

Attention-Deficit Hyperactivity Disorder and Internet Addiction among Medical Students at a Tertiary Teaching Institute in South India

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Abstract

Objective: To determine the frequency of adult attention-deficit hyperactivity disorder (ADHD) symptoms as well as internet addiction in medical undergraduates and to evaluate the relationship between ADHD status and internet addiction. **Design:** An analytical cross-sectional study. **Setting:** The study was carried out at a tertiary teaching institute in South India. **Participants:** Overall, 950 medical undergraduates aged 17–25 years participated in the study. Adult ADHD was assessed with the Adult ADHD self-report scale, and internet addiction was evaluated using the internet addiction test. **Outcome Measures:** The primary outcomes were the prevalence of adult ADHD symptoms and internet addiction. Internet use was categorized as normal, mild, moderate, or severe addiction. The association between ADHD status and internet addiction was analyzed using a Chi-square test and odds ratios with 95% confidence intervals (CI). **Results:** Participants had a mean age of 20.6 ± 1.7 years, and 58.2% were female. ADHD symptoms were identified in 20.0% of students. The prevalence of internet addiction was 65.5%, with 45.1% at moderate to severe levels. The higher the degree of Internet addiction, the higher the prevalence of ADHD symptoms. The adjusted analysis showed that mild (adjusted odds ratios [AOR] = 2.05; 95% CI: 1.20–3.51), moderate (AOR = 3.12; 95% CI: 1.86–5.23) and severe addiction (AOR = 4.71; 95% CI: 2.80–7.94) were significantly associated with higher odds of ADHD symptoms ($P < 0.01$). **Conclusion:** Internet addiction was prevalent and strongly associated with ADHD symptoms, despite the moderate prevalence of adult ADHD. Integrated screening strategies are recommended to support student mental health and academic functioning.

Key words: Attention-deficit hyperactivity disorder, behavioral addiction, internet addiction, medical students

INTRODUCTION

Attention-deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder that is classically diagnosed in childhood but is increasingly being recognized as persisting into adulthood in a substantial proportion of individuals. Adult ADHD is characterized by persistent symptoms of inattention and impulsivity, and hyperactivity that impair functioning in multiple domains of daily life. ADHD is associated with serious impairments in academic achievement, occupational functioning, interpersonal relationships, and quality of life generally.^[1] Adult ADHD has been increasingly recognized over the past few decades and has challenged

the assumption that ADHD is a childhood disorder and is important across the lifespan.

Population studies suggest that adult ADHD occurs in about 4–5% of people, and similar rates are reported among students at colleges and universities.^[2] Adult ADHD is, however, still under-recognized, particularly in high-performing

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groups, such as medical students, whose symptoms may be masked by compensatory mechanisms, a structured learning environment and a strong desire to succeed academically.^[3]

Concurrently, Internet addiction has been a major behavioral health problem in adolescents and young adults in the digital era. Internet addiction is a problem of diminished control over the use of the internet, continued use despite the adverse consequences, and the presence of significant functional impairment in social, academic, or occupational contexts.^[4] The rapid growth of digital technology, together with growing access to smartphones and the availability of online platforms for education, communication and entertainment, has resulted in significant changes in the ways that students are using the Internet.

Research on health professional undergraduates has shown that between 20 and 45% of students have some level of internet addiction, usually mild to moderate.^[5] Increasingly, there is evidence that the symptoms of ADHD are closely and clinically relevant to internet addiction. The core symptoms of ADHD – inattention, impulsivity, and a dislike for delayed gratification – may increase the vulnerability of a person to overusing the Internet as these traits reinforce instant gratification and lower one's tolerance for boredom.^[6] Digital platforms, particularly social media and online gaming, offer constant stimulation and immediate feedback that may be particularly attractive to people with attention problems. A systematic review and meta-analysis found significantly higher rates of internet addiction in people with ADHD versus controls, suggesting a strong and consistent association of these two conditions.^[7]

Cross-sectional studies in university students have repeatedly demonstrated that students who screen positive for ADHD symptoms score significantly higher on measures of Internet addiction.^[6,8] Regarding the dimensions of ADHD symptoms, inattention appears to be more associated with problematic internet use than hyperactivity or impulsivity, indicating the importance of sustained attention and task persistence in the development of maladaptive internet behaviors.^[8] These findings suggest that internet addiction may co-exist with ADHD and could be one of the vulnerability factors for the development of internet addiction.

Medical undergraduates are a particularly vulnerable population, exposed to high academic demands, long hours in front of screens, lack of leisure time and competitive learning environments. The pressure to perform academically, combined with easy access to digital resources, may inadvertently promote excessive and poorly regulated internet use. Both adult ADHD and internet addiction are independently associated with academic difficulties, emotional distress and long-term occupational impairment, making their coexistence especially concerning in future healthcare professionals.^[3,7] Despite this, most available studies exploring this association are cross-sectional in nature, and data from South Indian medical institutions

remain limited, restricting the generalizability of existing findings to this regional context.

Against this background, this study aimed to determine the frequency of adult ADHD symptoms as well as internet addiction undergraduate medical students at a tertiary teaching institution in South India and to evaluate the relationship between ADHD status and internet addiction.

METHODS

Study design and setting

An across-sectional analytical study was carried out over a period between August and November 2025, in a tertiary care center located in Chennai, India. It caters to a large number of undergraduate medical students, thereby providing an appropriate setting for the assessment of behavioral and psychological problems among medical undergraduates.

Study participants and sampling procedure

The study included undergraduate medical students aged 17–25 years enrolled during the study period at the participating tertiary teaching institution. Stratified sampling was applied to provide appropriate representation from pre-clinical, para-clinical, and clinical phases.

The required minimum sample size was calculated with G*Power software version 3.1, based on a two-tailed test, 5% level of significance ($\alpha = 0.05$), 80% statistical power, and a medium effect size corresponding to an odds ratio of approximately 2.0. The estimated minimum sample size required was approximately 787 participants. Considering a potential 10% allowance for non-response or incomplete data rate, the required sample size was subsequently increased accordingly. All eligible students were invited to participate to accommodate this anticipated loss. A total of 950 medical undergraduates were retained for the final analysis, thereby surpassing the calculated minimum sample requirement and ensuring adequate statistical power.

Inclusion and exclusion criteria

Students 17–25 years of age who provided written informed consent were included in this study. Students who were unwilling to participate or unable to provide informed consent were excluded. In addition, students with a known history of psychiatric illness or those currently receiving psychiatric treatment were excluded to minimize potential confounding.

Data collection procedure

Approval for the study was secured from the Institutional Ethics Committee of the participating tertiary-care, Chennai.

Participants were given a detailed explanation of the study purpose and procedures, and written informed consent was taken before enrolment. Information was gathered through face-to-face interviews with a pre-tested, semi-structured to record sociodemographic details. The pro forma was developed based on a literature review and assessed for content validity by an expert panel in Community Medicine as well as Psychiatry, and necessary modifications were made.

Study instruments

ADHD symptoms were assessed with the Adult ADHD Self-Report Scale (ASRS v1.1), a validated six-item screening tool based on Diagnostic and Statistical Manual of Mental Disorders criteria. The scale assesses main symptoms of inattention and hyperactivity-impulsivity, including difficulty sustaining attention, problems with task completion, forgetfulness, restlessness, and impulsive behaviors.^[9]

Internet addiction was evaluated with Young's internet addiction test (IAT), a 20-item scale that evaluates patterns of internet use across domains, such as excessive use, compulsive behavior, neglect of daily activities, social withdrawal, emotional pre-occupation, and functional impairment. The IAT classifies internet use into normal, mild, moderate, and severe addiction categories based on total score.^[10]

Statistical methods

The data were entered in Microsoft Excel and analyzed with the Statistical Package for the Social Sciences version 22. Categorical variables were then expressed as frequency counts and percentages, while numerical variables were then summarized using mean and standard deviation.

The association between ADHD screening status and internet addiction categories was examined using the Chi-square test. Odds ratios (OR) with 95% confidence intervals (CI) were computed to estimate the strength of association.

Multivariable binary logistic regression was used to determine independent predictors of ADHD screening status. Internet addiction severity, age, gender, and academic year were included in the adjusted model based on theoretical relevance. Adjusted OR (AOR) with 95% CI were presented. Statistical significance was set at a two-tailed *P*-value below 0.05.

RESULTS

Overall, 950 medical undergraduate students took part in the study. The mean age of the participants was 20.6 ± 1.7 years (range 18–25 years). The participants were 58.2% female ($n = 553$) and 41.8% male ($n = 397$) students [Figure 1].

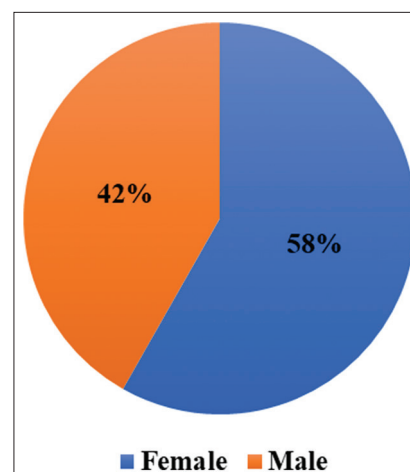


Figure 1: Gender distribution of study participants

Students were recruited from all years of undergraduate medical education and were relatively evenly distributed between the academic years.

Prevalence of ADHD symptoms

Based on ASRS screening, 190 students screened positive for adult ADHD symptoms, resulting in a prevalence of 20.0% among the study participants. The remaining 760 students (80.0% of the sample) screened negative for ADHD symptoms. Prevalence of screening status of ADHD in medical undergraduates is shown in [Table 1].

These results suggest that around one in five medical undergraduates had clinically relevant symptoms of ADHD. This suggests a considerable load of attentional and behavioral symptoms among a student population exposed to prolonged academic stress, long study hours and high cognitive demands.

Prevalence of severity of internet addiction

The distribution of severity of internet addiction based on IAT scores showed that 328 students (34.5%) had normal internet use. Mild internet addiction was observed in 193 students (20.3%), while 237 students (24.9%) had moderate internet addiction and 192 students (20.2%) had severe internet addiction. The severity-wise distribution of internet addiction is shown in [Table 2].

Overall, 65.5% of participants showed some degree of problematic internet use, ranging from mild to severe internet addiction. Moderate and severe internet addiction together accounted for 45.1% of the sample, indicating that excessive internet use was common among the study participants. The frequency distribution of internet addiction categories is illustrated in [Figure 2].

Table 1: ASRS-based prevalence of ADHD among medical undergraduates (n=950)

ASRS screening status	Number (n)	Percentage
ADHD screen-positive	190	20.0
ADHD screen-negative	760	80.0
Total	950	100.0

ASRS: Adult ADHD self-report scale, ADHD: Attention-deficit hyperactivity disorder

Table 2: Distribution of internet addiction severity based on IAT scores (n=950)

IAT	Number (n)	Percentage
Normal internet use (0–30)	328	34.5
Mild addiction (31–49)	193	20.3
Moderate addiction (50–79)	237	24.9
Severe addiction (≥80)	192	20.2
Total	950	100.0

IAT: Internet addiction category

Association between ADHD screening status and internet addiction

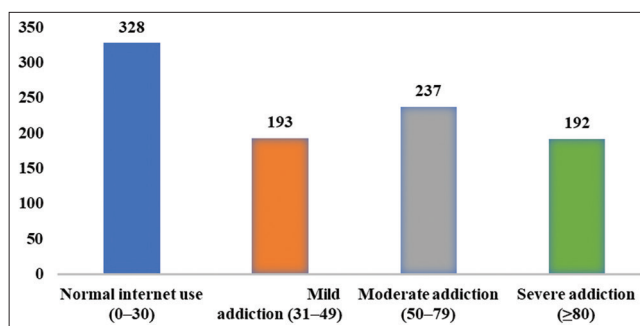
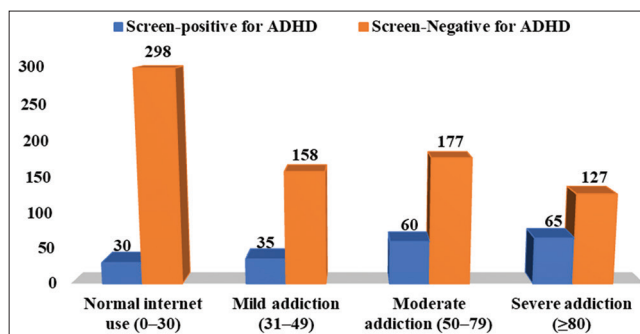
A progressive increase in ADHD screen positivity was observed with increasing severity of internet addiction. Among students with normal internet use, 30 students (9.1%) screened positive for ADHD. This proportion increased to 18.0% among those with mild internet addiction, 25.3% among those with moderate internet addiction, and 33.9% among those with severe internet addiction. The association between ADHD screening status and internet addiction severity is shown in [Table 3].

The association between ADHD screening status and internet addiction severity was statistically significant using the chi-square test ($\chi^2 = 51.83$, $df = 3$, $P < 0.001$). Students who screened positive for ADHD were more frequently represented in the moderate and severe internet addiction categories compared with students who screened negative. The distribution of ADHD screening status across internet addiction categories is presented in [Figure 3].

As this was a cross-sectional study, the observed association should be interpreted as a relationship between ADHD symptoms and internet addiction severity rather than evidence of causality.

Logistic regression analysis

In univariable logistic regression analysis, increasing severity of internet addiction was associated with progressively higher odds of ADHD symptoms. Compared with students with normal internet use, those with mild internet addiction had higher odds of ADHD symptoms (OR = 2.20; 95% CI:

**Figure 2: Frequency distribution of internet addiction category****Figure 3: Distribution of attention-deficit hyperactivity disorder screening status according to levels of internet addiction**

1.30–3.72; $P = 0.003$). The odds were further increased among students with moderate internet addiction (OR = 3.37; 95% CI: 2.05–5.55; $P < 0.001$) and severe internet addiction (OR = 5.08; 95% CI: 3.04–8.49; $P < 0.001$). These associations remained statistically significant after adjustment for age, gender, and academic year, as shown in [Table 4].

After adjustment, students with severe internet addiction had the highest odds of screening positive for ADHD (AOR = 4.71; 95% CI: 2.80–7.94; $P < 0.001$), followed by those with moderate addiction (AOR = 3.12; 95% CI: 1.86–5.23; $P < 0.001$) and mild addiction (AOR = 2.05; 95% CI: 1.20–3.51; $P = 0.008$). This indicates a dose-response pattern, where greater internet addiction severity was associated with higher odds of ADHD symptoms.

Demographic predictors of ADHD screening status

Age, gender, and clinical year were examined as possible predictors of ADHD screening status. In both univariable and adjusted analyses, none of these demographic variables showed a statistically significant association with ADHD screening status. The results of this analysis are presented in [Table 5].

Although female gender showed slightly higher odds of ADHD symptoms in the unadjusted model, the association did not reach statistical significance after adjustment. Similarly, age and clinical year were not independently associated with ADHD screening status.

Table 3: Association between ADHD status and internet addiction among medical undergraduates

Internet use category	Screen-positive for ADHD (n=190) (%)	Screen-Negative for ADHD (n=760) (%)	Total (950)
Normal internet use (0–30)	30 (9.1)	298 (90.9)	328
Mild addiction (31–49)	35 (18)	158 (81)	193
Moderate addiction (50–79)	60 (25.3)	177 (74.7)	237
Severe addiction (≥ 80)	65 (33)	127 (66.1)	192

ADHD: Attention-deficit hyperactivity disorder. $\chi^2=51.83$, $P<0.001$ **Table 4:** Association between internet addiction severity and ADHD screening status

Internet addiction category	OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Normal (reference)	1.00	—	1.00	—
Mild	2.20 (1.30–3.72)	0.003	2.05 (1.20–3.51)	0.008
Moderate	3.37 (2.05–5.55)	<0.001	3.12 (1.86–5.23)	<0.001
Severe	5.08 (3.04–8.49)	<0.001	4.71 (2.80–7.94)	<0.001

ADHD: Attention-deficit hyperactivity disorder, OR: Odds ratios, CI: Confidence intervals

Table 5: Demographic predictors of ADHD screening status

Variable	OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Age (years)	1.05 (0.95–1.16)	0.29	1.07 (0.96–1.19)	0.21
Female gender	1.34 (0.98–1.83)	0.06	1.29 (0.92–1.81)	0.13
Clinical year	1.22 (0.86–1.73)	0.25	1.18 (0.82–1.71)	0.36

ADHD: Attention-deficit hyperactivity disorder, OR: Odds ratios, CI: Confidence intervals

Academic year and ADHD screening status

The association between academic year and ADHD screening status was further examined. Compared with 1st-year students, students in higher academic years showed slightly higher odds of ADHD symptoms; however, none of these associations were statistically significant. The findings are shown in [Table 6].

Although the odds of ADHD symptoms appeared to increase gradually from 2nd year to internship, this trend was not statistically significant. Overall, internet addiction severity was the only variable that remained independently associated with ADHD screening status in the adjusted analysis.

DISCUSSION

The present analytical cross-sectional study in undergraduate medical students with a mean age of 20.6 ± 1.7 years gives a valuable insight into the co-occurrence of adult ADHD and problematic internet use in a population under severe academic and psychosocial demands. Twenty percent of the participants had symptoms of screening for adult ADHD, mainly with a moderate-to-severe category of Internet addiction. These findings highlight an increasing challenge in behavioral health in medical training environments where psychological vulnerabilities are often ignored.

The prevalence of adult ADHD in this study is very close to the population-based estimates derived from the National Comorbidity Survey Replication in the United States (4.4%)^[11] and is slightly lower than the 5.4% reported among Indian college students.^[12] Similar figures have been reported among medical undergraduates of India.^[13] There could be several reasons for the rather low prevalence in the present cohort. First, the use of screening instruments (rather than structured diagnostic interviews) may have resulted in conservative estimates, especially for inattentive or less obvious forms of ADHD and for subclinical forms.^[14] Second, medical students are a selectively high-achieving population, in which attentional deficits might be compensated by high intellectual abilities, motivation, and structured academic routines.^[15] Stigma associated with psychiatric disorders, fear of academic consequences, and ignorance about adult ADHD could also be factors leading to under-reporting of symptoms.^[16]

The fact that over two-fifths of participants showed some degree of problematic internet use also indicates that problematic internet use is widespread in this population. This estimate is comparable to the 41.1% prevalence among Indian medical students reported by Afshan *et al.*^[13] and Kandre *et al.*^[17] However, some Indian cohorts have been reported to have lower rates previously.^[18] International studies also show quite a range. Reported prevalence rates vary from about 15% to >40%, depending on where you are,

Table 6: Academic year as predictor of ADHD screening status

Academic year	OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
1 st year (Reference)	1.00	—	1.00	—
2 nd year	1.12 (0.65–1.93)	0.68	1.08 (0.62–1.89)	0.77
3 rd year	1.25 (0.74–2.10)	0.40	1.18 (0.69–2.01)	0.54
Final year	1.36 (0.81–2.29)	0.24	1.29 (0.76–2.19)	0.34
Internship	1.48 (0.88–2.50)	0.14	1.41 (0.83–2.39)	0.20

ADHD: Attention-deficit hyperactivity disorder, OR: Odds ratios, CI: Confidence intervals

what thresholds you use to make the diagnosis, and how you assess it.^[19] This heterogeneity underlines the importance of sociocultural and methodological factors in the observed prevalence.

The rapid spread of digital technologies in medical education, such as online learning platforms, electronic medical resources, and virtual communication, has further blurred the line between adaptive and maladaptive internet use.^[4] The great pressure of school and lack of leisure time may make students more likely to turn to online activities to relieve stress and connect with peers.^[20] Furthermore, the COVID-19 pandemic has reinforced reliance on digital media by normalizing long screen times due to remote learning and less face-to-face interaction.^[21] This may perpetuate increased internet usage even after the pandemic.

The high association between ADHD symptoms and problematic internet use is one of the main findings of the present study. Participants screened positive for ADHD were almost 6 times more likely to be addicted to the internet than those who did not have these symptoms. Previous studies have well documented this relationship. Wang *et al.* performed a systematic review and meta-analysis and found that individuals with ADHD had a significantly higher risk of internet addiction.^[7] Similar associations have been reported in other cultural contexts,^[22–24] suggesting that this association is robust and not population-specific.

Indian data also corroborates this association. Afshan *et al.* reported a moderate positive correlation between severity of ADHD symptoms and internet addiction scores among medical students.^[13] Previous research in Turkey and Europe has also shown that ADHD symptoms are important predictors of problematic internet use,^[23,24] suggesting common behavioral and neuropsychological pathways for both conditions.

From a mechanistic point of view, some features of ADHD are likely to contribute to excessive use of the internet. The rapid, stimulating and ever-rewarding nature of digital environments is especially compatible with difficulties in sustaining attention, impulsivity, emotional dysregulation and an increased preference for immediate reward.^[25,26] Internet platforms are deliberately designed to capture and retain users' attention by providing immediate feedback,

algorithmic content delivery and intermittent reinforcement, which may be especially appealing to those with impaired inhibitory control.^[27]

Moreover, deficits in executive functions, such as time management, planning and self-monitoring may further impair the ability of people with ADHD to control their internet use.^[2,9] On the other hand, continued overuse of the Internet may contribute to attention difficulties by disrupting sleep patterns, increasing cognitive fatigue, and reducing physical activity and real-world social interactions.^[29] Neurobiological evidence suggests that ADHD and internet addiction are associated with changes in neural circuits involved in executive control and reward processing,^[30,31] possibly indicating common pathophysiological mechanisms.

These findings are in line with increasing evidence of a possible bidirectional association between internet addiction and ADHD symptoms, in which the presence of one can be a factor for the development or maintenance of the other. However, the cross-sectional design of the present study precludes any temporal or causal inferences, and longitudinal studies are warranted to determine the directionality.

The co-occurrence of symptoms of ADHD and internet addiction among medical undergraduates has important implications from a public health and education perspective. Each condition alone has been linked with poor academic performance, emotional instability, decreased quality of life, and long-term occupational impairment.^[32,33] Their co-existence may have a particularly negative combined effect and may affect professional competence, empathy and patient safety among future health care providers.

The findings underscore the importance of holistic mental health interventions in healthcare settings. Regular screening for attentional difficulties and problematic internet use, inclusion of digital wellbeing programs and timely psychoeducational interventions could be of substantial help in the early detection and prevention.^[34] Modules on responsible technology use, time management, sleep hygiene, and coping strategies for stress may also contribute to the development of healthier behavioral patterns among students.^[35]

In conclusion, this study identifies Internet addiction as an important behavioral correlate of difficulties associated with

ADHD in medical students and highlights the need for an integrated approach to students' mental health, including psychological, behavioral, and educational aspects.

Strengths and recommendations

The present study has a number of notable strengths. It tackles an emerging and under-researched behavioral health issue among medical undergraduates. It simultaneously investigates adult ADHD symptoms and internet addiction within the same cohort. The reliability of results is further strengthened by the use of validated and widely used screening tools, including the ASRS v1.1 and the IAT, allowing for comparison with existing literature. The relatively large sample size and involvement of students from several tertiary teaching institutes adds to the robustness of the results and reduces the potential for center-specific bias. Further, the use of a high-risk academic population provides contextually relevant evidence that can inform mental health strategies at the institutional level.

According to the findings, some recommendations can be proposed. Student health services in medical colleges may incorporate routine screening of ADHD symptoms and problematic internet use for early identification and timely intervention. Incorporation of psychoeducational programs on digital wellbeing, healthy internet use, time management, and stress coping strategies in the medical curriculum should be considered. Faculty sensitization and student counselling services can also help in creating a conducive environment to deal with behavioral and psychological issues. From the research perspective, longitudinal studies are recommended to investigate the causal association and temporal patterns between ADHD symptoms and Internet addiction. Furthermore, interventional studies are needed to assess the effectiveness of targeted behavioral and psychological interventions in this population.

Limitations

Although the present study has its strengths, there are also some limitations to be considered when interpreting the results. First, the cross-sectional design precludes conclusions regarding causality or temporal ordering between ADHD symptoms and internet addiction. Second, screening instruments rather than diagnostic interviews may have led to misclassification or underestimation of true prevalence, especially for adult ADHD. Third, the study relies on self-report data, which is subject to recall and social desirability biases that may have affected participants' responses.

Furthermore, the use of convenience sampling restricts the extent to which the results can be generalized to all medical undergraduates, especially those in other areas or institutional settings. The study was conducted in selected tertiary care institutes of South India, and hence the results

may not be truly representative of medical students all over the country. Finally, other potential confounding factors, such as coexisting anxiety, depression, sleep disorders and substance use were not assessed and might have affected the observed associations.

Such limitations suggest the need for cautious interpretation of findings and the importance of future multi-centric, longitudinal and diagnostically rigorous studies to further elucidate the relationship of adult ADHD and internet addiction among medical students.

CONCLUSION

The present study highlights the co-existence of adult ADHD symptoms and problematic internet use among medical undergraduates in a tertiary teaching institute of South India. Prevalence of adult ADHD symptoms was (20%). Internet addiction of any severity was present in 65.5% of participants, with 45.1% in moderate to severe categories. Importantly, we found a strong statistically significant association between internet addiction and ADHD symptoms, with significantly greater odds of problematic internet use among students who screened positive for ADHD.

Our findings indicate that internet addiction is an important behavioral correlate of ADHD-related difficulties in medical students and emphasize the importance of considering digital addiction not only as an isolated behavioral problem but also as a potential marker of underlying attentional and psychological vulnerabilities. Considering the academic demands and psychological stress inherent in medical training, the coexistence of these conditions may have serious implications on students' academic performance, emotional wellbeing and future professional competence.

The present study results support the routine screening of ADHD symptoms and problematic internet use in student health services of medical institutions. Early identification with appropriate counselling, behavioral interventions and referral pathways may contribute to better mental health outcomes and healthier digital habits among medical undergraduates. Moreover, inclusion of strategies for digital wellbeing and mental health in the medical curriculum may help with reducing the increasing burden of behavioral addictions in this population.

Finally, because this study was cross-sectional, further longitudinal and interventional studies are needed to clarify the causal relationship between ADHD symptoms and Internet addiction and to assess the efficacy of targeted preventive and therapeutic approaches. Such efforts will be essential in developing evidence-based policies to foster psychological resilience and academic success among future healthcare professionals.

ETHICS

This study did not involve human participants or experimental animals directly; therefore, ethical approval was not required.

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None.

DATA ACCESS

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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