the self-report questionnaire found that usual game users and risky game users have higher levels of practical support in life than non-game users. On the other hand, even though the level of emotional support was evaluated subjectively, there was no significant decline in the two groups' emotional support compared to non-game users. Therefore, the confounding effect of differences in socio-economic conditions and support systems was small. Additionally, since this study targeted the young adults aged between 18 and 30 years, it was possible to compare the differences between game users in a relatively homogeneous group. In Korea, most of the early adulthood period involves preparing for economic independence as students or job seekers (Park and Sandefur, 2005), and the percentage of digital game users is higher than in other adulthood periods (Kim et al., 2017). In the age group where there is a relatively small percentage of digital game users, various biases may exist for game use itself. By limiting the target group to young adults, the reliability of the study is expected to be higher.

The strengths of this study are as follows: 1. A representative group was selected and evaluated using a rigorous statistical method, 2. Well-trained interviewers conducted face-to-face interview with participants and made a reliable clinical diagnosis using structured interview tools, and 3. The characteristics of digital game users could be understood from various aspects by conducting various self-report questionnaires related to perceived satisfaction and happiness.

4.1. Limitations

This study has limitations as well. First, risky users for digital game addiction were defined by the cut-off of the questionnaire; thus, it may not exactly match the clinical diagnosis of digital game addiction. Digital game addiction is not yet incorporated into the DSM diagnosis system, but diagnostic criteria based on consensus exist for research purposes (Griffiths et al., 2016; Petry et al., 2014). However, GSO-Q showed a considerable level of sensitivity and specificity in predicting clinical digital game addiction (Baek et al., 2020); hence, this limitation was overcome to some extent. Additionally, results similar to the main analysis were also obtained in the sensitivity analysis, that is, addicted

users were newly defined as the top 5.2 percentile of GSO-Q scorers, by referring to the prevalence of the epidemiological study, thereby increasing the reliability of the results.

Second, as the number of participants was reduced to 415 while limiting the age range to 18–30 years, statistical power may have decreased (Type II error). Perceived satisfaction and happiness in the usual game users was not significantly lower in this study, but if the number of study participants increased, negative association between the usual group and perceived mental health might have been significant. It is also possible that the prevalence of MDD might have been significantly higher in usual game users in the same context. However, the effect sizes (β) of usual game users in perceived satisfaction and happiness were lower than those of risky game users; therefore, the characteristic difference between the two groups seems to exist. Additionally, in the analysis using MDD, alcohol dependence, and suicidal ideation as dependent variables, the OR difference between the groups for alcohol dependence and suicidal idea was not significant, while that of MDD was significant. Consequently, we have discussed above, the possibility of a psychopathological difference between the two groups.

Last, since this study is a cross-sectional observational study, it was not possible to define the temporal relationship, and furthermore, the causal relationship between game use and mental health. However, this study suggests not only that mental health outcomes worsen due to an excessive use of games but also that in people with existing impulsive predispositions, use of games and negative mental health outcomes may co-occur. This can be tested if longitudinal studies, especially those involving children and adolescents, are conducted and the results of long-term follow-up are presented.

5. Conclusion

Not only addicted digital games users but also digital game users under the addiction threshold were likely to be at risk for mental health disorders as compared to non-game users. However, the difference between two groups is lies in psychopathology, suggesting the need for customized interventions for each group.

Data availability statement

The dataset is available upon the reasonable request to corresponding author.

CRediT authorship contribution statement

Gihwan Byeon: Conceptualization, Formal analysis, Writing – original draft. **Jee Eun Park:** Funding acquisition, Methodology, Project administration, Supervision, Writing – review & editing. **Hong Jin Jeon:** Funding acquisition, Methodology, Project administration, Validation, Writing – review & editing. **Su Jeong Seong:** Funding acquisition, Project administration, Writing – review & editing. **Dong-Woo Lee:** Funding acquisition, Project administration, Writing – review & editing. **Seong-Jin Cho:** Funding acquisition, Project administration, Writing – review & editing. **Sung Man Chang:** Funding acquisition, Project administration, Writing – review & editing. **Byung-Soo Kim:** Funding acquisition, Project administration, Writing – review & editing. **Bong-Jin Hahm:** Funding acquisition, Project administration, Writing – review & editing. **Jin Pyo Hong:** Funding acquisition, Methodology, Project administration, Validation, Writing – review & editing. **Jong-Ik Park:** Funding acquisition, Methodology, Project administration, Validation, Writing – review & editing.

Declaration of Competing interest

All the authors declare no confliction of interests.

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