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Table of Contents

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Abstract

Background: Both Internet Gaming Disorder (IGD) and Internet Addiction (IA) have been associated with diverse psychopathologies, but how the two conditions relate to each other, and which is associate with more severe psychopathologies is unclear.

Objective: This study aimed to compare the association between IGD and IA and with several types of psychopathology symptoms.

Methods: This cross-sectional study surveyed three independent samples: 8125 first-year undergraduates at a large university, 1720 high school students, and 492 inpatients 13-19 years old at two tertiary mental health centers. IGD was defined as a score > 21 on the IGDScale-9 Short Form (IGDS9-SF), while IA was defined as a score ? 50 on Young's 20-item IA Test (IAT-20). Symptoms of depression, anxiety, psychoticism, paranoid ideation and attention deficit-hyperactivity were assessed using internationally validated surveys.

Results: Across the three samples, the frequency of IGD ranged from 4.8 to 32.3%, while the frequency of IA ranged from 7.3 to 45.9%. Scores on the IGDS9-SF and IAT-20 correlated moderately with each other (r = 0.51-0.55) and with severity of most types of psychopathological symptoms in all three samples, with IAT-20 scores linked to more severe symptoms. In all three samples, psychopathological symptoms were significantly more severe in individuals with IA, either alone or comorbid with IGD, compared to those with IGD only.

Conclusions: IGD and IA appear to be distinct disorders that correlate with each other. Both are associated with diverse psychopathological symptoms, IA is generally more severe in the case of addiction. These findings may facilitate diagnosis and treatment of these and potentially other disorders related to online entertainment.

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addiction. These findings may facilitate diagnosis and treatment of these and potentially other disorders related to online entertainment.

Keywords: internet gaming disorder; internet addiction; psychopathology.

Introduction

In 2023, approximately 5.4 billion people were using the Internet [1], many of whom were teenagers and young adults. These groups are at a critical stage of growth and development, which can be endangered by excessive or inappropriate use of the Internet, potentially leading to IGD and IA [2, 3]. IGD has been defined in the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* [4], which specifies nine dimensions of preoccupation, withdrawal, tolerance, unsuccessful attempts to stop or limit gaming, loss of interest in previous activities, continued use despite harm, avoidance, deception, and harm. The 11th edition of the International Classification of Diseases, for its part, has defined a disorder involving "predominantly online" gaming that emphasizes impaired control, prioritization of gaming over other activities, and continued gaming despite negative consequences[5] Both definitions imply significant social dysfunction arising from excessive online gaming. Studies based on perhaps the most accurate survey for diagnosing Internet gaming disorder, the Internet Gaming Disorder Scale – Short Form (IGDS9-SF) [6], suggest that the condition affects 8-15% of adolescents in various countries [7] [8] [9]. Studies of adolescents have linked the condition to antisocial behavior, depression, anxiety, and hyperactivity/inattention [10, 11].

In contrast to Internet gaming disorder, IA has yet to be recognized as a *bona fide* disorder in the *Diagnostic and Statistical Manual* or other consensus guidelines [12]. It is typically defined as a behavioral addiction involving impaired control over Internet use or online behaviors that leads to significant distress and impairment in daily functioning [13]. Studies based on the instrument most widely used to diagnose IA , the 20-item Young's Internet Addiction Test (IAT-20)[14], suggest that up to 18% of adolescents may suffer moderate IA and up to 1.5% may suffer severe addiction [15]. Studies based on the IAT-20 have linked IA to diverse psychopathological symptoms including depression, anxiety, obsessive-compulsive disorder, and suicidal ideation [16, 17].

How IA and IGD relate to each other is unclear, with studies proposing that they are one and the same, that they are entirely separate from each other, or that one is a subtype of the other [18] [19]. Few studies have examined both conditions, with most focusing on IGD because of its inclusion in the *Diagnostic and Statistical Manual.* The present study used internationally validated instruments to detect both disorders in three samples of adolescents in different settings in China. Our goal was to explore potential correlations between the two disorders and to determine which disorder is more strongly associated with psychopathological severity. Ultimately the findings from our study may contribute to conversations about diagnosing and treating compulsive Internet use.

METHODS

Participants

Three samples were recruited: first-year undergraduates from Sichuan University (Chengdu, China), high school students from Fuyang Xindeng Middle School (Hangzhou, China), and inpatients aged 13–19 from two psychiatric hospitals located in Hangzhou and Chengdu, China.

Individuals were excluded from the study if they were younger than 13 or older than 19 years; if they failed to answer all items completely; if their responses seemed unreliable, such as if they always indicated the same severity of symptoms on all items of the questionnaires; or if they used the same personal identification number as another participant. Undergraduates were excluded if they failed to submit their questionnaires properly through the online system, or if they submitted the questionnaires after the deadline.

Measures

In addition to the following internationally validated questionnaires, participants also filled out an *ad hoc* questionnaire that collected data on sociodemographic background.

IGDS9-SF to identify Internet gaming disorder

The IGDS9-SF [6] assesses the frequency of symptoms of IGD during the previous 12 months. The symptoms considered the diagnostic criteria of the 5th edition of the *Diagnostic and Statistical Manual* and the features defined by the 11th edition of the International Classification of Diseases. The IGDS9-SF is one of the few questionnaires about IGD that includes the criterion of "continued Internet use despite harm" [6]. Participants respond to each of the 9 items on a 5-point scale from 1 ("rarely") to 5 ("always"), giving rise to a total score from 0 to 45. Scores ≥ 21 were defined as indicative of Internet gaming disorder[20]. Cronbach's α in all three samples of the present study ranged from 0.89 to 0.93.

IAT-20 to identify IA

The IAT-20 [21] is the most frequently used self-report survey of problematic Internet use [22]. Participants respond to each of the 20 items on a 5-point scale from 1 ("rarely") to 5 ("always") or by entering the value 0 ("not applicable"), yielding a total score from 0 to 100. Scores ≥ 50 were defined as indicative of IA[23]. Cronbach's α in all three samples of the present study ranged from 0.93 to 0.94.

Patient Health Questionnaire-9 (PHQ-9) to assess severity of depressive symptoms

The PHQ-9 assesses the severity of depressive symptoms during the previous two weeks. Participants respond to each of nine items on a 4-point scale from 0 ("not at all") to 3 ("nearly every day"), yielding a total score from 0 to 27. Higher scores indicate greater symptom severity. The scale has demonstrated satisfactory psychometric properties in Chinese populations [24]. Cronbach's α in all three samples of the present study ranged from 0.86 to 0.91

Generalized Anxiety Disorder-7 (GAD-7) to assess severity of anxiety symptoms

The GAD-7 [25] assesses the severity of anxiety symptoms during the previous two weeks.

Participants respond to each of seven items on a 4-point scale from 0 ("not at all") to 3 ("nearly every day"), giving a total score from 0 to 21. Higher scores indicate greater symptom severity. The Chinese version has demonstrated satisfactory validity and reliability. Cronbach's α in all three samples of the present study ranged from 0.90 to 0.93.

Subscales of the Symptom Checklist-90 to assess severity of psychoticism and paranoid ideation

The severity of psychoticism and paranoid ideation was assessed using the corresponding subscales of the Symptom Checklist-90. Participants respond to each of the 10 items on the psychoticism subscale or six items on the paranoid ideation subscale using a 5-point scale from 0 ("not at all") to 4 ("extremely"). The SCL-90 has demonstrated robust validity and reliability in Chinese populations [26]. This survey was administered only to undergraduates, for whom Cronbach's α was 0.83 for psychoticism and 0.87 for paranoid ideation; and to inpatients, for whom Cronbach's α was 0.79 for psychoticism and 0.84 for paranoid ideation.

Attention Deficit-Hyperactivity Disorder Self-Report Scale (ASRS) to assess severity of attention deficit and hyperactivity

The ASRS, widely used clinically to screen adults for attention deficit-hyperactivity disorder, is based on the 18 criteria in the "TR" revision of the 5th edition of the *Diagnostic and Statistical Manual of Mental Disorders[27]* The survey examines symptoms over the previous six months. Participants respond to 18 items on a scale from 0 ("never") to 4 ("very often"), giving a total score from 0 to 72. Higher scores indicate more severe symptoms. The Chinese version has demonstrated both reliability and validity in young adults in Taiwan[28]. This survey was administered only to high school students, for whom Cronbach's α was 0.93; and to inpatients, for whom Cronbach's α was 0.91.

Recruitment

First-year undergraduates that enrolled in 2020 were asked to complete questionnaires online by themselves by October 31, 2020. High school students completed paper-based questionnaires and inpatients completed online questionnaires under the supervision of specially trained graduate students and clinicians.

Analysis

Data were analyzed using SPSS 27.0 (IBM, Armonk, NY, USA). Results were reported in terms of numbers, proportions or rates, means, medians, and 95% confidence intervals (95%CIs) as indicated. When testing for associations between scores on different questionnaires, the standardized residuals of the scores were used to control for potential confounding by age and sex. The significance of univariate associations was assessed using, as appropriate, *t* tests, chi-squared tests or ANOVA. Results from the ANOVA were adjusted according to Tukey's honest significant difference to correct for multiple comparisons. Potential relationships among variables were explored using multiple linear and logistic regression. Where appropriate, relationships were expressed in terms of odds ratios (ORs) and corresponding 95%CIs. The results of statistical testing were considered significant if associated with a two-tailed $p< 0.05$.

Ethical Considerations

The study procedures were carried out in accordance with the Declaration of Helsinki. The Institutional Review Board of West China Hospital, Sichuan University (Approval No. 2016-171) and the Ethics Committee of Hangzhou Seventh People’s Hospital (Approval No. 2023-064) approved the study. All Sample 1 participants provided electronic informed consent; in Samples 2 and 3, participants and their parents received study information and provided written consent via paper questionnaires and electronically after full briefing, respectively.

Results

Of the 9,409 freshmen invited to participate, 8,125 (86.4%) completed the surveys and were included in the final analysis, together with 1,720 of the 2,200 invited high school students (78.2%) and 551 of the 635 invited inpatients (86.8%). All participants completed all surveys, except that high school students did not fill out either subscale of the Symptom Checklist-90, while undergraduates and 310 of the 551 of inpatients did not fill out the ASRS.

Males made up the slight majority of undergraduates (54.5%), but they were slightly in the minority among high school students (43.8%) and strongly in the minority among inpatients (26.0%). Mean ages in years were 18.07 (95%CI 18.05,18.09) among undergraduates, 17.30 (17.00, 17.60) among high school students and 15.56 (15.41, 15.71) among inpatients.

Prevalence of IGD and IA

Scores on the IGDS9-SF did not correlate significantly with age among undergraduates or high school students but showed a modest negative correlation among inpatients (r = -0.10, P = .020). In contrast, scores on the IAT-20 correlated negatively with age among undergraduates (r = -0.02, P = .04), positively among high school students (r = 0.05, P = .04), and negatively among inpatients (r = -0.09, P = .04).

IGD was significantly more prevalent among men than women in undergraduates (t = 26.2, P < .001), high school students (t = 9.92, P < .001), and inpatients (t = 3.18, P = .002). Conversely, IA was significantly more prevalent among women in undergraduates (t = -7.00, P < .001) and high school student (t = -3.67, P < .001) or, whereas no significant sex differences were observed among inpatients (t = 0.61, P = .55).

The mean score on the IGDS9-SF was 11.8 (95%CI [11.7, 12.0]) for undergraduates, which was significantly lower than the mean score of 15.1 (14.8, 15.4) for high school students, which in turn

was significantly lower than the mean score of 18.8 (17.8, 19.7) for inpatients. Analogously, the prevalence of Internet gaming disorder, based on our predefined cutoff of ≥ 21, was 4.8% (95%CI [4.3%, 5.2%]) among undergraduates, which was significantly lower than the prevalence of 15.8% (14.0, 17.5%) among high school students, which in turn was significantly lower than the prevalence of 32.3% (28.4, 36.2%) among inpatients.

Similar trends were observed across the three samples for IA. The mean score on the IAT-20 was 31.7 (95%CI [31.5, 32.0]) among undergraduates, which was significantly lower than the mean score of 32.4 (31.5, 33.3) among high school students, which in turn was significantly lower than the mean score of 47.7 (45.5, 49.9) among inpatients. Analogously, the prevalence of IA, based on our predefined cutoff of ≥ 50, was 7.3% (6.8%, 7.9%) among undergraduates, which was significantly lower than the 18.8% (17.0%, 20.6%) among high school students, which in turn was significantly lower than the 45.9% (41.8%, 50.1%) among inpatients.

In other words, most undergraduates in our study had neither IGD nor IA 90.4% (95%CI [89.8, 91.1%]), while small percentages had only IGD 2.24% (1.94%, 2.59%), only IA 4.83% (4.38%, 5.32%) or both 2.51% (2.19%, 2.88%). A smaller majority of high school students had neither disorder 74.85% (72.75%, 76.83%) and correspondingly higher prevalence of only IGD 6.33% (5.27%, 7.59%), only IA 9.47% (8.17%, 10.94%), or both 9.36% (8.06%, 10.83%). In contrast, a slight majority of inpatients had one or both disorders: only 45.92% (41.71%, 50.18%) had neither disorder, whereas 8.17% (6.08%,10.86%) had IGD alone, 21.78% (18.45%, 25.51%) had IA alone, and 24.14% (20.67%, 27.98%) had both (**Table 1**).

Table 1. the mean scores and correlation matrix of demographics in IGD, IA and psychopathologies

	Among all participants	age	gender	IAT-20	IGDS9-SF	PHQ-9	GAD-7	SCL90-Psychoticism	SCL90-Paranoid ideation	ASRS
S1	**(**n=8194)									
IAT-20	31.7(31.5,32.0)	-0.02 *	0.08 ***	1.00	0.51 ***	0.50 ***	0.46 ***	0.52 ***	0.48 ***	-
IGDS9-SF	11.8(11.7,12.0)	0.02	-0.28 ***	0.51 ***	1.00	0.27 ***	0.24 ***	0.32 ***	0.27 ***	-
PHQ-9	3.0(2.9,3.1)	-0.00	0.12 ***	0.50 ***	0.27 ***	1.00	0.77 ***	0.63 ***	0.56 ***	-
GAD-7	2.0(1.9,2.1)	-0.00	0.10 ***	0.46 ***	0.24 ***	0.77 ***	1.00	0.61 ***	0.56 ***	-
SCL90-Psychoticism	1.2(1.2,1.3)	-0.01	0.03 **	0.52 ***	0.32 ***	0.63 ***	0.61 ***	1.00	0.80 ***	-
SCL90-Paranoid ideation	1.3(1.2,1.3)	-0.02	0.06 ***	0.48 ***	0.27 ***	0.56 ***	0.56 ***	0.80 ***	1.00	-
S2	**(**n=1720**)**									
IAT-20	32.4(31.5,33.3)	0.05 *	0.09 ***	1.00	0.55 ***	0.54 ***	0.48 ***	-	-	0.62 ***
IGDS9-SF	15.1(14.8,15.4)	-0.02	-0.24 ***	0.55 ***	1.00	0.35 ***	0.30 ***	-	-	0.41 ***
PHQ-9	6.3(6.0,6.5)	0.03	0.11 ***	0.54 ***	0.35 ***	1.00	0.69 ***	-	-	0.55 ***
GAD-7	4.1(3.9,4.2)	0.02	0.07 **	0.48 ***	0.30 ***	0.69 ***	1.00	-	-	0.55 ***

ASRS	22.8(22.3,23.3)	-0.01	0.05 *	0.62 ***	0.41 ***	0.55 ***	0.55 ***	-	-	1.00
S3	**(**n=551**)**									
IAT-20	47.7(45.5,49.9)	-0.09 *	0.03	1.00	0.57 ***	0.24 ***	0.16 *	0.26 ***	0.18 **	0.35 ***
IGDS9-SF	18.8(17.8,19.7)	-0.10 *	-0.14 **	0.57 ***	1.00	0.13	0.08	0.14 *	0.16 *	0.24 ***
PHQ-9	18.2(17.4,19.1)	-0.16 ***	0.13 **	0.24 ***	0.13	1.00	0.77 ***	0.67 ***	0.57 ***	0.57 ***
GAD-7	13.5(12.9,14.1)	-0.14 **	0.11 **	0.16 *	0.08	0.77 ***	1.00	0.69 ***	0.58 ***	0.53 ***
SCL90-psychoticism	2.5(2.3,2.6)	-0.18 ***	0.06	0.26 ***	0.14 *	0.67 ***	0.69 ***	1.00	0.77 ***	0.67 ***
SCL90-Paranoid ideation	2.5(2.3,2.7)	-0.17 ***	0.07	0.18**	0.16*	0.57 ***	0.58 ***	0.77 ***	1.00	0.59 ***
ASRS	**(**n=241**)** 54.0(51.8,56.2)	-0.17 **	0.12	0.35 ***	0.24 ***	0.57 ***	0.53 ***	0.67 ***	0.59 ***	1.00

S1 represents students enrolled at Sichuan University, S2 denotes high school students from Hangzhou Fuyang Xindeng Middle School, and S3 refers to participants from Hangzhou Seventh People's Hospital (Affiliated Mental Health Center of Zhejiang University School of Medicine) as well as the Mental Health Center of West China Hospital of Sichuan University. Values are means with 95% confidence intervals, * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Correlation between IGD and IA

Univariate correlation indicated that scores on the IGDS9-SF and IAT-20 correlated moderately with each other in undergraduates (r = 0.51, $P < .001$), high school students (r = 0.55, $P < .001$) and inpatients (r = 0.51, $P < .001$) These associations remained significant after controlling for sex and age. Similarly, multivariate analysis controlling for sex and age indicated that the likelihood of IA was significantly higher in the presence of IGD among undergraduates (adjusted OR 29.6; 95% CI [23.2, 37.9]), high school students (adjusted OR 14.1, 95% CI [10.3, 19.6]) and inpatients (adjusted OR 6.5; 95% CI [4.3, 9.9]) **(Table 1)**.

Severity of psychopathological symptoms

Severity of pathophysiological symptoms did not correlate with age in the case of undergraduates or high school students, but it did correlate negatively with age in the case of inpatients (r = -0.09 to -0.18;). Several types of symptoms were significantly more severe in women than men among undergraduates and high school students, while fewer types of symptoms showed this sex bias among inpatients

Mean score on the PHQ-9 for depressive symptoms was significantly lower for undergraduates 3.0 (2.9, 3.1) than for high school students 6.3 (6.0, 6.5), which in turn was significantly lower than for inpatients 18.2 (17.4, 19.1). Similarly, mean score on the GAD-7 for anxiety symptoms was significantly lower for undergraduates 2.0 (1.9, 2.1) than for high school students 4.1 (3.9, 4.2), which in turn was significantly lower than for inpatients 13.5 (12.9, 14.1).

Mean score on the psychoticism subscale of the Symptom Checklist-90 was significantly lower among undergraduates (1.2; 95%CI [1.2, 1.3]) than among inpatients 2.5 (2.3, 2.6). Similarly, mean score on the paranoid ideation subscale was significantly lower

among undergraduates 1.3 (1.2, 1.3) than among inpatients 2.5 (2.3, 2.7).

Mean score on the ASRS for attention deficit-hyperactivity was significantly lower for high school students 22.8 (22.3, 23.3) than for inpatients 54.0 (51.8, 56.2) (**Table1)**

Correlations of IGD or IA with severity of psychopathological symptoms

To explore whether IGD or IA correlated with psychopathology in our samples, first we performed analyses in which the independent variable was standardized residuals of psychopathological symptoms, while the dependent variable was the presence or absence of IGD or IA, based on our predefined cutoff scores on the IGDS9-SF or IAT-20. Pairwise comparisons between IGD and non-IGD groups, as well as between IA and non-IA groups, revealed statistically significant differences across all psychopathological variables in each of the three samples. Notably, the dimensional psychopathology scores of participants with IA were significantly more severe than those of participants with IGD on the PHQ-9, GAD-7, and SCL-90 paranoid ideation subscale in S1. A comparable trend of differences was observed in S2 and S3, though the differences did not reach statistical significance (**Table 2**).

Table 2. Mean score (95%CI) of measurements for IA, IGD and other psychopathologies among All participants, those with IGD and IA, and those without IGD or IA across three samples

Sample	Psychopathologies	Among participants with IGD	Among participants with IA	Among participants without IGD	Among participants without IA
S1		(n=393)	(n=598)	(n=7801)	(n=7596)
	IAT-20	50.8(49.3,52.3)	58.2(57.5,58.8)	30.8(30.5,31.0)	29.6(29.4,29.8)
	IGDS9-SF	25.2(24.7,25.7)	17.6(17.0,18.2)	11.2(11.1,11.2)	11.4(11.3,11.5)
	PHQ-9	6.0(5.5,6.5)	7.2(6.9,7.6)	2.8(2.8,2.9)	2.7(2.6,2.7)
	GAD-7	4.6(4.1,5.1)	5.6(5.3,6.0)	1.9(1.9,2.0)	1.8(1.7,1.8)
	SCL90-Psychoticism	1.6(1.5,1.7)	1.7(1.6,1.7)	1.2(1.2,1.2)	1.2(1.2,1.2)
	SCL90-Paranoid ideation	1.7(1.6,1.7)	1.8(1.7,1.8)	1.3(1.3,1.3)	1.2(1.2,1.3)
S2		(n=271)	(n=323)	(n=11449)	(n=1397)
	IAT-20	53.4(51.3,55.4)	62.8(61.8,63.9)	28.4(27.5,29.4)	32.4(31.9,32.8)
	IGDS9-SF	26.5(25.9,27.0)	21.3(20.4,22.2)	13.0(12.8,13.2)	13.6(13.4,13.8)
	PHQ-9	9.8(9.1,10.5)	10.6(10.0,11.2)	5.7(5.4,5.9)	5.2(5.0,5.4)
	GAD-7	6.8(6.1,7.5)	7.4(6.9,7.9)	3.5(3.3,3.8)	3.2(3.1,3.3)
	ASRS	31.9(30.4,33.5)	33.9(32.7,35.0)	21.0(20.3,21.6)	20.0(19.4,20.6)
S3		(n=178)	(n=253)	(n=373)	(n=298)
	IAT-20	60.9(58.1,63.8)	67.2(65.6,68.8)	41.4(39.4,43.5)	31.2(29.7,32.6)
	IGDS9-SF	30.0(29.0,30.9)	23.1(21.9,24.4)	13.5(13.0,13.9)	15.1(14.3,15.8)
	PHQ-9	17.9(17.0,18.9)	18.9(17.8,19.9)	18.4(17.7,19.1)	17.7(16.9,18.5)
	GAD-7	13.2(12.4,14.1)	14.0(13.3,14.7)	13.6(13.0,14.3)	13.1(12.4,13.8)
	SCL90-psychoticism	2.6(2.4,2.7)	2.7(2.6,2.9)	2.4(2.3,2.5)	2.2(2.1,2.3)
	SCL90-Paranoid ideation	2.7(2.5,2.9)	2.8(2.7,2.9)	2.4(2.3,2.5)	2.3(2.1,2.4)
	ASRS	**(**n=88**)** 56.5(54.0,59.0)	**(**n=10**)** 56.7(54.9,58.5)	**(**n=59**)** 52.4(50.3,54.4)	**(**n=84**)** 50.0(46.3,53.7)

Similar logic applies to other variables. CIs refer to Confidence Intervals. IGD (Internet Gaming Disorder) is defined based on the total score of the Internet Gaming Disorder Scale-Short Form, with a cutoff of ≥21, IA (Internet Addiction) is defined based on the total score of the Young's 20-item Internet Addiction Test (IAT-20) with a cutoff of ≥50;

Next, we examined whether scores on the IGDS9-SF and IAT-20 were associated with scores for psychopathological symptoms. In these analyses, the independent variable was standardized residuals of psychopathological symptoms, while the dependent variable was standardized residuals of scores on the IGDS9-SF or IAT-20. Use of standardized residuals allowed us to control for age and sex. Univariate models found that scores on both the IGDS9-SF and IAT-20 were significantly associated with scores for all psychopathological symptoms. These associations were significantly stronger, in terms of R^2, in the case of IAT-20 than IGDS9-SF among undergraduates and high school students. A similar difference was observed among inpatients, though most associations did not achieve statistical significance in this sample.

Consistently, multivariate models showed that scores for the various types of psychopathological symptoms accounted for a larger proportion of the observed variation in IAT-20 scores than of the variation in IGDS9-SF scores among undergraduates (0.33 [0.30, 0.35] vs. 0.13 [0.11, 0.16]) and high school students (0.44 [0.39, 0.49] vs. 0.23 [0.18, 0.27]). A similar trend was observed among inpatients, although it did not achieve statistical significance.

In high school students, IAT-20 scores showed a stronger univariate association, in terms of R2, with severity of attention deficit-hyperactivity 0.39 (95% CI [0.33, 0.43]) than with severity of depression 0.28 (0.23, 0.32) or anxiety 0.22 (0.18, 0.26). IGDS9-SF scores, for their part, also showed stronger univariate association with severity of attention deficit-hyperactivity 0.19 (0.14, 0.23) than with anxiety 0.10 (0.07, 0.14). Similar trends were observed among inpatients, although they did not achieve statistical significance **(Table 3).**

Table 3. Associations of IGDS9-SF, IAT-20, and identified IGD and IA with the severities of other psychopathologies using ZREs.

Sample	Psychopathology	IGDS9-SF		IAT-20		IGD		IA	
		R^2 in univariate Model (95%CIs)	R^2 in univariate Model[b] (95%CIs)	R^2 in univariate Model (95%CIs)	R^2 in multivariate model[b] (95%CIs)	Unadjusted OR (,95%CIs)	Adjusted OR[b] (95%CIs)	Unadjusted OR (95%CIs)	Adjusted OR[b] (95%CIs)
S1			**0.13(0.11,0.16)**		**0.33(0.30,0.35)**				
	PHQ-9[a]	**0.10(0.08,0.12)**		**0.25(0.23,0.27)**		**1.89(1.76,2.04)**	1.33(1.16,1.53)	**2.50(2.33,2.69)**	1.50(1.34,1.69)
	GAD-7[a]	**0.08(0.06,0.10)**		**0.21(0.19,0.23)**		**1.76(1.64,1.89)**	1.09(0.95,1.23)	**2.23(2.09,2.39)**	1.22(1.09,1.35**)**
	SCL90-Psychoticism[a]	**0.12(0.10,0.14)**		**0.27(0.25,0.30)**		**1.87(1.75,2.00)**	1.24(1.08,1.42)	**2.40(2.25,2.58)**	1.54(1.36,1.74)
	SCL90-Paranoid ideation[a]	**0.09(0.07,0.11)**		**0.23(0.21,0.25)**		**1.88(1.75,2.01)**	1.32(1.16,1.51)	**2.21(2.07,2.36)**	1.16(1.03,1.30)
S2			**0.23(0.18,0.27)**		**0.44(0.39,0.49)**				
	PHQ-9[a]	**0.15(0.11,0.19)**		**0.28(0.23,0.32)**		**2.20(1.93,2.52)**	1.56(1.28,1.91)	**3.08(2.66,3.58)**	1.89(1.54,2.31)
	GAD-7[a]	**0.10(0.07,0.14)**		**0.22(0.18,0.26)**		**1.90(1.68,2.15)**	1.02(0.84,1.23)	**2.47(2.17,2.83)**	1.09(0.90,1.31)
	ASRS[a]	**0.19(0.14,0.23)**		**0.39(0.33,0.43)**		**2.85(2.43,3.38)**	2.17(1.80,2.65)	**4.60(3.80,5.64)**	3.18(2.57,3.96)

S3		0.06(0.03,0.16)	0.13(0.06,0.26)				
PHQ-9[a]	0.00(0.00,0.01)	0.01(0.00,0.03)	0.93(0.78,1.12)	0.92(0.60,1.41)	**1.16(0.98,1.37)**	1.21(0.79,1.85)	
GAD-7[a]	0.00(0.00,0.00)	0.00(0.00,0.02)	0.93(0.78,1.11)	0.89(0.57,1.40)	1.13(0.95,1.34)	0.85(0.54,1.33)	
SCL90-Psychoticism[a]	**0.02(0.00,0.05)**	**0.10(0.06,0.16)**	1.16(0.97,1.40)	0.98(0.59,1.63)	1.71(1.43,2.06)	1.17(0.69,1.99)	
SCL90-Paranoid ideation[a]	0.03(0.01,0.07	0.11(0.06,0.16)	1.32(1.09,1.59)	1.21(0.78,1.87)	1.65(1.37,1.99)	0.80(0.50,1.24)	
ASRS[a]	0.06(0.01,0.14)	0.11(0.02,0.22)	1.40(1.07,1.85)	1.43(0.99,2.09)	1.73(1.30,2.36)	1.75(1.19,2.64)	

Multivariate linear regression analysis was conducted using standardized residuals (adjusting for the effects of age and gender on psychopathological scores). Logistic regression analysis was performed based on whether the score exceeded the cutoff. The regression coefficients are expressed in exponential form as relative risk ratios, with normal internet use serving as the reference category. R^2 represents the coefficient of determination; Cls refers to confidence intervals; OR denotes odds ratios. a: Standardized scores; b: Control for basic demography

Finally, we classified participants into four groups, depending on whether they had both IGD and IA, neither condition, or only one or the other. Among undergraduates, severity of depression, anxiety and paranoid ideation symptoms was significantly worse among those with only IA than among those with only Internet gaming disorder. Similar trends were observed among high school students and inpatients, although they did not achieve statistical significance.

Post hoc analysis of undergraduates revealed a significant, stepwise increase in the severity of symptoms of depression, anxiety, psychoticism and paranoid ideation in moving from individuals without either disorder to those with only Internet gaming disorders, then to those with only IA, and finally to those with both disorders. Similar trends were observed among high school students for the severity of symptoms of depression, anxiety, and attention deficit-hyperactivity. Consistently, inpatients showed significantly milder psychopathological symptoms in the presence of no disorder or only IGD than in the presence of IA (**Figure 1**).

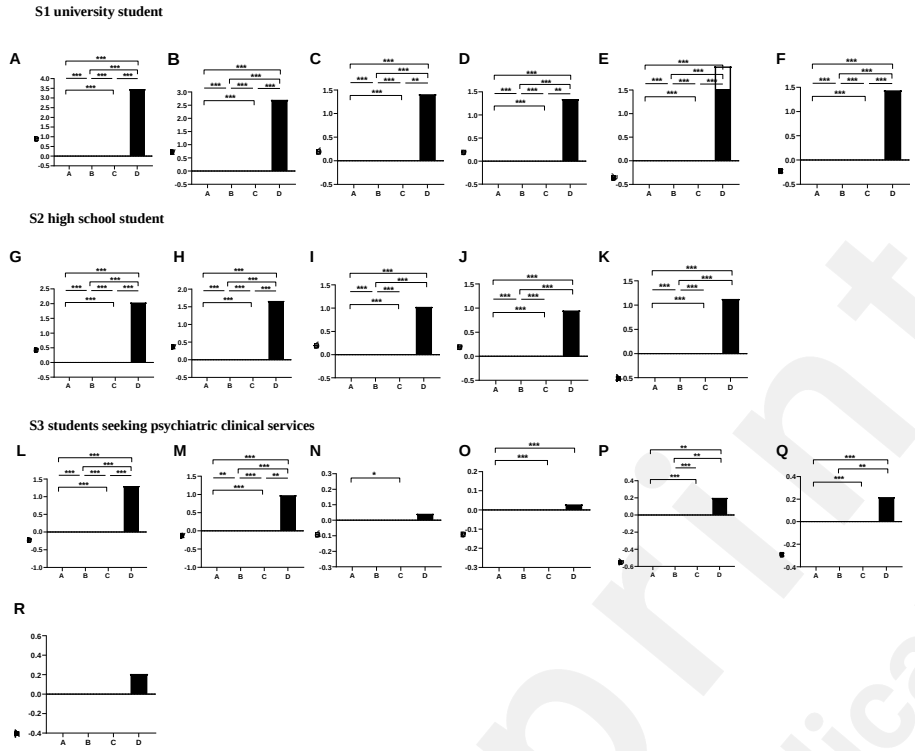

Figure 1. Post hoc analysis among psychologies (i.e., depression, anxiety, psychoticism, paranoid and hyperactivity/inattention between A(control group), B(IGD-only group), C(IA-only group) , and D(IGD+IA group) in S1(university student), S2(high school student) and S3(students seeking psychiatric clinical services) Controlling for age and gender. The sample sizes for hyperactivity/inattention in groups A, B, C, and D were 88, 10, 59, and 84, respectively. The boxplots show medians and 95% confidence intervals. ***p<0.001 **p<0.01 *p<0.05.

Discussion

Findings

To our knowledge, this is the first study to examine a potential relationship between IGD and IA, as well as compare the relationship of each disorder with severity of diverse types of psychopathologies. Our results from three independent samples of Chinese adolescents and young people, two from the general community and one from inpatient populations at mental health centers, suggest that IGD and IA correlate moderately with each

other, implying that they are different yet related disorders. They further suggest that IA is associated with more severe psychopathology than Internet gaming disorder.

The moderate association that we detected between the two disorders (r = 0.51-0.55) is similar to the moderate association reported between so-called "problematic Internet use" and "problematic online gaming" [18], but weaker than the associations between symptoms of depression and anxiety reported in the present study (r = 0.69-0.77) and in previous work with other Chinese samples [29, 30]. These observations argue for considering IGD and IA as distinct entities, rather than as a single entity or as a subtype within a type [18, 19]. Consistent with this interpretation, we identified participants who satisfied the most widely used diagnostic criteria for IGD but not the most widely used criteria for IA, and *vice versa*. In our participants, IA, whether on its own or comorbid with Internet gaming disorder, was associated with more severe psychopathological symptoms than IGD on its own.

In our study, both IGD and IA were associated more strongly with symptoms of attention deficit-hyperactivity than with symptoms of depression or anxiety, consistent with findings from a study of adults 20-40 years old in Taiwan [31]. In fact, evidence from adolescents in several countries suggests that attention deficit-hyperactivity disorder often co-occurs with−and may even predict onset of−IGD and IA [32, 33]. The impulsivity, inattention, heightened sensation seeking and poor regulatory control in attention deficit-hyperactivity may increase risk of problematic Internet use [33-35]. More generally, it may be that both disorders are more associated with "externalizing" symptoms like those in attention deficit-hyperactivity than with "internalizing" symptoms like those in depression or anxiety. The closer association with externalizing symptoms may relate to the immediate gratification and sensory stimulation inherent in gaming as well as other forms of online entertainment [36, 37]. Internalizing symptoms, in contrast, may serve as a coping

mechanism to relieve psychological distress [10] [38, 39].

We consider our data to be reliable because we diagnosed IGD and IA using the surveys most widely used for that purpose and because we were able to cross-correlate our findings among three independent samples of adolescents. In addition, the differences in psychopathological symptoms that we detected across the samples are consistent with what we would expect: hospitalized adolescents exhibited high levels of psychopathological symptoms that were consistent with those in a study of Caucasian adolescents [40], and these levels were higher than those in high school students, which in turn were higher than those in undergraduates. Our high school students may have been under particular stress because of their upcoming national university entrance exam (*gao kao*), which may help explain their higher levels of depression and anxiety [41]. Our first-year undergraduates, in contrast, had already been successful enough on their entrance exam to win a place at a top-tier university. This may have contributed to their lower levels of depression and anxiety. More generally, students admitted to top-tier universities in China may possess more effective coping strategies and problem-solving skills, which may protect against psychopathological symptoms [42].

Male sex in our samples appeared to increase risk of Internet gaming disorder, but reduce risk of IA , consistent with previous work in Chinese and US populations in which the two disorders were conceptualized as separate constructs [43, 44]. Future research should explore whether and how sex influences risk of either disorder, especially in light of sex differences in Internet use: males tend to engage more in computer gaming, while females tend to engage more in social networking and social media [45]. Previous studies have diverged in their conclusions about whether sex influences risk of IGD or IA[46, 47]. These divergences may reflect differences in relative proportions of subjects who have only Internet

gaming disorder, only IA or both.

Strengths

Despite its limitations, our study provides evidence that IGD and IA are separate, yet related entities, with the latter associated with more severe psychopathological symptoms. Our results may be relevant to compulsive online behaviors other than gaming. Even though "gaming" is currently the only type of online activity codified into the International Classification of Diseases or the *Diagnostic and Statistical Manual of Mental Disorders*, other types of online entertainment, such as social media and algorithm-driven short video platforms, may pose similar or even greater risk to mental health, harming psychological well-being, academic achievement, and family dynamics [48, 49]. It may be more appropriate to refer to "Internet entertainment disorder" and "Internet entertainment addiction" to fully capture the addictive behavioral spectrum related to Internet use. These constructs may require even further expansion or adaptation to consider the growing use of immersive technologies such as virtual/artificial reality and artificial intelligence, which may also lend themselves to addictive behavior.

Limitations

Our findings should be interpreted with caution in light of several limitations. One is that the cross-sectional design of our study precludes the inference of causal relationships. All data were obtained from self-report questionnaires, which increases risk of social desirability bias and recall bias. Our sample comprised exclusively Chinese living in China, which may limit the generalizability of our findings to other cultural and geographic contexts. Our sample of inpatients was relatively small and scored near the upper limit of most scales ("ceiling effect"), both of which can reduce statistical power and therefore may explain why so many associations that were significant among undergraduates and high school students

were not significant among inpatients. Nevertheless, most analyses among inpatients showed similar tendencies as in the other two samples.

Conclusion

Acknowledgment

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Author Contributions

YYL and WJG conceived and designed the study and drafted the manuscript; YYL, HAQ and LLY curated and analyzed the data; AQH and WW performed data visualization; YYL, LLY, AQH, JW, and ZXM collected the data; QYL, WJD, and JJX validated the results; YQH, SH, and XJL provided resources; JJX, QW, XJL, TL, and WJG supervised the project; TL and WJG acquired funding and administered the project; and QW, WD, YZH, TL, and WJG reviewed and edited the manuscript. All authors have full access to the study dataset and are responsible for ensuring its integrity and the accuracy of the resulting analyses.

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Conflicts of interest

None declared

Data statement

Data supporting the findings of this study are available upon request from the corresponding authors. The data are not publicly available due to privacy concerns.

Abbreviations

IA: Internet Addiction

IGD: Internet Gaming Disorder

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Supplementary Files

Figures

Post hoc analysis among psychologies in three groups.