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The association between a stress-is-enhancing mindset and internet gaming disorder was mediated by behavioral disengagement among medical undergraduate students: a multi-center survey in China

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Abstract

Background The stress-is-enhancing mindset has beneficial effects on physical, psychological, and emotional well-being. However, its association with internet gaming disorder (IGD) had not been investigated. By integrating stress mindset into the cognitive evaluation process of commonly used stress coping theories, this study examined the association between stress mindset and IGD and explored relevant mediation mechanisms via behavioral disengagement. The gender differences in the above associations and mediations were also explored.

Methods An online, anonymous, cross-sectional survey was conducted among medical undergraduate students from seven cities (Baotou, Qiqihar, Harbin, Wenzhou, Guangxi, Dali, and Shantou) in China from December 2023 to February 2024. The final sample size was 8,552 (a mean response rate of 71.0%). The DSM-5 IGD Checklist, the Stress Mindset Measure-General, and the behavioral disengagement subscale of Brief-Coping Orientation to Problems Experienced Inventory were used to assess IGD, stress mindset, behavioral disengagement, respectively. Multivariate logistic regression analyses were conducted to test the significance and direction of the determinants of IGD. Path analysis was performed to examine the mediation mechanisms and the moderation effect of gender. All these analyses were adjusted for background factors.

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Results Of all participants, the prevalence of IGD was 7.5%, and males had significantly higher prevalence than females (14.7% versus 7.4%, $p < 0.001$). Multivariate logistic regression analyses found that the stress-is-enhancing mindset was negatively associated with IGD (ORa = 0.94, 95% CI: 0.92 ~ 0.97) while behavioral disengagement was positively associated with IGD (ORa = 1.66, 95% CI: 1.57 ~ 1.76). Path analysis found that behavioral disengagement fully mediated the association between stress mindset and IGD, i.e., the stress-is-enhancing mindset was negatively associated with behavioral disengagement, which in turn was positively associated with IGD. However, gender did not significantly moderate the associations between stress mindset and behavioral disengagement, between behavioral disengagement and IGD, and between stress mindset and IGD.

Conclusions This study observed the relatively high prevalence of IGD among Chinese medical undergraduate students. It also revealed that the stress-is-enhancing mindset was potentially protective against IGD, and behavioral disengagement might fully explain such a beneficial effect. Future longitudinal and interventional studies are needed to verify and extend these findings.

Keywords Stress mindset, Internet gaming disorder, Avoidant coping, Medical students, China

Introduction

Internet gaming disorder (IGD) was first introduced as a condition warranting more clinical research and experience in the *Fifth Edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5)* in 2013, including nine clinical symptoms of preoccupation, withdrawal, tolerance, unsuccessful attempt to control gaming, loss of interest in previous hobbies due to gaming, continued gaming despite psychosocial problems, deception of gaming time, gaming for escapism, and significant negative consequences due to gaming [1]. It was then included as a subtype of gaming disorder, which is characterized by a pattern of persistent and recurrent gaming behaviors manifested by symptoms of impaired control over gaming, increasing priority given to gaming, and continuation and escalation of gaming despite negative consequences, in the *11th Revision of the International Classification of Diseases (ICD-11)* in 2018 [2]. This medicalization process has officially defined IGD as a mental disorder. IGD could cause significant impairments to academic performance, social well-being, and mental health among adolescents and young adults [3–5]. A review of 160 studies reported that the prevalence of IGD ranged from 0.21 to 57.50% in the general population globally; the wide range was probably due to the variations in the study population, regions, and assessment tools [6].

University students are a high-risk group for IGD, as they face various challenges related to academic performance, time management, financial strain, and social adjustment, all of which are risk factors of IGD [5, 7, 8]. Furthermore, due to a more intense curriculum, longer study duration, and exposure to clinical events, medical students tend to face more academic pressure, financial burdens, emotional strains, peer-based bullying/victimization, and clinical mental problems (e.g., alexithymia and depression) as well as lower levels of physical activities [9–16], predisposing them to greater risk of IGD. The extant literature reported that the prevalence of other types of digital addiction, including internet addiction, smartphone addiction, and social media addiction, were in general higher in medical than non-medical university/college students [17–19]. However, there is a lack of empirical evidence on the comparison of IGD prevalence. In China, the prevalence of IGD ranged from 5.5 to 14.8% among university students [20–23], but, to our knowledge, only one study reported the prevalence of 19.7% among Chinese medical students specifically [24]. International data is also scarce; only eight studies were located, reporting that the prevalence of IGD ranged from 2.0 to 20.0% in India, Indonesia, Saudi Arabia, Egypt, and Iran [25–32]. More evidence is needed to understand better the prevalence and factors of IGD in medical students.

The Transactional Model of Stress and Coping [33] was used as the theoretical foundation of this study. The model postulates that individuals would evaluate whether a stimulus would be stressful (i.e., the cognitive appraisal process) [34]. The evaluation would then affect the selection of coping strategies for the stressor, which would, in turn, determine the health outcomes, including behavioral addictions [35–37]. This study was novel to integrate the concept of stress mindset into the cognitive appraisal process of this model. Mindset is defined as one's connected beliefs about certain physical or mental phenomena [38]. Accordingly, a stress mindset refers to the belief on whether the stress would enhance or weaken one's productivity, health, well-being, learning, and growth, i.e., the variations in viewing the nature of stress [39]. It represents a continuum with two extremes: the stress-is-enhancing mindset and the stress-is-debilitating mindset. The former considers the nature of stress as an opportunity for personal growth and gain, while the latter perceives it as a source of damage and loss [40]. Stress mindset was in general associated with physical, emotional, mental, and social well-being. Those holding a stress-is-enhancing mindset tend to have more

adaptive cortisol reactivity profiles and cognitive flexibility, reflecting favorable responses to stress and mood [41–43]. In addition, to our knowledge, the sole study targeting university students found that those with a stress-is-enhancing mindset had better physical and psychological well-being, stronger academic performance, improved coping skills, greater resilience, stronger tolerance of uncertainty, and more energy than those with a stress-is-debilitating mindset [37]. Given these potential multidimensional benefits, it was assumed that the stress-is-enhancing mindset would protect against IGD, but no studies investigated such an association specifically. Despite the absence of empirical studies, the negative association between the stress-is-enhancing mindset and IGD could be supported by the Cognitive-Behavioral Model of Pathological Internet Use postulating distorted perceptions of the self and the world (e.g., stress-is-deliberating mindset) would increase the likelihood of specific pathological internet use (e.g., IGD) [44].

Coping strategies refer to strategies that individuals use to manage stress and negative emotions, including adaptive (e.g., problem-focused coping) and maladaptive (e.g., avoidant coping) coping strategies [45]. Being representative of maladaptive coping strategies [46], avoidant coping strategies (e.g., behavioral disengagement) tend to direct people at escaping, rather than actively addressing, the stressor or negative emotions [47]. Avoidant coping strategies are particularly important in addiction research; they are known predictors of IGD [48, 49], as internet gaming is an effective platform for escaping stress and negative emotions from real life [50, 51]. Specifically, behavioral disengagement refers to the tendency to relinquish one's efforts toward achieving a goal hindered by a stressor, effectively withdrawing from the challenges rather than confronting them [52, 53]. Theoretically, the Compensatory Internet Use Theory postulates that individuals disengaging from real-world stressors may turn to internet gaming as a compensatory behavior for escapism and the fulfillment of unmet psychological needs, leading to the increased risk of pathological internet use (e.g., IGD) [44]. This and other empirical evidence [54–56] support the positive association between behavioral disengagement and IGD. In addition, a stress mindset could be a form of the cognitive appraisal process as aforementioned [34, 39]. According to the stress coping model, stress mindset (the cognitive appraisal process) would affect the coping strategies, which would in turn affect the health outcome [34]. Furthermore, the Learned Helplessness Theory postulates that the negative interpretation of stressful events (e.g., stress-is-deliberating mindset) would weaken one's belief in his/her capability in achieving goals, resulting in the adoption of avoidant coping strategies [57]. The negative associations between the stress-is-enhancing mindset and avoidant coping strategies (including behavioral disengagement) have also gained empirical support [39, 42, 58]. An intervention study further found that an increased stress-is-enhancing mindset was associated with decreased avoidant coping strategies among medical students [59]. Based on the above, it was hypothesized that behavioral disengagement would mediate the association between stress mindset and IGD. This mediation mechanism was also supported by the stress belief model proposing that individuals' beliefs about stress (e.g., stress mindset) would influence health and behavioral outcomes directly or indirectly via coping strategies [37, 60, 61]. However, to our knowledge, this theoretical assumption had not been empirically tested.

This study further examined the gender differences in the mediation mechanism of stress mindset → behavioral disengagement (avoidant coping strategies) → IGD, based on the potential gender differences in stress mindset, coping strategies, and IGD. First, females tended to report a stronger stress-is-deliberating mindset than males as females were more likely to make negative comments about stressful situations [62]. Second, females were more likely than males to use maladaptive coping strategies, including avoidant coping [63–65]. However, the positive association between avoidant coping and IGD might be significant only in males but not in females [64]. Such indicates a potential gender difference in the association between avoidant coping strategies and IGD. Last, it was extensively reported that males demonstrated a much higher risk of IGD than females [5, 66–68]. Such was also true in medical students [29, 31, 69, 70].

Given the background, this study aimed to investigate the prevalence of IGD among medical undergraduate students from seven Chinese cities and its associations with stress mindset and behavioral disengagement. Furthermore, the mediation effect of behavioral disengagement on the association between stress mindset and IGD was examined. It was hypothesized that the stress-is-enhancing mindset would decrease behavioral disengagement, which would in turn reduce the risk of IGD (Fig. 1a). Furthermore, the moderation effect of gender on this mediation mechanism was tested. It was hypothesized that there would be gender differences in the associations between stress mindset and behavioral disengagement, between behavioral disengagement and IGD, and between stress mindset and IGD (Fig. 1b).

Methods

Study design, participants and data collection

A cross-sectional study was conducted among undergraduate students from medical universities/colleges in seven Chinese cities from December 2023 to February 2024, including Baotou (North China), Qiqihar and Harbin (Northeast China), Wenzhou (East China), Guangxi

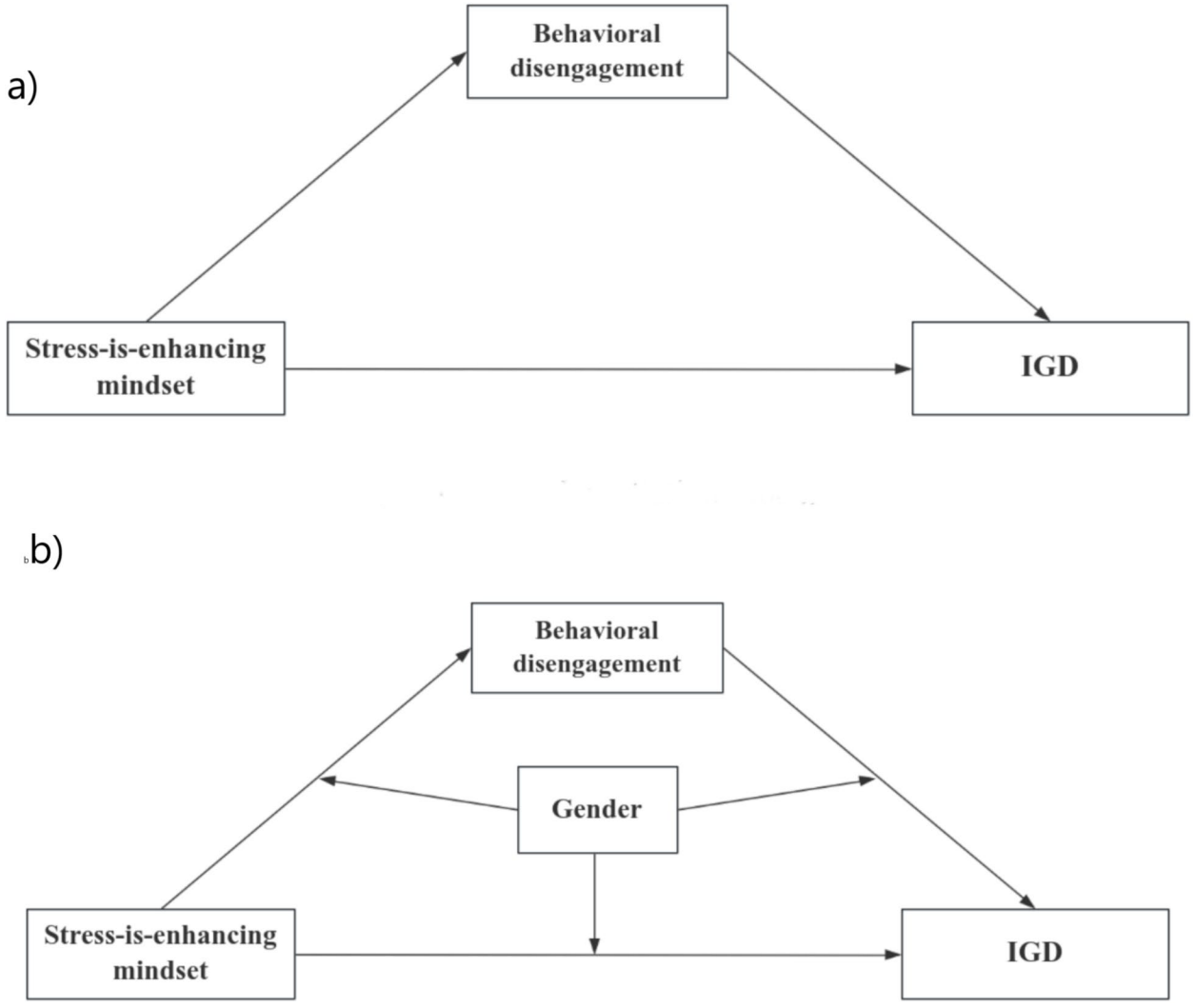

Fig. 1 Diagrams for key research hypotheses. (**a**) Proposed mediation model. (**b**) Proposed moderated mediation model

and Dali (Southwest China), and Shantou (South China). The inclusion criteria included: (a) age of 18 or above, (b) a full-time medical undergraduate student, (c) being able to read and write Chinese, and (d) being willing to participate in this study and provide informed consent. Exclusion criteria included those who refused to participate in this study and failed to pass the quality check of the completed questionnaire. Stratified cluster sampling was adopted. In all participating universities/colleges, undergraduate students who were majoring in clinical medicine and non-clinical medicine (e.g., pharmacy) were recruited with a ratio of 1:1 in all five grades (undergraduate medical education in China in general takes five years). In each grade, all students of the randomly selected classes were invited to participate in this study with the help of the corroborating teachers and student helpers. An invitation letter, a hyperlink with access to an online questionnaire, and several reminders were sent to the students via WeChat groups that were used for in-class communication. Students were pre-briefed about the objective, content, and voluntary nature of the survey in both the invitation letter and the cover page of the questionnaire. They were also required to endorse a question indicating that they fully understood the briefing information and were willing to participate in the study; no signature was requested to maintain anonymity. After obtaining the informed consent, the students self-administered the questionnaire which took about 20 to 30 min to complete. Upon submitting the completed questionnaire, the students could voluntarily join a lottery draw offering four prizes of 100 RMB (about 14 USD), six prizes of 50 RMB (about 7 USD), and 20 prizes of 20 RMB (about 3 USD). This study was approved by the ethics committee of Wenzhou Medical University (Ref No. 2023-017; date of approval: December 5, 2023).

In total, 12,912 invitations were sent out, of which 9,163 returned the completed questionnaire; the response rate was 71.0%. A total of 611 questionnaires were further

removed due to low quality (e.g., short completion time of ≤ three minutes). The final sample size was 8,552 in this study. Of all participants, the mean age was 19.91 (SD = 1.54; range = 18 ~ 30) years; more than half were female (64.0%). The proportions of participants recruited from Baotou, Qiqihar, Wenzhou, Guangxi, Dali, Harbin, and Shantou were 24.6%, 20.8%, 15.5%, 11.1%, 10.2%, 9.9%, and 7.9%, respectively.

Measures

Background factors

Background information was collected, including gender, age, study of year, city of study, study major, whether being a local student, and self-rated relative family financial situation (see Supplementary materials).

Internet gaming disorder (IGD)

The DSM-5 IGD Checklist was developed according to the nine clinical symptoms of IGD in DSM-5 [71]. Its Chinese version has been translated and validated among Chinese adults by Sigerson, et al. and Ko, et al. [72, 73]. The checklist assesses the presence of nine IGD symptoms in the past 12 months, including (1) preoccupation, (2) withdrawal, (3) tolerance, (4) unsuccessful attempts to control internet gaming, (5) loss of interest in previous hobbies due to internet gaming, (6) continuation of excessive gaming despite psychosocial problems, (7) deceiving family members or others regarding the amount of internet gaming, (8) using internet gaming to escape from negative moods, and (9) jeopardising or losing a significant relationship, education or career opportunity due to internet gaming [1]. The items were assessed by using the binary response options (0 = no; 1 = yes), and the checklist included nine items in total. A summative score was calculated (range = 0 to 9); higher scores indicated more IGD symptoms. Those who scored five or higher levels were considered as IGD cases. The Cronbach's alpha of the checklist was 0.86 in this study.

Stress mindset

The Stress Mindset Measure-General (SMM-G) was developed by Crum, et al. [41], and its Chinese version was translated and validated among Chinese adults by He, et al. [74]. The scale assessed individuals' beliefs and attitudes towards stress. A sample items include: "experiencing stress facilitates my learning and growth". The items were rated with a 4-point Likert scale (0 = strongly disagree to 4 = strongly agree), and the scale included eight items in total with no reverse scoring. The total score ranged from 0 to 32, with higher scores indicating higher levels of the stress-is-enhancing mindset. The scale has also been applied to general college students [75] and medical students [59] in China. The Cronbach's alpha of the scale was 0.63 in this study.

Behavioral disengagement

The behavioral disengagement subscale of the Brief-Coping Orientation to Problems Experienced Inventory (Brief-COPE) was used. The Brief-COPE was developed by Carver et al. [76], and its Chinese version has been translated and validated by Su, et al. [77]. The scale assessed individuals' tendency to adopt behavioral disengagement; the two items were "I've been giving up trying to deal with it" and "I've been giving up the attempt to cope". The items were rated with a 4-point Likert scale (0 = I haven't been doing this at all to 3 = I've been doing this a lot), of which both do not have reversed scoring. The total score ranges from 0 to 6, with higher scores indicating higher frequencies of adopting behavioral disengagement. The Cronbach's alpha of the subscale was 0.83 in this study.

Statistical analysis

Statistical analysis was performed by using SPSS version 20.0 and Mplus 8.0. IGD was treated as a binary dependent variable in this study. Continuous variables were described by reporting mean [standard deviation (SD); range] scores, while categorical variables by frequencies and proportions. The between-group difference in the prevalence of IGD by gender was examined by using the Chi-square test. Univariate and multivariate (with the adjustment of background variables) were conducted to examine the factors of IGD (stress mindset and behavioral disengagement). Crude odds ratios (ORc), adjusted odds ratios (ORa), and corresponding 95% confidence intervals (CIs) were reported. Path analysis was conducted to test the mediation effect of behavioral disengagement on the association between stress mindset and IGD, after adjusting for background variables. The effect size of the indirect effect (if significant) was calculated by dividing the indirect effect by the total effect. Furthermore, the moderation effects of gender on the three structural paths of the mediation model were examined, with the adjustment of background factors. In each path, a corresponding interaction term was generated, and its significance was tested to indicate whether the moderation effect exists. All the above path analysis models used the bootstrapping method (sampling times = 5,000) and the estimator of Weighted Least Square with Mean and Variance (WLSMV). Statistical significance in this study was defined as a two-sided p-value < 0.05.

Results

Participants' background characteristics

Of all participants the majority were of lower grades (Year 1 to Year 3: 80.8%) and non-local students (86.6%); over one-third majored in clinical medicine (33.4%), and 17.7% self-reported poor or very poor relative family financial situation (Table 1). The prevalence of IGD was

Table 1 Participants' characteristics

Variables	*n*	%
Overall	8,552	100
City of study		
Wenzhou	1,327	15.5
Dali	875	10.2
Guangxi	951	11.1
Harbin	845	9.9
Baotou	2,100	24.6
Qiqihar	1,780	20.8
Shantou	674	7.9
Gender		
Male	3,082	36.0
Female	5,470	64.0
Year of study		
Year1	2,861	33.5
Year2	2,096	24.5
Year3	1,954	22.8
Year4	1,178	13.8
Year5	463	5.4
Study major		
Clinical medicine	2,855	33.4
Non-clinical medicine	5,697	66.6
Local students		
Yes	1,150	13.4
No	7,402	86.6
Self-rated relative family financial situation		
Good/very good	1,437	16.8
Moderate	5,600	65.5
Poor/very poor	1,515	17.7
Internet gaming disorder		
No	7,907	92.5
Yes	645	7.5

7.5%; it was significantly higher in male than female students (14.7% versus 7.4%, $p < 0.001$).

The mean (SD; range) scores for stress mindset and behavioral disengagement were 17.09 (3.81; 0 ~ 32) and 3.97 (0.02; 2 ~ 8), respectively; such results were not tabulated.

Factors of IGD

Similar to the results of univariate logistic regression analyses, multivariate logistic regression analyses, after adjusting for background factors, showed that the stress-is-enhancing mindset was negatively associated with IGD (ORa = 0.94, 95% CI = 0.92 ~ 0.97) while behavioral disengagement was positively associated with IGD (ORa = 1.66, 95% CI = 1.57 ~ 1.76). In addition, male students had higher risk of IGD than females, with the adjustment of other background factors (ORa = 2.76, 95% CI = 2.33 ~ 3.26) (Table 2).

Mediation effect of behavioral disengagement on the association between stress mindset and IGD

Figure 2 presents the path analysis on the mediation effect of behavioral disengagement on the association between stress mindset and IGD, after adjusting for background factors. The results showed that stress-is-enhancing mindset was negatively associated with behavioral disengagement (β = -0.08; $p < 0.001$), which was positively associated with IGD ($\beta = 0.46$; $p < 0.001$). The direct effect of stress mindset on IGD was not statistically significant (β = -0.18; $p = 0.128$), indicating a full mediation effect via behavioral disengagement (β = -0.037; $p < 0.05$).

Moderation effect of gender on the mediation mechanism

Figure 3 presents the results testing the moderation effects of gender on the direct and indirect paths of the above mediation mechanism, after adjusting for background factors. As seen from the significance of the interaction terms, gender did not moderate the paths of stress mindset → behavioral disengagement ($\beta = 0.01$; $p = 0.538$), behavioral disengagement → IGD (β = -0.01; $p = 0.899$), and stress mindset → IGD ($\beta = 0.01$; $p = 0.735$), indicating that these associations did not differ between genders.

Discussion

This multi-center study observed the prevalence of IGD of 7.5% among medical undergraduate students in China. Although the prevalence was lower than that among medical students in Anhui, China (19.7%) [24], it was comparable to that of general students in Macao, China (7.4%) [23] and higher than that among freshmen in Hubei, China (5.5%) [21]. These studies used the same assessment tool and cut-off value (i.e., the DSM-5 IGD Checklist ≧ 5). Despite potential regional variations, medical students were considered to experience higher levels of academic stress (e.g., demanding curriculum)

Table 2 Logistic regression analyses examining the factors of IGD

	ORc (95%CI)	ORa (95%CI)
Stress-is-enhancing mindset	0.95 (0.93 ~ 0.97) ***	0.94 (0.92 ~ 0.97) ***
Behavioral disengagement	1.66 (1.57 ~ 1.76) ***	1.66 (1.57 ~ 1.76) ***
Gender		
Female	Reference = 1.0	Reference = 1.0
Male	2.78 (2.36 ~ 3.28) ***	2.76 (2.33 ~ 3.26) ***

Notes: IGD, internet gaming disorder; ORc, crude odds ratio; ORa, adjusted odds ratio; CI, confidence interval. The adjusted models were adjusted for the studied background variables, including gender, age, year of study, city of study, study major, whether being a local student, self-rated relative family financial situation

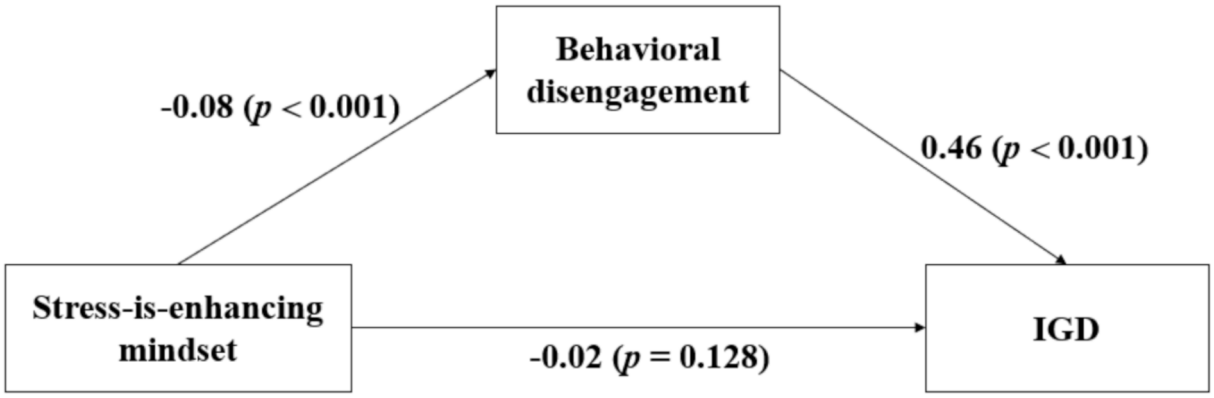

Fig. 2 Mediating effect of behavioral disengagement between the stress-is-enhancing mindset and IGD. (***, $p < 0.001$. Standardized coefficients were reported. The model was adjusted for background factors, including gender, age, grade, city of study, study major, whether being a local student, and self-rated relative family financial situation)

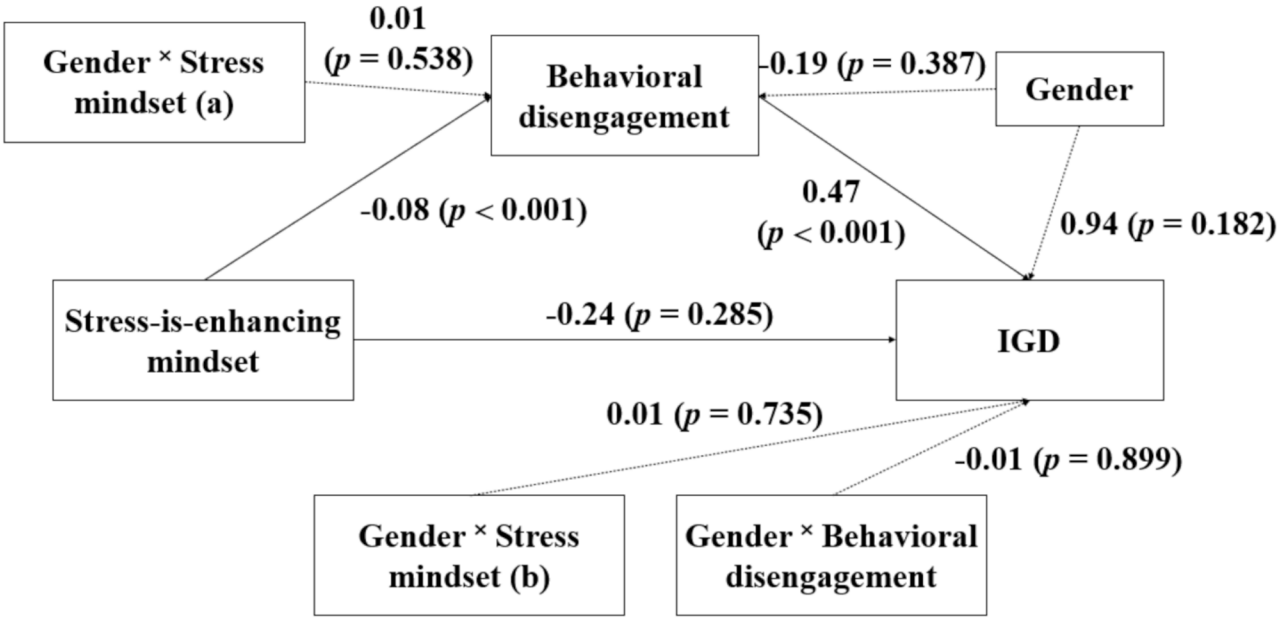

Fig. 3 The moderation effect of gender on the mediation mechanism. (Standardized coefficients were reported. Solid line = Statistically significant path; Dashed line = Statistically non-significant path. The model was adjusted for background factors, including age, grade, city of study, study major, whether being a local student, self-rated relative family financial situation)

[9], mental distress (e.g., anxiety) [78], and clinical psychological problems (e.g., alexithymia) [16], which might increase their risk of IGD [3, 10, 37, 79]. Nonetheless, the observed prevalence in this study was relatively high and highlights the need for a better understanding of the IGD development, maintenance, and interventions in this seemingly neglected population.

This study also observed that the prevalence of IGD among male students almost doubled over that of females (14.7% versus 7.4%), which corroborates previous findings that males were at greater risk of IGD than females [28, 31, 70]. Such may be explained by the gender differences in gaming motivations, brain responses, and psychosocial variables (e.g., social support). Male students tended to report stronger avoidant motivation for gaming than females [80], while avoidant motivation was positively associated with IGD [51, 81]. Neurologically, males demonstrated weaker control over game-elicited cravings and stronger mesocorticolimbic reward system activation and functional connectivity than females, increasing their risk of IGD due to weakened ability to identify the addictive risks and hazards related to internet gaming [82–84]. Females also tended to have stronger social support than males, which would reduce their risk of IGD [85]. Given the above, male students are a high-risk group that should be targeted in IGD interventions.

This study was the first to reveal the negative association between stress-is-enhancing mindset and IGD

specifically, although similar findings reported that the stress-is-enhancing mindset was associated with better physical, mental, and emotional outcomes [37, 42, 62, 86]. It also supports the Cognitive-Behavioral Model of Pathological Internet Use [44] as described in the Introduction. The protective effect of a stress-is-enhancing mindset may be explained by the behavior processing mode and psychological experience mode of stress [87]. Those holding a stronger stress-is-enhancing mindset tend to take actions to accept or utilize stress for enhancement instead of escaping or avoiding stress (e.g., gaming for escapism) [51]. Meanwhile, they were more likely to generate positive emotions in stressful situations and have fewer psychological problems [37, 86], and such would reduce their risk of IGD, as stress, anxiety, and depression were known determinants of IGD [10, 88, 89]. The findings of this study hence highlight the potential beneficial effects of the stress-is-enhancing mindset on IGD, and such a stress mindset might be particularly relevant for medical students who experience multiple sources of stress [90]. Notably, the stress mindset could be modified and cultivated. Brief interventions of watching multiple short videos demonstrated effectiveness in eliciting a greater stress-is-enhancing mindset among university students in the U.K [91]. and adolescents in Canada [92]. The other potentially effective interventions included the metacognitive approach (provisions of training on adopting an enhancing mindset in daily lives actively and deliberately) [93] and imagery-based intervention (using image videos of various stimuli for training on stress exposure and subsequently eliciting favorable responses and beneficial outcomes) [94].

This study further confirmed previous theoretical (e.g., the Compensatory Internet Use Theory) and empirical findings that behavioral disengagement was positively associated with IGD [44, 54–56]. As a typical type of avoidant coping strategies, behavioral disengagement means escaping from stress instead of directly addressing it [52, 53]. Addictive behaviors including internet gaming are typical avoidant behaviors disengaging with stressors and negative emotions [49], and, again, this avoidant motivation of internet gaming might be more prominent among medical students who face high levels of stress [95, 96]. Moreover, avoidant coping strategies were associated with more psychological problems (e.g., anxiety and depression), which would increase the risk of IGD as aforementioned [10, 97, 98]. Furthermore, this study revealed that behavioral disengagement fully mediated the association between a stress mindset and IGD, i.e., a stress-is-enhancing mindset might reduce behavioral disengagement, which might then reduce IGD. These results support the Transactional Model of Stress and Coping [33] and the stress belief model [37, 60, 61], both proposing that coping strategies would mediate between stress mindset and health outcomes. It also corroborates the Learned Helplessness Theory and empirical evidence regarding the negative association between the stress-is-enhancing mindset and avoidant coping strategies [39, 42, 57, 58]. Accordingly, modifications on behavioral disengagement could potentially and substantially enlarge the beneficial effects of a stress mindset on IGD. The literature has demonstrated several effective interventions for reducing avoidant coping strategies among university students, including the Stress Management Intervention Program (through raising awareness about stress, problem-solving training, instructions in self-expression skills, anger management, self-regulation, and activity planning) [99], the Transforming Stress Program (incorporating Cognitive Behavioral Therapy and Dialectical Behavioral Therapy) [59], and mindfulness-based interventions [100].

This study further observed that the significant associations between stress mindset and behavioral disengagement, between behavioral disengagement and IGD, and between stress mindset and IGD were consistent across genders, which was inconsistent with some previous findings. In literature, mixed results were reported. A study found that males were more likely to exercise avoidant behaviors (e.g., internet gaming) to cope with stress than females [101], while the other study showed that females adopted more frequently avoidant coping than males [102]. Furthermore, the positive association between avoidant coping and IGD was significant only among male university students but not among females [64], probably due to the increased amount of time and energy among males [103]. Such discrepancies may be associated with the characteristics of medical students. Individuals' views varied on the nature of stressors and subsequent coping strategies [60, 88]. Speculatively, academic stress is the primary stressor in both genders of Chinese medical students, and similar stressors might result in similar cognitive appraisal processes and coping responses.

This study has the strength of recruiting medical students from seven cities across China, which enhanced the geographical representativeness of the study population. In addition, this study was the first to identify stress mindset as a novel protective factor against IGD, along with relevant mediation mechanisms. These findings are implicative for future research. First, given that medical students represent a unique subgroup of undergraduate students facing a wider variety of stressors and heightened stress levels. Future studies could specify the sources of these stressors and explore their differential impacts on stress mindset, coping strategies, and IGD. Second, it is essential to verify whether the current findings are applicable to university students from different majors and other populations (e.g., middle school

students). Third, there is a lack of empirical studies comparing the prevalence and determinants of IGD between medical and non-medical students. Future research is recommended to recruit both groups simultaneously and clarify whether medical students were at a higher risk of IGD compared to their peers. Fourth, intervention studies aimed at IGD prevention may consider modifying the significant variables and mediation mechanisms identified in this study. Last, this study integrated the concept of stress mindset into the cognitive appraisal process of stress coping theories. Future studies could expand this angle by incorporating other stress-coping variables (e.g., coping flexibility), interpersonal (e.g., social support), and environmental (e.g., school climate) factors of IGD to provide a more nuanced understanding of IGD development.

This study has several limitations. First, although this multi-center study recruited participants from seven Chinese cities, the generalizability of the findings to other regions/countries should be made cautiously. This study focused on only medical students, and non-medical students were not recruited for comparison. Second, as the questionnaire was self-administered, there might be reporting bias (e.g., recall bias and social desirability bias). For instance, participants might underreport their levels of behavioral disengagement, which is less socially desirable. Third, the cross-sectional nature of this survey made it unable to generate causal/temporal inferences. In addition, there might be a bi-directional association between behavioral disengagement and IGD, as empirical studies reported that IGD cases tend to adopt more behavioural disengagement than non-IGD cases [54, 104]. Fourth, the effect size of the significant association between the stress-is-enhancing mindset and IGD was relatively small (ORa = 0.94, 95% CI: 0.92–0.97). It suggests that, despite being statistically significant, a stress mindset might have limited practical implications on individual IGD prevention. However, importantly, at the population level, moderate improvement in the stress-is-enhancing mindset might result in substantial benefits for the population of medical undergraduate students. Last, the DSM-5 IGD Checklist was used for the screening, rather than diagnostic, purpose, which might inflate the prevalence of IGD in this study.

In conclusion, this study was the first to report the IGD prevalence of 7.5% among Chinese medical university students. It also found that the stress-is-enhancing mindset was potentially protective against IGD, and the avoidant coping strategy of behavioral disengagement might fully explain such a beneficial effect. IGD intervention programs targeting medical university students could hence modify stress mindset and behavioral disengagement. This study is also theoretically implicative by integrating the concept of stress mindset into the stress coping theories.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12888-025-06910-4.

Supplementary Material 1

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Author contributions
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Data availability
The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study has been conducted in full compliance with the Declaration of Helsinki. All participants provided informed consent prior to their involvement in the study. The research protocol was approved by the ethics committee of Wenzhou Medical University (Ref No. 2023-017; date of approval: December 5, 2023).

Consent for publication
All participants in this study provided written informed consent for publication of the study results.

Competing interests
The authors declare no competing interests.

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