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# The mediation role of low social-connectedness in association of internet gaming disorder and anger among adolescents: a multi-centre, large-sample and cross-sectional study

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## Abstract

**Background** Although internet improves modern life, the corresponding consequences of internet gaming disorder (IGD), low social-connectedness and anger-emotion are emerging as global concerns. However, the association between these psychopathologies remain unclear.

**Methods** This survey enrolled 9,616 adolescents (11–19 years) from multi-center in China from September 2022 to March 2023. Association of self-reported social-connectedness (20-item revised Social Connectedness Scale, SCS) with IGD (9-item Internet Gaming Disorder Scale-short Form) and anger (6-item DSM-5-TR-Level 2-Anger Form) were characterized.

**Results** 197 (2.05%) adolescents had been estimated as probable IGD, 364 (3.79%) reported severe-anger, and 1056 (10.98%) shown low reality social-connectedness (RSCS). The female (OR:2.16, 95%CI: 1.67–2.79), younger (OR:1.12; 95%CI: 1.04–1.20), IGD (OR:5.17; 95%CI: 3.30–8.08) were independent correlators of sever-anger after controlling the confounding of low RSCS (OR:7.21; 95%CI: 5.61–9.27). Furthermore, the RSCS could partially mediate the effects of IGD on Anger with indirect-effect of 29.50%.

**Conclusion** The effect of IGD contribution to anger might be not only directly accomplished by IGD itself, and also influenced by indirectly mediation of low social-connectedness with reality, especially in the negative dimension.

## Key message

- Low social-connectiveness with reality could partly mediate the effect of IGD to anger.
- Associations of social-connectedness in reality and internet might be different with IGD and anger.
- Negative dimension of social-connectedness scale in Internet may be more effective in illustrating adolescents' real perceptual experience comparing with positive dimension.

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**Keywords** Internet gaming disorder, Social-connectedness, Anger, Mediation model, Adolescent

## Introduction

Internet is becoming more and more popular and being part of our daily life that provides leisure activities and brings new prospects to education [1]. Epidemics data from USA suggest that adolescents spend >11 h per day online including game, leading fewer time in school or with their friends [2]. Nowadays, Internet gaming disorder (IGD) can cause mental problem and social function affecting personal cognition, mood imbalance and relationship [3–5]. The International Statistical Classification of Diseases and Related Health Problems (ICD-11) has divided game disorder into predominantly online and offline [5], the former related to internet might be homologous with IGD proposed by the fifth edition of the Diagnostic and Statistical Manual of Mental Disorder (DSM-5) [6]. The prevalence of IGD in youth and early adulthood aged 11–21 years ranged from 1.1 to 9.1% [7–9], whereas the prevalence in general people is much lower that only ranged from 0.6 to 1.6% [10]. Seemingly, adolescents may be more prone to be vulnerable to developing IGD.

On stage of development, adolescents with immature coping and appraising could appear negative mood potentially increasing the risk of IGD; IGD also could diminish opportunities to ‘face-to-face’ communication leading to low social-connectedness with real word [11–13] and mood imbalance including depression, anxiety and anger, simultaneously. Based on prior literatures, association between IGD with various of psychopathology [14–20], including low social-connectedness and mood imbalances, might be bidirectional effects or common vulnerable in pathogenic factors, which need to furtherly confirmed. However, anger as a common mood experience among IGD adolescents [3, 4, 21], it’s putative function to promote confrontation in adaptive contexts [22]. On one hand, anger can develop to aggressive behavior [23] and even severe to lead to violence, murder [24, 25] and maltreatment [26]; on the other hand, anger also could be increased by some mental disorders and lower life experience, being related to greater symptom severity and comorbidities [27–29]. Although some meta-analyses suggested that the association between video game had influences on increase aggression and reduce prosocial behavior, the effect-size of relationship were inconsistent might due to flaw in methodological inconsistencies [30, 31]. Moreover, anger commonly could be an explicit emotion of aggressive dispositions and IGD might be an impulsive behavior [14, 15], while their association and overlapped mechanism remains confused and should be a crucial issue for future studies.

Nowadays, maladaptive cognitive-appraise-behavioral regulation is a central and influential theory to explain the mechanism of maladaptive anger [32–34]. Namely, individuals will appear specific mood when encounter stressors under the mediation of cognitive-appraise system. Meanwhile, social-connectedness could be considered as a self-attributed cognition in interpersonal relatedness, developed early in childhood, stabilized in adult, and extended throughout the whole life span [35]. The mediation effect of social-connectiveness in contribution of IGD to anger is not verified by direct evidences in the same study. Hence, combined with Person-Affect-Cognition-Execution hypothesis from Brand, which indicated that IGD might be the consequence of interactions between predisposing factors (psychological and neurobiological constitutions), moderators (cognitive biases and coping styles), and mediators (emotional and cognitive responses) to situational triggers in combination with attenuated executive function [18]. We assume an idea that low social-connectedness (dysfunctional cognition) may partly mediate the contribution of IGD to anger (negative emotion). A multi-center, larger-sample and cross-sectional study among adolescents was conducted to explore the association between them.

## Methods

### Study design and setting

This was a cross-sectional multi-center study in three zones across eastern, middle and western of China during September 2022 to March 2023. Each region simple-randomly selected one city, while two cities have been selected from eastern region for relatively small acreage. And then, each city simple-randomly selected one schools as a cluster to constitute total sample. Finally, students of four schools were come from four cities of Zhenjiang in Jiangsu (eastern), Xiamen in Fujian (eastern), Chengdu in Sichuan (middle) and Karamay in Xinjiang (western).

Total sample size was estimated by the design effect (deff) on sample random sampling. Generally, total sample size could be equal to the product of deff (the value ranges from 1 to 3) and the sample size of simple random sampling [36]. According to epidemiologic data, the population rate of IGD ranges from 1.1 to 9.1% [7–9], allowable absolute error ( $\delta$ ) was 0.01 with a level of statistical significance at 5% ( $\alpha=0.05$ ) for two-tailed test. If the deff was calculated to be 3 and dropout-rate of 20%, the total sample size is estimated about 771 (193 in each school) to 5840 (1460 in each school). However, total-sample finally depended on actual survey in condition of no less than the minimum of estimated sample-size.

## Participants

All the students from four cities were asked to complete series of online questionnaires (<https://www.wjx.cn/app/survey.aspx>) in a quiet room, simultaneously. Participants were Han Chinese and age among 11 to 19 years. Those students who answered dishonestly, spent less time (<10 min) and had missing basic information (gender and age), were excluded from this study.

## Measurements

### 9-item internet gaming disorder scale-short form

The 9-item Internet Gaming Disorder Scale-Short Form (IGDS9-SF) developed by Pontes [37] was used to assess and classify the severity of IGD. The questionnaire includes 9-item based on the diagnostic criteria of Internet Gaming Disorder according to DSM-5. Each item was rated from 1 to 5 (1 = never; 2 = almost never; 3 = sometimes; 4 = often; and 5 = almost always) with a total score ranging from 9 to 45. The total score of 32 has been evident as an optimal cutoff point for probable IGD in Chinese sample [38]. The Cronbach alpha ( $\alpha$ ) coefficients of IGDS9-SF for the Chinese version among Chinese population were 0.90 in prior study [39]. The questionnaire has excellent criterion validity and good internal consistency for wide-ranging populations that has been widely used within clinical and research settings [40].

### 6-item DSM-5-TR-level 2-anger

The 6-item DSM-5-TR-Level 2-Anger (Anger-6) is a self-reported questionnaire used to assess the domain of anger in children and adolescents [41–43]. Participants were asked to rate the severity of anger during the past one week. The Anger-6 is a 5-point scale rating from 1 to 5 (1 = never; 2 = almost never; 3 = sometimes; 4 = often; and 5 = almost always) with a total score ranging from 6 to 30. The criteria of mild, moderate and severe anger were total scores  $\geq 16$ ,  $\geq 18$  and  $\geq 24$ , respectively (<http://www.dsm5.org/Pages/Feedback-Form.aspx>).

### 20-item revised social connectedness scale

The 20-item revised Social Connectedness Scale (SCS) was used to assess social-connectedness [44] with 10 positive items (SCS\_P) and 10 negative items (SCS\_N). The positive items rating from 1 (strongly disagree) to 6 (strongly agree), reversely rated by the negative items. Total score and scores for positive and negative items were calculated separately with a total score ranging from 20 to 120. Total scores  $\leq 70$  might be screened as potential low social-connectedness [44]. With the development of technology, world has been divided into real and internet-virtual world. Hence, social-connectedness could be distinguished into reality (RSCS) and internet (ISCS). To explore in the latter mediation-analyses, we calculated the total score (SCSM), mean value of positive (IRM\_P)

and negative (IRM\_N) dimensions in reality and internet SCS. The Cronbach alpha ( $\alpha$ ) coefficients of SCS 0.91 for SCS of Chinese version in prior study [45].

## Statistical analysis

Continuous variables are presented as mean  $\pm$  SD, and categorical variables are presented as the number (n) and percentage (%). Comparisons of continuous variables and proportions between two groups were performed using *t*-test and chi-square test. Adjusted odds ratios (aOR) and their 95% CIs for participants with severe Anger and demographic statistic were estimated by using Binary-logistic regression controlling for age, sex, BMI, sibling. The correlation between scales of IGDS9-SF, RSCS (SCS\_P and SCS\_N), ISCS (ISC\_P and ISC\_N), and Anger-6 scores were analyzed by Pearson correlation.

In order to verify the mediation-effect of social-connectedness in contribution of IGD to anger, mediation-analysis was performed with IGD scores as the independent variable, anger scores as the dependent variable, RSCS or ISCS score as proposed mediators. Age, sex and sampling-region were controlled as confounding factors. The significance of the mediation was conducted by the bias-corrected bootstrap method (with 1,000 random samplings). All statistical analyses were conducted using SPSS 22.0 (IBM, 2013, New York, USA) and Mplus 7.4 [46], and  $p < 0.05$  with two-tailed test was defined as statistically significant.

## Results

### Demographics and clinical parameters

A total of 11,946 participants filled the online questionnaire. 498 participants with age among 11 to 19 years, 619 participants with online-time < 10 min, 1207 participants who did not answer questions honestly and 6 participants with missing data were excluded. Altogether, 9,616 (4661 male and 4966 female) participants were included in the final analyses. The flow chart was shown in Supplementary-material Fig. 1. The mean  $\pm$  SD age was  $14.9 \pm 1.7$  years old and there was no significant difference between males and females ( $t = -0.83$ ;  $p = 0.40$ ). Meanwhile, the prevalence rates of probable IGD were 0.9% (95%CI: 0.1–1.6%) in Zhenjiang, 1.1% (95%CI: 0.4–1.7%) in Xiamen, 2.3% (95%CI: 1.5–3.1%) in Chengdu and 2.3% (95%CI: 1.9–2.6%) in Karamay ( $\chi^2 = 10.48$ ;  $p = 0.015$ ).

The mean ( $\pm$  SD) scores for IGDS9-SF, Anger-6, RSCS and ISCS were 14.4 ( $\pm 6.5$ ), 10.9 ( $\pm 5.6$ ), 84.9 ( $\pm 16.1$ ) and 77.6 ( $\pm 11.9$ ). The Cronbach alpha ( $\alpha$ ) coefficients of IGDS9-SF, SCS with reality and internet, and Anger-6 were 0.93, 0.90 and 0.76, and 0.95 in our study, respectively. The detection-rate of probable IGD, severe-anger, low RSCS and low ISCS were 2.05% (95%CI: 1.77–2.33%), 3.79% (95%CI: 3.40–4.17%), 10.98% (95%CI: 10.36–11.61%) and 16.76% (95%CI:

16.02–17.51%). In addition, the mean  $\pm$  SD values of IGDS9-SF (male:  $15.7 \pm 6.9$ ; female:  $13.2 \pm 5.8$ ), Anger-6 (male:  $10.3 \pm 5.2$ ; female:  $11.6 \pm 5.9$ ), RSCS (male:  $85.5 \pm 15.8$ ; female:  $84.3 \pm 16.4$ ) and ISCS (male:  $78.2 \pm 12$ ; female:  $77.1 \pm 11.9$ ) were significantly different between subgroup in gender. The detection-rates of probable IGD among male adolescents (2.9%; 95%CI: 2.4–3.3%) was significantly higher than the females (1.3; 95%CI: 1.0–1.6%), while the detection-rates of severe-anger was higher among female (5.1%; 95%CI: 4.5–5.7%) than male (2.4%; 95%CI: 1.9–2.8%) adolescents (Table 1).

#### Risk factors contributed to the development of severe anger

As shown in Table 2, in the logistic-regression (Enter) model enrolled in age, sex, BMI, sibling, probable IGD and low ISC, younger-adolescents (OR = 1.09; 95%CI: 1.02–1.16), female (OR = 2.47; 95%CI: 1.90–3.17), probable IGD (OR = 8.07; 95%CI: 5.33–12.22) and low ISC (OR = 1.73; 95%CI: 1.34–2.24) are independent risk factors for having severe-anger. Accordingly, also controlled abovementioned characteristics and Low RSC, we found

that younger-adolescents (OR = 1.12; 95%CI: 1.04–1.20), female (OR = 2.16; 95%CI: 1.67–2.79), probable IGD (OR = 5.17; 95%CI: 3.30–8.08) and low RSC (OR = 7.21; 95%CI: 5.61–9.27) are also independent risk factors for having severe-anger, except of low ISC (OR = 0.96; 95%CI: 0.73–1.28).

#### Correlation among scores of Anger-6, IGDS9-SF and SCS

As shown in Fig. 1, Anger-6 score was positively associated with IGDS9-SF score ( $r = 0.34$ ), ISC\_P ( $r = 0.21$ ) and age ( $r = 0.04$ ); negatively associated with RSCS ( $r = -0.41$ ), ISCS ( $r = -0.12$ ), RSC\_N ( $r = -0.46$ ), RSC\_P ( $r = -0.17$ ) and ISC\_N scores ( $r = -0.38$ ), respectively. IGDS9-SF score was negatively correlated with RSCS ( $r = -0.33$ ), RSC\_N ( $r = -0.39$ ), ISC\_N ( $r = -0.40$ ), RSC\_P ( $r = -0.11$ ), and ISCS ( $r = -0.06$ ) scores; positively associated with ISC\_P score ( $r = 0.28$ ) and age ( $r = 0.03$ ), respectively. RSCS score was positively associated with RSC\_P ( $r = 0.76$ ), RSC\_N ( $r = 0.74$ ), ISC\_N ( $r = 0.48$ ), ISCS ( $r = 0.44$ ) and ISC\_P ( $r = 0.04$ ); negatively associated with age ( $r = -0.33$ ), respectively. All of abovementioned correlation coefficients

**Table 1** Demographic characteristics and clinical parameters

Variables	Total	Male	Female	t/ $\chi^2$	p
N (%)	9616 (100)	4661 (48.5)	4966 (51.5)	-	-
Age, years	$14.9 \pm 1.7$	$14.9 \pm 1.7$	$14.9 \pm 1.7$	-0.83	0.40
BMI, kg/m <sup>2</sup>	$21.2 \pm 4.0$	$21.9 \pm 4.4$	$20.5 \pm 3.6$	15.50	<0.001
Having sibling, n (%)				28.56	<0.001
Yes	5317 (55.3%)	2447 (52.5%)	2870 (57.9%)		
No	4299 (44.7%)	2214 (47.5%)	2085 (42.1%)		
IGDS9-SF score	$14.4 \pm 6.5$	$15.7 \pm 6.9$	$13.2 \pm 5.8$	19.43	<0.001
Probable IGD, n (%)				29.20	<0.001
Yes	197 (2.1%)	133 (2.9%)	64 (1.3%)		
No	9419 (97.9%)	4528 (97.1%)	4891 (98.7%)		
Anger-6 score	$10.9 \pm 5.6$	$10.3 \pm 5.2$	$11.6 \pm 5.9$	-11.41	<0.001
Severe anger, n (%)				50.46	<0.001
Yes	364 (3.8%)	110 (2.4%)	254 (5.1%)		
No	9252 (96.2%)	4551 (97.6%)	4701 (94.9%)		
RSCS score	$84.9 \pm 16.1$	$85.5 \pm 15.8$	$84.3 \pm 16.4$	3.50	<0.001
RSC_P score	$39.5 \pm 11.0$	$39.7 \pm 11.4$	$39.4 \pm 10.6$	1.15	0.25
RSC_N score	$45.4 \pm 10.6$	$45.8 \pm 10.6$	$44.9 \pm 10.5$	4.14	<0.001
Low RSC, n (%)				44.19	<0.001
Yes	1056 (11.0%)	410 (8.8%)	646 (13.0%)		
No	8560 (89.0%)	4251 (91.2%)	4309 (87.0%)		
ISCS score	$77.6 \pm 11.9$	$78.2 \pm 12.0$	$77.1 \pm 11.9$	4.28	<0.001
ISC_P score	$32.2 \pm 11.4$	$32.5 \pm 11.8$	$32.0 \pm 11.0$	2.04	0.04
ISC_N score	$45.4 \pm 9.9$	$45.7 \pm 10.0$	$45.1 \pm 9.8$	2.80	0.005
Low ISC, n (%)				32.50	<0.001
Yes	1612 (16.8%)	677 (14.5%)	935 (18.9%)		
No	8004 (82.2%)	3984 (85.5%)	4020 (81.1%)		

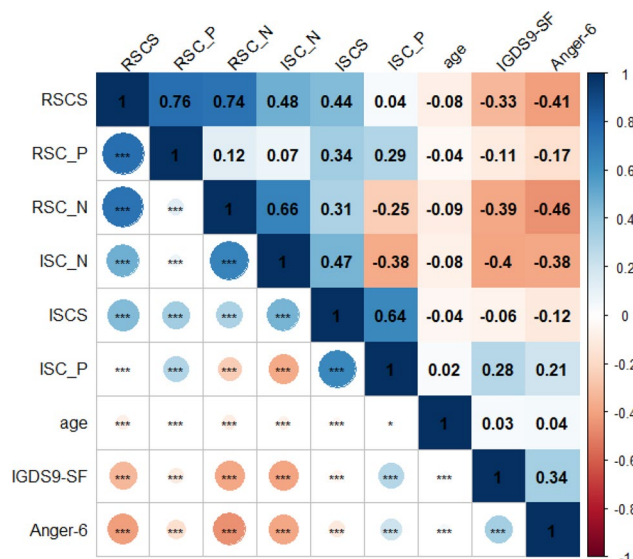
BMI: Body mass index; IGDS9-SF: 9-item Internet Gaming Disorder Scale-Short Form; IGD: Internet gaming disorder; RSCS: Social Connectedness Scale in reality; RSCS\_P: 10 positive-item score of Social Connectedness Scale in reality; RSC\_N: 10 negative-item score of Social Connectedness Scale in reality; ISCS: Social Connectedness Scale in Internet; ISCS: Social Connectedness Scale in Internet score; ISC\_P: 10 positive-item score of Social Connectedness Scale in Internet; ISC\_N: 10 negative-item score of Social Connectedness Scale in Internet; Low RSC: total score of SCS in reality  $\leq 70$ ; Low ISC: total score of SCS in internet  $\leq 70$

**Table 2** Risk factors for having severe anger

	Number	Prevalence rates (95%CI)	OR1 (95%CI)	p1	OR2 (95%CI)	p2
<b>Total</b> (n = 9616)	364	3.79 (3.40, 4.17)				
<b>Age</b>	-	-	0.92 (0.86, 0.98)	<b>0.005</b>	0.89 (0.83, 0.96)	<b>0.002</b>
<b>BMI</b>	-	-	1.03 (0.98, 1.06)	0.06	1.02 (0.99, 1.05)	1.14
<b>Sex</b>				<b>&lt;0.001</b>		<b>&lt;0.001</b>
Male (n = 4664)	110	2.36 (1.92, 2.79)	1		1	
Female (n = 4955)	254	5.13 (4.51, 5.74)	2.47 (1.90, 3.17)		2.16 (1.67, 2.79)	
<b>Having-sibling</b>				0.07		0.13
Yes (n = 5317)	224	4.21 (3.67, 4.75)	1.23 (0.98, 1.55)		1.20 (0.95, 1.52)	
No (n = 4299)	140	3.26 (2.72, 3.79)	1			
<b>Probable IGD</b>				<b>&lt;0.001</b>		<b>&lt;0.001</b>
Yes (n = 197)	38	19.29 (13.73, 24.85)	8.07 (5.33, 12.22)		5.17 (3.30, 8.08)	
No (n = 9419)	326	3.46 (3.09, 3.83)	1		1	
<b>Low ISC</b>				<b>&lt;0.001</b>		0.80
Yes (n = 1002)	96	9.58 (7.76, 11.41)	1.73 (1.34, 2.24)		0.96 (0.73, 1.28)	
No (n = 8004)	268	3.01 (2.65, 3.36)	1		1	
<b>Low RSC</b>						<b>&lt;0.001</b>
Yes (n = 1056)	163	15.44 (13.25, 17.62)			7.21 (5.61, 9.27)	
No (n = 8560)	201	2.35 (2.03, 2.67)			1	

OR1 is adjusted for age, BMI, sex, having-sibling, probable IGD, and low ISC score and

OR2 is adjusted for age, BMI, sex, having-sibling, probable IGD, low ISCS and low RSCS

BMI: body mass index; IGD: Internet gaming disorder; ISC: Social Connectedness in Internet; RSC: Social Connectedness in reality; Low RSC: total score of SCS in reality  $\leq 70$ ; Low ISC: total score of SCS in internet  $\leq 70$ **Fig. 1** Matrix graph of Spearman analysis. Abbreviations: SCS: Social Connectedness Scale; RSCS: Reality SCS Score; RSC\_P: 10 positive-item score of Reality SCS; RSC\_N: 10 negative-item score of Reality SCS; ISC\_N: 10 negative-item score of Internet SCS; ISCS: Internet SCS; ISC\_P: 10 positive-item score of Internet SCS; IGDS9-SF: 9-item internet gaming disorder scale-short form scores; Anger-6: Anger-6 scale scores; \*\*\*:  $p < 0.001$ , \*\*:  $p < 0.01$ , \*:  $p < 0.05$ 

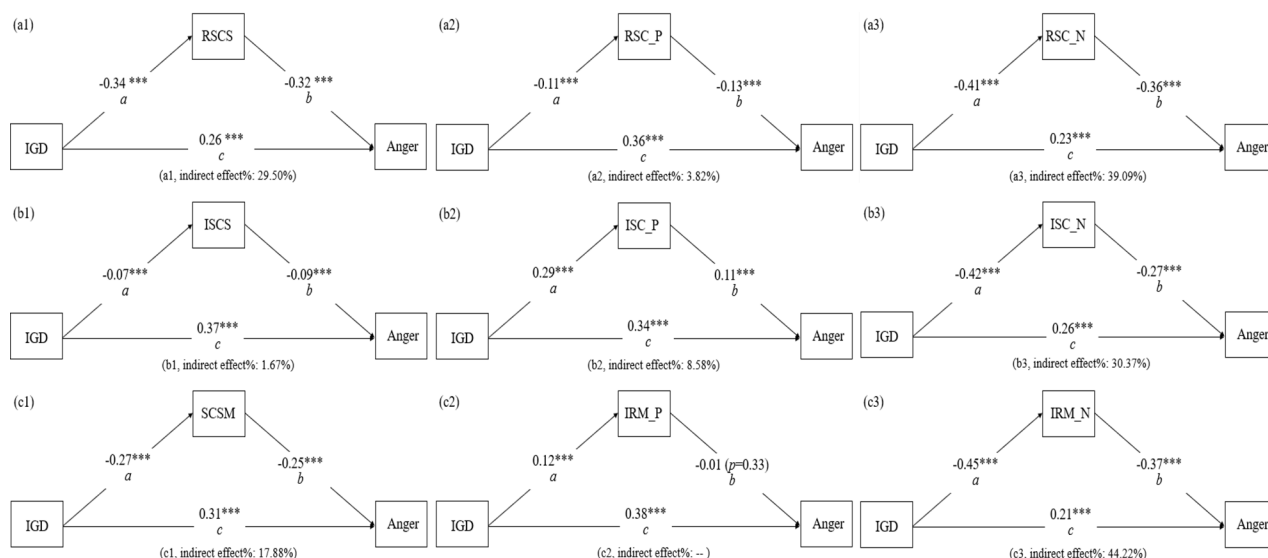
have  $p$ -value less than 0.001 (Supplementary materials Table S1).

### Mediating model

Due to younger-adolescents and female were independent risks for severe anger in the logistic-regression (Enter) model, we controlled age, sex and sampling-region variables as confounding factors in mediation analyses (Fig. 2). These findings were showed that RSCS, ISCS and SCSM score were significant mediators of the association between IGDS9-SF and Anger-6 score. Meanwhile, significant direct-effects of IGDS9-SF score to Anger-6 score were found in all models. RSCS, ISCS and SCSM scores were significant associated with Anger-6 score ( $p < 0.001$ ). Namely, RSCS, ISCS and SCSM scores partially mediated the effects of IGDS9-SF score on Anger-6 score with the indirect-mediation effects of 29.50%, 1.67% and 17.88%. All of abovementioned mediation models have  $p$ -value less than 0.001. The RSC\_P, ISC\_P, RSC\_N, ISC\_N, and IRM\_N scores on IGDS9-SF score to Anger-6 score presented similarly indirect-mediation effects ( $p < 0.001$ ), except for IRM\_P ( $p = 0.33$ ). These indirect proportion of above-mentioned mediators were 3.82%, 8.58%, 39.09%, 30.37% and 44.22%, respectively (Fig. 2, a2-c2 & a3-c3). Those effect-size values of mediation analyses both in standardized and unstandardized models were specifically show in Supplementary materials Table S2.

In order to explore the difference of mediation analyses between different sex, we recalculated same mediation-analyses among male and female adolescents, respectively. Final results also suggested that the





**Fig. 2** Mediation analysis. *Abbreviations:* IGD: Internet gaming disorder; SCS: Social Connectedness Scale; RSCS: Reality SCS Score; RSCS\_P: 10 positive-item score of Reality SCS; RSC\_N: 10 negative-item score of Reality SCS; ISCS: Internet SCS; ISC\_P: 10 positive-item score of Internet SCS; ISC\_N: 10 negative-item score of Internet SCS; SCSM: mean value of RSCS and ISCS; IRM\_P: mean value of ISCS and RSCS in 10 positive items; IRM\_N: mean value of ISCS and RSCS in 10 negative items; indirect effect%: the ratio of indirect effect to total effect; \*\*\*,  $p < 0.001$

abovementioned findings of mediation-analyses among total sample were similar with subgroup in gender (Supplementary materials Figs. 2 & 3).

## Discussion

Based on Person-Affect-Cognition-Execution hypothesis, this study furtherly explored the association between IGD, social-connectiveness and anger, and finally found that low social-connectiveness with reality could partly mediate the effect of IGD to anger. Meanwhile, we have found the difference of social-connectiveness between reality and internet, and even heterogeneity in positive and negative dimension of SCS. The last but not least, an interesting finding showed that the detection rate of low social-connectiveness in reality was higher than probable IGD and severe anger. These results indicated that not only should distinguish the difference of social-connectiveness with reality or internet and it's different dimensions of SCS in scientific research, and also necessary to strengthen the attention to social-connectiveness with reality in term of educators and clinicians to avoid emotional imbalance and maladaptive behavior.

Firstly, our findings indicated that higher social-connectiveness in reality was protective factor for severe anger, while IGD severity was risked factor. Meanwhile, higher social-connectiveness in reality was protective factor for IGD, while positive dimension of social-connectiveness with internet was risked indicator. These results suggested the association between IGD with social-connectiveness and anger, and the difference in social-connectiveness between reality and internet. In consistence with existed literatures, Internet game might

help adolescents to escape negative life events and physical isolation for a short time, thus some adolescents may failure to digest maladaptive mood in a long-time and could destroy ecosphere of interpersonal-communication, leading to low social-connectedness with reality and anger [13, 47]. Moreover, mediation analyses in our study also indicated that low social-connectiveness with reality could explain the partly effect of IGD in contribution to anger with indirect effect of 29.5%. If social-connectiveness is a significant biomarker of self-attributed cognition in interpersonal relatedness, IGD adolescents with low social-connectiveness in reality may have less capacity of appraisal-bias on risk-benefit system [34, 35, 44] that may cause significantly negative mood and behavior [18]. Due to that above results based on cross-sectional design might have limited capacity to ensure this assumption, which low reality social-connectiveness could partially enhance the contribution of IGD to anger, failure to verify their casus and effect [48]. Even so, these findings might provide some worthwhile directions for educators and clinicians. Given that detection rate of low social-connectiveness with reality (10.98%) was higher than probable IGD (2.05%) and severe anger (3.79%), which should be a more effective and routine index among IGD adolescents to early recognize potentially severe consequences. Therefore, school educators and clinical workers should pay more attention on it and could attempt to improve their social-connectiveness with reality to avoid mood imbalances and maladaptive behavior.

Meanwhile, correlations between different dimensions of SCS in reality or internet with IGD and anger were diverse in our study. For instance, negative dimensions

of SCS both in reality and internet were protective indexes for IGD, while positive dimension of SCS in internet was risked factor. Negative dimensions of RSC, ISC and their mean-value (IRM) could explain more significant mediated-effect of IGD to anger with indirect effect higher than 29.5%. The indirect mediation-effect of 29.5% belonged to RSCS was moderate effect-size [49], furtherly verified abovementioned assumption that the development of IGD to anger might partly mediate by low social-connectedness with reality. Hence, we not only should strengthen the difference of social-connectedness between reality and internet, and also should distinguish their heterogeneous dimensions in position and negation. Although prior study suggested that virtual game could promote mental and physical health by improving virtual socialization [50]. Combined with our findings, the essentiality of social-connectedness should be distinguished for their difference in reality and internet. Even though virtual game may provide better online social-connectedness to improve mental health for short stage, specific connective objects (reality vs. internet) and long-term negative consequences should be taken seriously and identified. Moreover, educators and clinicians could improve social connectedness in reality by restructuring adaptive cognition, strengthening team activities, learning corresponding knowledge and providing the counseling.

In addition, male adolescent might be vulnerable to develop IGD and the female youngsters become severe anger in this survey. Given the difference of gender on the influence for IGD and severe anger, mediation analyses had been recalculated in total sample, male sample and female sample. Finally, all results furtherly indicated that social-connectiveness could partly mediate the influence of IGD to anger whether in total, male or female sample. Although males seemingly tend to have higher detection-rate of IGD than females [51], the specific conclusion and mechanisms remain unclear for some confounding factors including sample methods and size of investigation on the epidemiology. Based on published evidences on sex difference, males commonly have higher risks than females [52, 53], especially among younger adolescents [3, 54], while some authors hypothesized that differences in emotional regulation and processing of feedback should be concerned warrant additional consideration [55–58]. Moreover, the prevalence rates of IGD were different between four different cities across different dimensions of China possibly due to different culture and geographical environment, which need to furtherly study.

Several limitations should be acknowledged about this study. First, due to simultaneity in exposure, outcome and covariate factors of the cross-sectional study, we only could attempted to verify the association between IGD, SCS and anger rather than the casus and effect [48].

Because causal inference based on observable sequence should be verified by prospective study for example longitudinal cohort, which ought to be needed in the future [59]. Second, this study used self-report scales to primary screening probable IGD, low social-connectivity and severe anger, but cannot to diagnose due to systematic appraise and objective indexes. Moreover, self-reported study has some disadvantages on inaccurate answer and recall bias. Therefore, future studies based on objective measures (gene or imaging) should be conducted to study. Thirdly, based on early literatures, other potential mediators (depression and anxiety), early childhood negative experiences, familial styles might also play an important impact on the development of an IGD among adolescents [60, 61]. Moving forward, some unmeasured confounding variables in this study, such as individual vulnerability (depression, anxiety, academic pressures, family dynamics and parental psychopathology), sociocultural factors (gender role expectations, social economy, cultural differences and mobility), and environmental situations (geography, family roles, school refusal, negative life event), need be deeply explored by controlling potential confounding in the future. The last but not least, sample-size of four cities was significant different and can't suitably controlled internal correlation, which might cause some sampling error and should be concerned in future research.

## Conclusion

In the study, we found that IGD could not only have direct effect on severe anger and also have indirect contribution to severe anger partially mediated by low social-connectedness with reality. Furthermore, the difference of social-connectedness in reality and internet, and difference in positive and negative dimension of SCS should be concerned by further study. Improving social-connectedness with reality may be a potentially effective method to avoid many serious consequences among adolescents.

## Abbreviations

IGD	Internet gaming disorder
SCS	Social Connectedness Scale
RSCS	Reality social-connectedness
ISCS	Internet social-connectedness
DSM-5	Diagnostic and Statistical Manual of Mental Disorder
ICD-11	International Statistical Classification of Diseases and Related Health Problems
IGDS9-SF	9-item Internet Gaming Disorder Scale-Short Form
Anger-6	6-item DSM-5-TR-Level 2-Anger
SCS_P	10 positive items of Social Connectedness Scale
SCS_N	10 negative items of Social Connectedness Scale
SCSM	Mean value of RSCS and ISCS score
IRM_P	Mean value of RSC_P and ISC_P score
IRM_N	Mean value of RSC_N and ISC_N score
aOR	Adjusted odds ratios

## Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-025-23142-z>.

Supplementary Material 1

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## Author contributions

YX prepared data, planned and performed the analyses, and wrote the manuscript. TL assisted in the preparation of data and the analysis, and produced the figures. XJQ and CXS developed the methods for the estimation. TXD checked the analyses and revised the manuscript. XJJ was PI for the study, planned the analyses and was responsible for the full draft of the manuscript. All authors read and approved the final manuscript.

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## Data availability

No datasets were generated or analysed during the current study.

## Declarations

### Ethics approval

The study was carried out the principles of Declaration of Helsinki, and approval by the Ethics Committee of West China Hospital, Sichuan University (NO. 2019–907). All the students who were willing to participate in this study were informed of the study purpose and Internet-based informed consent forms were signed by both participants and their guardians.

### Consent for publication

NA.

### Competing interests

The authors declare no competing interests.

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