General Psychiatry

The mediating role of sleep quality on the relationship between internet gaming disorder and perceived stress and suicidal behaviour among Indian medical students

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To cite: Garg S, Kharb A, Verma D, *et al*. The mediating role of sleep quality on the relationship between internet gaming disorder and perceived stress and suicidal behaviour among Indian medical students. *General Psychiatry* 2023;**36**:e100997. doi:10.1136/gpsych-2022-100997

► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/gpsych-2022-100997).

Received 07 December 2022
Accepted 27 April 2023

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ABSTRACT

Background In the recent digital era, individuals with internet gaming disorder (IGD) have reported a much higher prevalence of poor sleep quality, perceived stress and suicidal behaviour. However, the underlying mechanisms for these psychological problems remain unknown.

Aims The primary aims of this study were to explore the mediating role of sleep quality on the relationship between IGD and the health outcomes of perceived stress and suicidal behaviour and to assess the prevalence and risk factors for IGD among medical students.

Methods A cross-sectional study enrolling 795 medical students from two medical colleges in a rural area of North India was conducted from April to May 2022. The study participants were chosen using a stratified random sampling approach. A self-administered questionnaire was used to collect data, including sociodemographic and personal information and gaming characteristics. The study also included the Gaming Disorder and Hazardous Gaming Scale, the Pittsburgh Sleep Quality Index, the Perceived Stress Scale-10 and the Suicide Behaviors Questionnaire–Revised to measure IGD, sleep quality, perceived stress and suicidal behaviour, respectively. Multiple logistic regression for the risk factors and Pearson's correlation test for the relationship between variables were used. Hayes' PROCESS macro for SPSS was employed to carry out mediation analysis.

Results Among the 348 gamers with a mean age of 21.03 (SD 3.27) years, the prevalence of IGD was 15.23% (95% confidence interval: 11.6% to 19.4%). In the correlational analysis, small to large (r: 0.32–0.72) significant relationships between scores of IGD and other health outcomes were established. The indirect effect (B=0.300) via sleep quality accounted for 30.62% of the total effect (B=0.982) of IGD on perceived stress (partially mediated), while sleep quality (B=0.174) accounted for 27.93% of the total effect (B=0.623) of IGD on suicidal behaviour (partially mediated). The factors of being male, living in a single-parent family, using the internet for other than academic purposes (1–3 hours and more than 3 hours/day), playing games for more than 3 hours/day and playing games with violent content were associated with IGD symptoms.

Conclusions Using a dimensional measure, the results specified the relationship between IGD and perceived stress and suicidal behaviour by demonstrating that sleep quality meditated them. This modifiable mediating factor can be addressed by psychotherapy to mitigate the risk of perceived stress and suicidal behaviour among the future medical workforce.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The recent literature has investigated the psychological factors responsible for perceived stress and suicidal behaviour among adolescents with internet gaming disorder (IGD). However, studies of this type for medical students, including what mechanisms underlie this relationship, are scarce.

WHAT THIS STUDY ADDS

⇒ The present study findings contribute to the understanding of covariates associated with IGD and the mediating role of sleep quality on the relationship between IGD and perceived stress or suicidal behaviour among medical students, particularly in the setting of Indian culture, which has received little attention in the literature. Managing the sleep quality of medical students is crucial to avoiding suicidal behaviour and mental stress that might result from problematic internet gaming.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Developing awareness of the detrimental consequences of gaming should be emphasised in supporting medical students with problematic gaming; a broader aim is to understand the conceptual traps that tend to minimise the intensity of perceived stress and suicidal behaviour in the students' real-world lives.

INTRODUCTION

In recent years, advances in gaming technology and internet connection speeds

have made internet gaming more enticing and accessible.[1] Internet gaming disorder (IGD) is becoming a widely recognised mental illness linked with substantial impairment and distress. The World Health Organization (WHO) identified IGD as a global public mental health concern and included its diagnosis in the International Classification of Diseases, 11th Revision in 2018.[2] A systematic review found IGD's global pooled prevalence to be 3.05%.[3] A recent survey concluded that around 35% of the Indian population (486 million) had become online gamers in 2021, of which 68% were students.[4] The increased academic and emotional stresses among medical students can instigate psychopathologies such as anxiety and specific addictive behaviours via mood regulation and escapism tendencies.[5–7] A meta-analysis identified the global pooled prevalence of IGD to be 6.2% among medical students.[8] Given that the literature has mostly come from a few developed countries,[5–8] it was recognised that little detailed data were known about IGD among Indian medical students. A recent study in India revealed that around 57% of medical students were involved in playing online games.[9] Among Indian medical students, IGD prevalence was found to range between 3.6% and 8.71%,[9–11] while a meta-analysis identified an approximately 3.8% pooled prevalence of IGD in this population.[8]

Researchers have examined the combined framework of resilience and risk (individual, age-related, and environmental risks and mitigating variables) to explain the development of addiction behaviour (IGD).[12] The literature has concluded that multiple variables, such as lower-quality child–parent/family relationships, single-parent families, decreased self-esteem and self-control, limited social connections, accomplishment collections, gaming duration, substance addiction and intense neuroticism, were found to be related to higher risk of IGD.[12–15] Via the neurocognitive framework, dysfunctional online gaming activities impact gamers' cognitive processes and brain functions (executive functions in accomplishing critical daily duties), further evoking feelings of powerlessness and increasing the probability of psychological problems.[16] Previously, persons with IGD were identified with specific problems, such as diminished academic performance, disregarded interpersonal relationships, and increased irritability, leading to emotional problems, stress, depression, anxiety, personality problems, self-harm behaviour and a substantial risk of suicidal behaviour.[1 17–19] Many researchers have consistently found bidirectional relationships between dysphoric states (perceived stress/suicidal behaviour) and IGD.[17 20] Based on this, the current survey proposed that IGD is related to perceived stress and suicidal behaviour among medical students (hypothesis 1).

Recent literature has investigated the psychological factors responsible for suicidal behaviour among adolescents with IGD[20]; however, similar data that include mechanisms underlying the relationship between suicidal behaviour and IGD are scarce. As proposed within this paradigm, the role of sleep quality may shed light into understanding this mechanism. Distinctly, problems with sleep quality can be both a consequence and a cause of mental disorders.[21] Some evidence has supported that excessive gaming behaviour among internet users has altered sleep regulation, including compensatory processes and circadian rhythm.[22] Earlier evaluations found that poor sleep quality was significantly associated with health outcomes such as psychological stress[23] and suicidal behaviour.[24] Wang *et al*[25] discovered that sleep quality appeared to be a relatively weak mediator, with only 17.9% of the indirect effect of IGD being mediated by stress. In contrast, another study[20] revealed that poor sleep quality mediated 39% of the indirect effect (potent mediator) of IGD on depression. A recent work conducted among Chinese adolescents identified a substantial link between IGD and suicidal behaviour through the mediating effect of depression.[26] Yu *et al*'s[20] study on the IGD–suicidal behaviour relation examined insomnia's invariable mediating effect size among Chinese adolescents. However, the literature has not reached an agreement about sleep quality's mediating effect on the IGD–suicidal behaviour relationship. A few studies that examined the mediation model with problematic internet gaming, psychological problems and sleep quality were conducted in Chinese and Western cultures,[20 25 27] but it remains unclear whether sleep quality has a distinguishable mediating effect in the Indian context. According to our proposed investigations, sleep quality is substantially related to IGD, perceived stress and suicidal behaviour (hypothesis 2), and sleep quality mediates the relationship among suicidal behaviour, psychological stress and IGD (hypothesis 3). Furthermore, early recognition of associated risky psychological covariates at an appropriate time could ameliorate the frequency of perceived stress and suicidal behaviour among problematic internet game users. Despite the plethora of research on this aspect among medical students, only a few studies in India[9–11] have considered the covariates associated with IGD. Moreover, no prior research within India has evaluated sleep quality's mediating role in linking perceived stress and suicidal behaviour with IGD, along with IGD's prevalence and covariates in the same research. Therefore, this research was conducted in two medical school centres within the same resource-constrained setting in India.

METHODS

Study design and settings

This cross-sectional descriptive study was conducted at two medical colleges within 1 km of each other in a rural area of North India and was performed from April to May 2022. It was designed and conceptualised at a tertiary care teaching hospital that allows only female students in the Bachelor of Medicine and Bachelor of Surgery course and both male and female students in postgraduate studies. The college had a total enrolment of 680 medical students, including 560 undergraduates and 120

postgraduates. The other teaching institution allowed only female students in the Bachelor of Ayurvedic Medicine and Surgery undergraduate course and had 300 undergraduates, including interns.

Sample size

The sample population for the study (n=795) was measured using a single-population proportion formula. The sample size ($N=Z^2P(1-P)/d^2$) was calculated at a 95% confidence interval (CI) (Z) with the following assumptions: the absolute precision was considered to be 2% (d); the estimated prevalence (P) of IGD in the earlier Indian survey was 8.65%,[11] along with consideration of the 5% non-response rate of the study population.

Study sample

All eligible students from both institutions, studying from the first to the fourth academic years of the undergraduate courses, internship and postgraduate courses; aged more than 18 years; adept in comprehending English; and who accorded informed consent, were accrued in the survey, while students unwilling to consent for their participation were eliminated from the survey (figure 1).

Sampling and data collection procedure

Each academic year's student stratum was created using a stratified random sampling procedure. Then, the total sample population was allotted proportionately to each stratum of the academic year of undergraduates (years 1–4 and internship) and postgraduates. Finally, all survey respondents from different academic years were selected and enrolled using a computer-generated random number table (figure 1). With the help of an audiovisual recorded message, one of the researchers briefed the participants about the importance of a person's mental status, the aim of the survey and the significance of authentic responses. The participants were also assured of the privacy and confidentiality of their particulars. All the informants at both institutions were guided so that they could raise any queries about the study before their inclusion. Then, the pro forma with detachable detailed sheets about the survey was distributed to all the medical students by hand during clinical postings or in their lecture theatres before their classes, and written informed consent was secured in advance from the respondents to extract the desired information under the observation of one of the researchers. Finally, departmental contact numbers and email addresses were provided to the participants for easy access to professional help regarding their mental health and issues, if needed. Among 795 selected respondents, 374 (47.04%) students were identified as gamers who answered 'yes' to the statement 'use of the internet for playing games in the last 12 months'. A total of 348 game players were recruited for the final analysis, as 26 students were excluded due to exaggerated responses (figure 1).

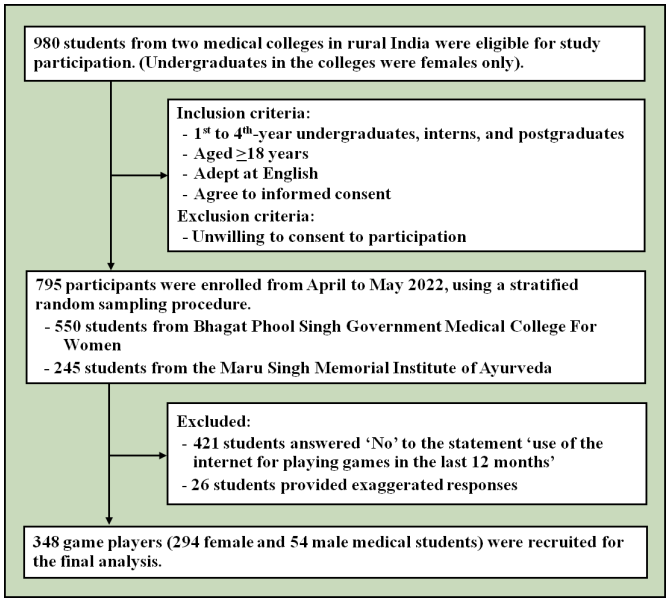

Figure 1 Flowchart of the study.

Data collection measures

Following extensive literature research, we devised survey questions regarding the content used in this study.[8–11 14 15 20 25] Then, we created a semistructured self-administered questionnaire. To investigate plausible issues, a pretest was conducted using this questionnaire on a group of 40 students from the same population (20 students from each institution). These students had no difficulty comprehending or responding to the questions. The final study did not include these responses. A self-administered questionnaire with sections 1–5 was used to gather the data: section 1 detailed concise information about the study's purposes; section 2 contained written informed consent; section 3 contained student background information (age, gender, locality, current living status, family type, family structure, relationship status, family and personal history of psychiatric illness, smoking and alcohol consumption status in the past 12 months, satisfaction with academic performance in the last session, and average use of the internet per day in hours); section 4 contained questions regarding students' gaming use characteristics (either using the internet for playing online games in the last 12 months, the average duration of gaming in hours per day or days/week, type of gaming gadget, expenditure per month spent on gaming, former long-term game companions, most preferred timing and location, and type of game); section 5 included the following screening scales: the Gaming Disorder and Hazardous Gaming Scale (GDHGS),[28] the Suicide Behaviors Questionnaire–Revised (SBQ-R),[29] the Perceived Stress Scale-10 (PSS-10)[30] and the Pittsburgh Sleep Quality Index (PSQI)[31] to measure IGD, suicidal behaviour, perceived stress and sleep quality, respectively.

Gaming Disorder and Hazardous Gaming Scale

GDHGS is a new, six-item scale designed by Balhara *et al*[28] to assess gaming disorders in adults. To diagnose IGD, two of the authors used a consensus procedure to add the word 'internet' before gaming in each item, which

was validated by a pretest. The initial five items are rated on a 5-point Likert-type scale using a frequency response chart. Each question was scored from 0 (never) to 4 (daily or almost daily). In the current survey, to diagnose IGD, the overall score was computed by summing the scores from the initial four items; the fifth item was set aside for hazardous internet gaming. A supplemental sixth item, evaluated in a 'yes' or 'no' format, was retained to look for any functional impairments across the subjects' distinct life domains. The presence of at least one substantial functional impairment in one life domain was required for the presence of IGD, but this was not considered when calculating the total GDHGS score. Respondents with a score of >9 were inferred to have IGD. In this survey, Cronbach's alpha (0.889) for this scale ranged between 0.835 and 0.958, signifying good internal consistency and reliability.

Suicide Behaviors Questionnaire–Revised Scale

SBQ-R is a multidimensional tool for evaluating the distinct aspects of suicidal behaviour, including four items.[29] In a structured diagnostic interview, a cumulative measured score of >7 was taken into account as the threshold score for the participants to have suicidal behaviour, with good sensitivity (94%) and specificity (96%). In this survey, Cronbach's alpha of SBQ-R was 0.806, signifying good internal consistency and reliability.

Perceived Stress Scale-10

The PSS-10 is a stress evaluation self-reported tool with 10 questions. Every question was assigned on a 5-point Likert-type scale ranging from 0 (not at all) to 4 (very often). Respondents with a score of 0–13 were inferred to have low/no stress, while respondents were assumed to be stressed (moderate/high) with a score of 14 or more.[30] In this survey, Cronbach's alpha (0.924) for this scale ranged between 0.762 and 0.925, signifying good internal consistency and reliability.

Pittsburgh Sleep Quality Index

The PSQI, which has 19 items, is an effective tool for evaluating the patterns and quality of sleep among adults. It distinguishes between 'poor' and 'good' sleep quality by monitoring seven sleep elements: subjective quality of sleep, sleep duration, sleep latency, habitual sleep efficiency, sleep disruption, daytime dysfunction and use of sleeping medications. In a structured diagnostic interview, a cumulative measured score of >6 was taken into account as the threshold score for the participants to differentiate sleep qualities, with good sensitivity (90%) and specificity (67%).[31] In this survey, Cronbach's alpha (0.931) for this scale ranged between 0.907 and 0.955, signifying good internal consistency and reliability.

Statistical analysis

The data's statistical analysis was performed using SPSS V.25.0, the Statistical Package for Social Sciences. The existing database's homogeneity was examined using the Shapiro-Wilk test. Cronbach's alpha was determined to assess the scales' internal reliability and consistency. Frequency and percentage estimates were conducted for categorical data, whereas mean (SD) measurements were performed for continuous variables. Then, univariate analyses of the association between exposure covariates and the outcomes were conducted using the χ^2 test. The independent risk factors were observed using multivariable logistic regression (adjusted odds ratios (AORs) with 95% confidence interval (CI)) analysis after adjusting the covariates which were significant ($p<0.05$) in bivariate analysis (crude OR (COR)). Pearson's correlation was used to evaluate the bivariate correlation coefficients. Hayes' PROCESS macro for SPSS was used to perform mediation analysis. A 10 000-sample bootstrapping technique was used to measure the bias-corrected (BC) 95% CIs to investigate the significance of the indirect effect. The mediation effect was considered significant when the bootstrapping CIs did not surpass 0. The mediation analysis was considered partial when the ratio of indirect-to-total effect was found to be within the range of 20%–80%; and below the value of 20%, the analysis was considered non-mediated. In the current survey, four models were tested in the mediation analysis: unadjusted (model 1); adjusted for sociodemographics (model 2); adjusted for sociodemographic and personal characteristics (model 3); and adjusted for sociodemographic, personal and gaming characteristics (model 4).

RESULTS

The final survey sample of 348 medical students was composed of 294 (84.48%) females and 54 (15.52%) males, with a mean age of 21.03 (SD 3.27, range=18–33) years. Most of the gamers (84.48%) were female. Students from urban backgrounds comprised more than half (58.62%) of the sample. Similar proportions (91.95%) of gamers had siblings and belonged to a non-single-parent family, and 87.64% lived with their friends or family. Only one-fourth of the gamers disclosed their relationship status. Academically, the satisfactory level for the majority of gamers (86.78%) was either above average or average. A fraction of the gamers (6.32%) stated a family history of psychiatric illness, while one-tenth (10.34%) revealed a personal history. Furthermore, a marginal proportion of gamers—71 (about 1 in 5) and 39 (about 1 in 9), respectively—used to drink alcohol and smoke tobacco. A greater proportion of respondents (>90%) had used the internet for more than 1 hour/day for other than academic purposes, as displayed in table 1. On average, the gamers used to play for 2.68 days/week, while per-day gaming time was 1.43 hours. The average sum of money invested in gaming per month was 64.37 rupees.

According to GDHGS criteria—with a cut-off score of 9 for functional impairment (mean (SD): 6.22 (2.82)), a total of 53 (15.23%, 95% CI: 11.6% to 19.4%) respondents with a mean age of 20.93 (3.39) years, were categorised as having IGD. Among the sociodemographic and personal characteristics (table 2), χ^2/t-test analysis

Table 1 Description of the study sample (N=348)

Covariates (N=348)	Subgroups	Frequency (%, 95% CI), mean (SD)
Age		21.03 (3.27)
Gender	Female	294 (84.48)
	Male	54 (15.52)
Locality	Urban	204 (58.62)
	Rural	144 (41.38)
Family type	Non-single parent family	320 (91.95)
	Single parent family	28 (8.05)
Family structure	Has siblings	323 (92.82)
	Single child	25 (7.18)
Relationship status	Single	262 (75.29)
	In a relationship/married	86 (24.71)
Current living status	Living alone	43 (12.36)
	Living with friends	266 (76.44)
	Living with family	39 (11.21)
Personal history of psychiatric illness	No	312 (89.66)
	Yes	36 (10.34)
Family history of psychiatric illness	No	326 (93.68)
	Yes	22 (6.32)
Smoking status in the past 12 months	No	309 (88.79)
	Yes	39 (11.21)
Alcohol status in the past 12 months	No	277 (79.60)
	Yes	71 (20.40)
Satisfaction with academic performance in the last session	Above average	95 (27.30)
	Average	207 (59.48)
	Below average	46 (13.22)
How long have you used the internet per day other than for academic purposes in the last 12 months (in hours)?	Less than 1 hour	29 (8.33)
	1–3 hours	265 (76.15)
	More than 3 hours	54 (15.52)
Average time spent on the internet other than for academic purposes (hours/day)		Median=2.0 Q1=2.0, Q3=2.3
Average time spent on the internet gaming (hours/day)		Median=0.7 Q1=0.7, Q3=2.5
GDHGS score (range: 4–16)		6.22 (2.82)
Suicidal behaviour/SBQ-R score (range: 3–15)		79 (22.70, 95% CI: 18.4 to 27.5), 5.02 (2.63)
Moderate–severe stress/PSS-10 Score (range: 0–40)		292 (83.91, 95% CI: 79.6% to 87.6), 21.81 (8.53)
Poor sleep quality/PQSI score (range: 0–21)		216 (62.07, 95% CI: 56.7 to 67.2), 9.37 (5.78)

CI, confidence interval; GDHGS, Gaming Disorder and Hazard Gaming Scale; PQSI, Pittsburgh Quality of Sleep Index; PSS-10, Perceived Stress Scale-10; SBQ-R, Suicide Behaviors Questionnaire–Revised.

confirmed that higher percentages of gamers in the IGD group were male (33.96% vs 12.20%, p<0.001), single children (16.98% vs 5.42%, p=0.007), belonged to single-parent families (20.75% vs 5.76%, p<0.001) and used the internet for something other than academic purposes more than 3 hours/day (32.08% vs 12.54%, p<0.001).

Among gaming characteristics (table 3), statistically significant differences between IGD and non-IGD groups were found for all the covariates except for the preferred time and location of the play. The number of participants who played internet games for 1–3 hours (30.19% vs 20.00%, p<0.001) or more than 3 hours/day (22.64% vs 1.02%, p<0.001), at maximum within a week (52.83% vs 22.71%, p<0.001) and paid for games (33.96% vs 9.83%, p<0.001) was significantly higher in the IGD group. For gaming gadgets, the IGD group used a desktop/laptop

Table 2 Binary and multiple logistic regression association of IGD with sociodemographic and personal characteristics among current gamers

Covariates	Subgroups (N=348), n (%)	n (%), mean (SD)		P value (χ^2 test/Student's t-test)	COR (95% CI)$^{P\ value}$	AOR (95% CI)$^{P\ value}$
		IGD				
		No (N=295)	Yes (N=53)			
Age		21.05 (3.26)	20.93 (3.39)	0.796	–	–
Gender	Female	259 (87.80)	35 (66.04)	<0.001	1	1
	Male	36 (12.20)	18 (33.96)		3.293 (1.682 to 6.447)$^{<0.001}$	3.224 (1.567 to 6.632)$^{<0.001}$
Locality	Urban	170 (57.63)	34 (64.15)	0.449	NS	NS
	Rural	125 (42.37)	19 (35.85)			
Family type	Non-single parent family	278 (94.24)	42 (79.25)	<0.001	1	1
	Single-parent family	17 (5.76)	11 (20.75)		4.283 (1.877 to 9.772)$^{<0.001}$	4.081 (1.666 to 9.994)$^{<0.001}$
Family structure	Has siblings	279 (94.58)	44 (83.02)	0.007	1	1
	Single child	16 (5.42)	9 (16.98)		3.567 (1.485 to 8.568)$^{<0.001}$	2.446 (0.930 to 6.433)$^{0.070}$
Relationship status	Single	220 (74.58)	42 (79.25)	0.435	NS	NS
	In a relationship/ married	75 (25.42)	11 (20.75)			
Current living status	Living alone	33 (11.19)	10 (18.87)	0.256	NS	NS
	Living with friends	230 (77.97)	36 (67.92)			
	Living with family	32 (10.85)	7 (13.21)			
Personal history of psychiatric illness	No	265 (89.83)	47 (88.68)	0.807	NS	NS
	Yes	30 (10.17)	6 (11.32)			
Family history of psychiatric illness	No	277 (93.90)	48 (90.57)	0.353	NS	NS
	Yes	18 (6.10)	5 (9.43)			
Smoking status in the past 12 months	No	265 (89.83)	44 (83.02)	0.157	NS	NS
	Yes	30 (10.17)	9 (16.98)			
Alcohol status in the past 12 months	No	237 (80.34)	40 (75.47)	0.459	NS	NS
	Yes	58 (19.66)	13 (24.53)			
Satisfaction with academic performance in the last session	Above average	81 (27.46)	14 (26.42)	0.987	NS	NS
	Average	175 (59.32)	32 (60.38)			
	Below average	39 (13.22)	7 (13.21)			
How long have you used the internet per day other than for academic purposes in the last 12 months (in hours)?	Less than 1 hour	27 (9.15)	2 (3.77)	<0.001	1	1
	1–3 hours	231 (78.31)	34 (64.15)		3.125 (1.584 to 6.134)$^{<0.001}$	3.030 (1.470 to 6.245)$^{0.034}$
	More than 3 hours	37 (12.54)	17 (32.08)		6.211 (1.321 to 29.411)$^{<0.001}$	5.071 (1.040 to 24.739)$^{0.015}$

Model parameters for IGD: Cox and Snell pseudo R^2=0.097, Negelkerke pseudo R^2=0.169.
Reference categories: female, non-single parent, has siblings and use of the internet for less than 1 hour by the students.
AOR, adjusted OR; CI, confidence interval; COR, crude OR; IGD, internet gaming disorder; NS, non-significant; OR, odds ratio.

Table 3 Binary and multiple logistic regression association of IGD with gaming characteristics among current gamers

Gaming covariates	Subgroups	n (%)					
			IGD				
		Total (N=348)	No (N=295)	Yes (N=53)	P value (χ^2 test)	COR (95% CI)$^{P\ value}$	AOR (95% CI)$^{P\ value}$
How long do you play games on the internet per day (in hours)?	Less than 1 hour	258 (74.14)	233 (78.98)	25 (47.17)	<0.001	1	1
	1–3 hours	75 (21.55)	59 (20.00)	16 (30.19)		2.527 (1.268 to 5.036)$^{<0.001}$	1.872 (0.866 to 4.050)$^{0.111}$
	More than 3 hours	15 (4.31)	3 (1.02)	12 (22.64)		37.280 (9.853 to 141.056)$^{<0.001}$	10.764 (2.237 to 51.795)$^{<0.001}$
What type of gadget you are using for playing games?	Smartphone/tabs	330 (94.83)	283 (95.93)	47 (88.68)	0.040	1	1
	Desktop/laptop	18 (5.17)	12 (4.07)	6 (11.32)		3.011 (1.078 to 8.412)$^{0.046}$	1.420 (0.354 to 5.694)$^{0.621}$
How much money do you spend playing games (per month in rupees)?	Non-paid	301 (86.49)	266 (90.17)	35 (66.04)	<0.001	1	1
	Paid	47 (13.51)	29 (9.83)	18 (33.96)		4.717 (2.376 to 9.364)$^{<0.001}$	1.355 (0.532 to 3.452)$^{0.524}$
On which days you used to play internet games?	During weekdays	128 (36.78)	117 (39.66)	11 (20.75)	<0.001	1	1
	During weekends	125 (35.92)	111 (37.63)	14 (26.42)		3.311 (1.628 to 6.756)$^{<0.001}$	1.856 (0.811 to 4.251)$^{0.143}$
	At maximum	95 (27.30)	67 (22.71)	28 (52.83)		4.445 (2.080 to 9.498)$^{<0.001}$	2.299 (0.927 to 5.698)$^{0.072}$
What is the preferred time of play?	During daytime only	58 (16.67)	51 (17.29)	7 (13.21)	0.673	NS	NS
	During night-time only	161 (46.26)	134 (45.42)	27 (50.94)			
	At anytime	129 (37.07)	110 (37.29)	19 (35.85)			
What is the preferred mode of play?	Single player	210 (60.34)	189 (64.07)	21 (39.62)	<0.001	1	1
	2–3 players	68 (19.54)	53 (17.97)	15 (28.30)		2.547 (1.228 to 5.282)$^{0.006}$	1.421 (0.595 to 3.398)$^{0.429}$
	More than three players	70 (20.11)	53 (17.97)	17 (32.08)		2.887 (1.422 to 5.862)$^{0.003}$	1.510 (0.573 to 3.968)$^{0.404}$
What is the preferred location of play?	Home/hostel	257 (73.85)	220 (74.58)	37 (69.81)	0.346	NS	NS
	Classrooms/library/duty hours	78 (22.41)	66 (22.37)	12 (22.64)			
	Anywhere	13 (3.74)	9 (3.05)	4 (7.55)			
What is the preferred type of play?	Non-violent	277 (79.60)	249 (84.41)	28 (52.83)	<0.001	1	1
	Violent	71 (20.40)	46 (15.59)	25 (47.17)		4.833 (2.589 to 9.023)$^{<0.001}$	2.570 (1.146 to 5.763)$^{0.013}$

Model parameters for IGD: Cox and Snell pseudo R^2=0.147, Negelkerke pseudo R^2=0.256.
Reference categories: playing for less than 1 hour/day, on smartphone/tabs, non-paid games, during weekdays, as a single player and non-violent games.
AOR, adjusted OR; CI, confidence interval; COR, crude OR; IGD, internet gaming disorder; NS, non-significant; OR, odds ratio.

more often than the non-IGD group (11.32% vs 4.07%, p=0.040). For the mode of play, gamers playing with more than three players (32.08% vs 17.97%, p<0.001) showed higher dependence of IGD, whereas the majority of participants in the IGD group played violent games (47.17% vs 15.59%, p<0.001).

Covariates associated with IGD

The binary logistic regression model (COR) for IGD depicted in tables 2 and 3 validated the results of the χ^2 tests of the same variables by remaining statistically significant. These significant covariates (as independent variables) were assigned for adjusted multiple logistic regression (AOR) analysis, showing no significant multicollinearity, to identify independent covariates associated with IGD (dependent variable). First, the factors of being male (AOR=3.224, 95% CI: 1.567 to 6.632), living in a single-parent family (AOR=4.081, 95% CI: 1.666 to 9.994) and using the internet for something other than academic purposes (1–3 hours, AOR=3.030, 95% CI: 1.470 to 6.245; more than 3 hours, AOR=5.071, 95% CI: 1.040 to 24.739) significantly predicted IGD. Second, with regard to gaming characteristics, playing games for more than 3 hours/day (AOR=10.764, 95% CI: 2.237 to 51.795) and playing games with violent content (AOR=2.570, 95% CI: 1.146 to 5.763) were independent risk factors for IGD among medical students.

Correlational analysis

Pearson's correlation analysis results (online supplemental table) demonstrated a significant positive correlation between IGD, suicidal behaviour, perceived stress and sleep quality after scores adjusted for medical students' sociodemographic, personal and gaming characteristics. IGD was strongly correlated with the suicidal behaviour score (r=0.72, p<0.001) while mildly correlated with the PSS-10 score (r=0.32, p<0.001). In addition, IGD showed a moderate correlation with the PSQI score, with the correlation coefficient (r) of IGD and PSQI being 0.61 (p<0.001).

Mediation role of sleep quality on the relationship between IGD and perceived stress and suicidal behaviour

The hypothesised mediating role of sleep quality was analysed in two models—model A, for perceived stress, and model B, for suicidal behaviour—by estimating the statistics and coefficients described in the four regression models (models 1–4) as depicted in table 4 and figure 2A,B. Haye's regression model, from the unadjusted to the completely adjusted model, demonstrated that the significant total effect on perceived stress attributed to IGD was increased from 0.967 to 0.982 (model A in the upper panel of table 4) by sleep quality, while the significant total effect on suicidal behaviour attributed to IGD was reduced from 0.671 to 0.623 (model B in the lower panel of table 4) by sleep quality, the mediating covariate. The bootstrapping results (table 4) in each model (models 1–4) indicated that the mediating or indirect effects of IGD on perceived stress (point estimate (β)=0.300, standard estimate (SE)=0.127, BC 95% CI: 0.046 to 0.540, p=0.002) and suicidal behaviour (β=0.174, SE=0.038, BC 95% CI: 0.106 to 0.253, p<0.001) were found to be significant. Furthermore, the direct effects of IGD on perceived stress (0.682) and suicidal behaviour (0.449) remained significant (p<0.001) in the adjusted model, as shown in figure 2A,B, respectively. Therefore, hypothesis 1 is supported. As per mediating analysis, the sleep quality score partially mediated the relationship between the IGD severity and outcome variables. Therefore, hypothesis 3 is supported. Altogether, the mediating effect of sleep quality was found to be 30.55% (SE of indirect/total effects=0.300/0.982) and 27.93% (SE of indirect/total effects=0.174/0.623) in the pathway from IGD to perceived stress and suicidal behaviour, respectively. As displayed in figure 2A,B, the gamers with higher (vs lower) IGD scores tended to report poor sleep quality, ultimately leading to a higher rating for perceived stress and suicidal behaviour. Therefore, hypothesis 2 is also supported.

DISCUSSION

Main findings

To our knowledge, this study was one of the first studies from India to add to the existing literature's findings on internet gaming. First, a significant positive relationship was detected between the degree of IGD symptoms and scores of perceived stress and suicidal behaviour in a sizeable sample of Indian medical students. Second, the mediating analysis demonstrated an inverse relationship with large effects between sleep quality and IGD scores and small effects between sleep quality and perceived stress or suicidal behaviour. Finally, the hypothesised mediating effect of sleep quality (indirect effect) was significant. This finding is a prompt for policymakers to consider the essentiality of sleep quality when constructing intervention strategies to mitigate the risk of mental health issues in medical students with IGD symptoms.

Research on Asian and Western university students[32 33] showed a strong and positive significant association between IGD severity and perceived stress, supporting the present survey results. Also, an Indian survey conducted on 922 medical students revealed that addiction to gaming behaviour correlated with perceived stress among undergraduate medical students.[11] Andreetta *et al*[7] observed that students with IGD symptoms could perceive greater stress regardless of age, grade, ethnicity, race or socioeconomic status. The plausible reason for this could be that online gamers with IGD symptoms spent much time in gaming activities, provoking more emotional difficulties that directly affected their academics and family relationships.[33 34] Furthermore, medical students experiencing problem gaming might have been exposed to more negative facets of gaming, for example, violence and cyber victimisation, sequentially increasing the tendency for impulsive suicidal behaviour.[35] In agreement with

Table 4 Mediation analysis for sleep quality (N=348)

	Model 1		Model 2		Model 3		Model 4	
	B (SE)	BC 95% CI (P value)	B (SE)	BC 95% CI (P value)	B (SE)	BC 95% CI (P value)	B (SE)	BC 95% CI (P value)
Model A: Sleep quality mediates the association between IGD and perceived stress								
Indirect effect	0.327 (0.126)	0.079 to 0.576 (0.009)	0.299 (0.126)	0.053 to 0.545 (0.001)	0.302 (0.128)	0.047 to 0.552 (<0.001)	0.300 (0.127)	0.046 to 0.540 (0.002)
Direct effect	0.640 (0.197)	0.252 to 1.028 (0.001)	0.629 (0.212)	0.212 to 1.047 (0.003)	0.676 (0.197)	0.289 to 1.063 (<0.001)	0.682 (0.199)	0.291 to 1.074 (<0.001)
Total effect	0.967 (0.154)	0.664 to 1.271 (<0.001)	0.928 (0.179)	0.576 to 1.281 (<0.001)	0.978 (0.154)	0.669 to 1.286 (<0.001)	0.982 (0.159)	0.671 to 1.296 (<0.001)
Proportion of indirect to total effect mediated (%)	33.82		32.22		30.88		30.62	
Model B: sleep quality mediates the association between IGD and suicidal behaviour								
Indirect effect	0.195 (0.037)	0.125 to 0.271 (<0.001)	0.192 (0.038)	0.119 to 0.269 (<0.001)	0.192 (0.039)	0.117 to 0.274 (<0.001)	0.174 (0.038)	0.106 to 0.253 (<0.001)
Direct effect	0.476 (0.042)	0.394 to 0.559 (<0.001)	0.473 (0.042)	0.389 to 0.557 (<0.001)	0.479 (0.043)	0.394 to 0.564 (<0.001)	0.449 (0.045)	0.360 to 0.538 (<0.001)
Total effect	0.671 (0.035)	0.603 to 0.740 (<0.001)	0.665 (0.035)	0.594 to 0.737 (<0.001)	0.671 (0.036)	0.599 to 0.744 (<0.001)	0.623 (0.041)	0.543 to 0.703 (<0.001)
Proportion of indirect to total effect mediated (%)	29.06		28.87		28.61		27.93	

Unadjusted mediation model: model 1; adjusted mediation models: model 2 (for sociodemographic factors), model 3 (for sociodemographic and personal factors) and model 4 (for sociodemographic, personal and gaming characteristics); B (unstandardised coefficient); BC 95% CI (based on 10 000 bootstrap samples).
BC, bias-corrected; CI, confidence interval; IGD, internet gaming disorder; SE, standard estimate.

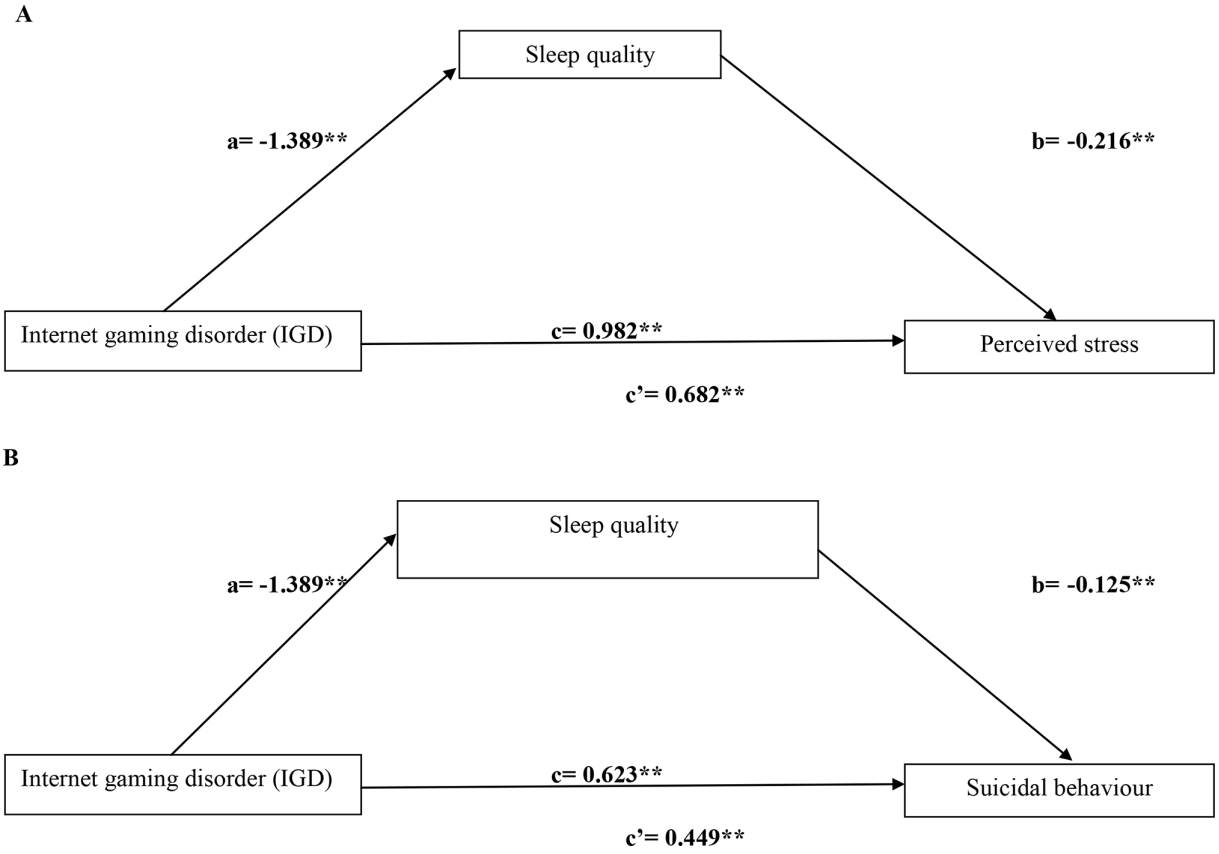

Figure 2 Mediation model A/B with sleep quality mediating the relationship between IGD and stress/suicidal behaviour (each path coefficient is symbolised by a, b, c and c'; c denotes the total effect of IGD on stress/suicidal behaviour without regulating mediating effect; c' indicates the direct effect of IGD on stress/suicidal behaviour with regulating mediating effect; each value provided is unstandardised. **p<0.001. IGD, internet gaming disorder.

previous research among adolescents[36] this demonstrated that internet gaming addiction behaviour was significantly associated with suicidal ideation/attempts, the present survey also showed that IGD symptoms directly affected suicidal behaviour. A systematic review[37] revealed significant positive and crude associations between IGD and suicidal behaviour after adjusting possible confounding variables. In contrast, research by Severo *et al*[38] revealed an inverse non-significant association between IGD symptoms and suicidal behaviour. The Diagnostic and Statistical Manual of Mental Disorders-5 diagnostic criteria for gaming disorder incorporates tolerance and withdrawal aspects that describe how often a gamer is consistently unable to control gaming and feels irritated, restless, frustrated and angry about stopping gaming.[39] Previously, it was suggested that these symptoms were responsible for increased sleep latency and poor sleep quality among gamers by activating circadian rhythm changes and causing delayed phases in the circadian rhythm.[25 33 40] The current research offers empirical evidence to support this hypothesis by unveiling similar results, demonstrating that an increase in IGD scores was significantly correlated with higher PSQI scores or poor sleep quality. Compared with other Western studies,[25 33] the current survey also suggested a strong relationship between IGD and poor sleep quality.

The present study unveiled the significant mediating effect of sleep quality in the IGD-perceived stress link among medical students. Moreover, the mediating analysis suggests an indirect effect of IGD on perceived stress via sleep quality, and sleep quality is recognised as a meaningful partial mediator. The key observation was that sleep quality explained 30.62% of the total effect of IGD on perceived stress. Such an interpretation agrees with a study among Chinese college students where sleep quality explained 18% of the total effect of IGD on perceived stress.[25] This finding may be better comprehended by contemplating the following mechanisms. Earlier, existing research indicates that the IGD–sleep quality association is well documented.[25 33 40] As aforementioned, IGD prompted poor sleep quality. Consequently, pathological gamers with poor sleep quality have manifested relatively more cognitive diversion from real-world problems and more expressive suppression due to low cognitive reappraisal; this, in turn, might worsen the gamers' unresolved emotional difficulties and causes significant stress in this population.[41 42]

Similarly, the association between IGD, sleep quality and suicidal behaviour in the correlational analysis was explained by the mediational analysis; that is, IGD significantly influenced students' sleep quality (negatively), which then influenced their suicidal behaviour (inversely),

as revealed in other surveys.[20 43] Another pivotal observation of the present survey was that sleep quality explained 27.93% of the total effect of IGD on suicidal behaviour; the Chinese population survey demonstrated that the mediating role of sleep quality explained 35% of its total effects on the IGD–suicidal behaviour link.[43] However, Sami *et al*[44] found that sleep quality failed to mediate the pathway to suicidal behaviour among pathological gamers significantly. Our finding may be better comprehended by contemplating the following mechanisms. As mentioned earlier, students who reported higher IGD symptoms were presumed to be more susceptible to having concurrently poor sleep quality. A recent study on Chinese medical students established that students with poor sleep quality have a higher proportion of interpersonal difficulties, poor face-to-face communication with peers and family members, decreased social support and increased loneliness, which, in turn, may have increased the risk of suicidal behaviour.[45] Investigations on the sleep framework have postulated that enhanced suicidal behaviour is attributed to the brain's electrophysiological activity during sleep; explicitly, central nervous system hyperarousal during sleep could be the underlying neurobiological correlate of suicidal behaviour.[46] Thus, it is entirely plausible that higher degrees of IGD symptoms are linked to suicidal behaviours through poor sleep quality.

In a research study on Brazilian undergraduate students,[38] the prevalence of IGD was reported as 18.2% of 555 gamers, nearly corroborating the current study's observations (15.7%); however, that study used a different tool (Nine-item Internet Gaming Disorder Scale - Short form, IGD9-SF) to measure gaming disorder. Other research conducted globally also yielded comparable results.[20 47 48] In addition, other international and national studies[49 50] of medical students found a substantially higher prevalence (>30%) of IGD than the present survey. More worrisome, an Indian scoping review revealed that the IGD prevalence ranged from 3.20% to 91.00% in clinical populations.[51] In dissonance with the present survey, research among medical students of different ethnicities revealed lower rates of IGD: 3.6%–6.98% in Indian gamers[9 10] and 4% in Chinese gamers.[52] Such variations in these results could be attributable to differences in methodology, population size, questionnaires used to estimate IGD and disparities in the targeted populations' sociocultural systems and attitudes. The present research also revealed the prevalence of suicidal behaviour, perceived stress and poor sleep quality among medical students who engaged in gaming behaviour to be 22.7%, 84.0% and 62.0%, respectively, which were significantly higher than those who did not engage in gaming behaviour (15.6%, 67.6% and 47.3%, respectively). Similarly, other studies[20 25 33 53] conducted on medical students or other younger populations also found that playing online games had increased the risk of suicidal behaviour, perceived stress and poor sleep quality.

The results of the current survey revealed that sociodemographic and personal domains such as gender (being male), living with a single parent and using the internet for 1–3 hours or more than 3 hours a day for something other than academic purposes were significant risk factors for IGD, whereas other covariates included in the survey were insignificant for the dependent variables. On the contrary, several studies have found a link between sociodemographic or personal covariates and IGD.[47 54] The present survey found that male participants had a 3.2 times greater odds risk of IGD than their female counterparts. Pre-existing literature observed that being male was significantly related to an elevated odds risk of IGD, providing consistent and robust support for the present study findings.[38 54] When confronted with gaming cues, women may exhibit greater executive control than men, perhaps offering better resiliency against developing IGD.[55] Also, it might be reasonable that poor self-control among men would result in a more pronounced unwillingness to quit playing without accomplishing gaming activities. These stronger cognition distortions among men may illustrate why they have a higher risk of IGD than women.[56] Contrary to the present survey findings, another similar Indian survey was unable to demonstrate significant differences in vulnerability to development of IGD among both genders.[9] Other clinical research on medical students noted that students who lived with both parents had only one-third the risk of developing IGD.[54] In the present study, students living in single-parent families had a 4.1 times higher odds risk of addiction to internet gaming, similar to a recent survey in Thailand, where these students also had a 1.7 times higher odds risk of IGD.[15] Other researchers argued that an increased risk of developing IGD in respondents living in single-parent families could be due to lower parental behavioural control and poorer family functioning.[57] Like the present study, substantial evidence has linked the timing of using the internet for something other than academic purposes or social networking and IGD.[58 59] Participants using the internet for something other than academic purposes for 1–3 hours or more than 3 hours in a day have a three to five times higher odds of risk of IGD in comparison with those who use it for less than 1 hour. Researchers have shown that time spent on social networking was a weaker predictor for IGD,[58 59] but our study found it to be the second-highest predictor for IGD. Surprisingly, many social networking sites that incorporate social media games are witnessing a growth in demand. The latest Facebook figures indicate that around 375 million inhabitants play Facebook-connected games each month, and smartphone applications forward an average of 735 million recommendations of games nearly daily.[60] However, on the contrary, the multivariable logistic regression could not substantiate the evidence of this relationship among medical students in the research conducted in India[9 61] and Saudi Arabia.[62] In line with our results, increased gaming time per day (in hours) was established as the strongest predictor for IGD (13.5 times the odd risk).[38]

Significantly, respondents who reported gaming more than 3 hours a day had a 10.8 times odds risk of developing IGD compared with those who reported gaming time less than 1 hour/day. Furthermore, many existing Indian studies also have established a significant link between IGD severity and time spent on gaming.[9 11 61] A survey from Liao *et al*[47] determined that as the time spent playing increases, players obtain more motivations for increasing play time, such as gaining status among players and obtaining rewards. Thus, intervention strategies designed to curtail the amount of time spent on gaming and excessive internet use may be a more beneficial approach to preventing and managing IGD among medical students. Notably, Billieux *et al*[63] discovered that individuals' motivations and inherent characteristics of the game genre anticipate overall in-gaming behavioural patterns and gaming commitment. However, violent gaming raises the gamer's immersion (a type of motive) during play, attributed to more competitive behaviour and intellectual thinking among these types of gamers compared with non-violent play gamers.[64] Existing research supports that gaming motivations like immersion were strongly linked with IGD.[63 64] It was also thought that playing violent internet games was potentially highly addictive among students.[9 65] Interestingly, our study's results provided supporting evidence regarding violent gaming being a substantial risk factor; those who played violent games had a 2.8 times odds risk of developing IGD symptoms compared with other gamers. As a result, assessing gaming trends among gamers may help determine troublesome implications and suggest appropriate behavioural modifications.[66]

The main strength of the present survey was that the relationship between IGD and health outcomes was assessed robustly by mediation analysis instead of multiple regression analysis, providing an appropriate inference mechanism in this interplay. It also analysed the dual roles of the mediator and the indirect and direct effects of IGD on health outcomes. Thus, the findings are noteworthy, with important clinical implications for preventing perceived stress and suicidal behaviour among online gamers. Additional survey strengths were the considerably larger data set, incorporation of multiple covariates and use of standardised diagnostic criteria.

Limitations

This cross-sectional research has several limitations, some of which propose possibilities for future research. First, outcomes cannot be representative and generalised to other populations because the respondents were recruited from rural medical institutions, and this survey was conceptualised at a female-only centre, resulting in a predominance of women in the study population. Second, this cross-sectional type of study design precluded the exploration of the causal link between IGD and perceived stress and suicidal behaviour, despite using mediation analysis, and thus warrants the need for longitudinal surveys to establish this causal relationship. Third, the cascade from IGD to suicidal behaviour may involve other elements besides the mediator studied here. For example, impulsivity is closely linked to addictive illnesses (eg, IGD) and other dangerous behaviours (eg, suicidal ideation). Fourth, information, selection, recollection and response bias cannot be ruled out in the current study due to using a self-administered questionnaire. Fifth, the magnitude and covariates for IGD were not examined individually for each academic year. Furthermore, including only rural medical students might have resulted in overestimating the association due to the resource-restrained settings. Future research should look at other psychological traits that may be linked to suicidal behaviour because students are prone to internal psychological transitions and external interpersonal adjustments.

Implications

In essence, this study showed the most recent estimates of the prevalence and contributing variables of IGD among medical students in a remote Indian community. To further comprehend these linkages and examine how these variables contribute to the emergence of IGD, qualitative research should be carried out in the future at the national level. Implementing a three-level preventative approach with general prevention, focused prevention, and early diagnosis and management is worthwhile. The current researchers reported that sleep quality had a significant partial mediating influence on the IGD–perceived stress and IGD–suicidal behaviour links. These results suggest that a substantial reduction in sleep quality was one possible explanation for the link between IGD and adverse mental health outcomes. Strategies to attenuate the detrimental effects of excessive internet gaming on psychological health should aim to enhance sleep quality by encouraging healthy browsing habits.

Acknowledgements The authors thank the students who participated in the study.

Contributors SG and AK designed the study and participated in all the steps of the preparation process, including analyses and the first draft, and contributed to the literature review and synthesis. DV, RA, BK, RS and DL contributed to the protocol preparation and participated in data collection. BK contributed to the editing and language of the manuscript. All the authors contributed to the article writing and approved the final version of the manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and ethical approval was obtained from the institutional ethical committee or review boards of Bhagat Phool Singh Government Medical College for Women, Sonipat, Haryana, India, and it was in consensus with the Declaration of Helsinki and ethical committee standards. Participants gave informed consent to participate in the study before taking part. The confidentiality regarding the information provided by the participants was also assured throughout the survey. The ethical approval number is not available.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement No data are available.

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Supplementary Table: Pairwise bivariate correlational analysis between internet gaming disorder, sleep quality, suicidal behaviour, and stress (N=348).

	IGD (r)	Suicidal behaviour (r)	Perceived Stress (r)	PSQI (r)
GDHGS Score	1			
SBQ-R Score	**0.319****	1		
PSS-10 Score	**0.719****	**0.378****	1	
PSQI Score	**0.613****	**0.638****	**0.292****	1

Pearson's Correlation coefficients (r). ** ($p<0.001$) Highly significant.