ORIGINAL ARTICLE

Chronotype: Its effect on cognitive flexibility among medical students with Internet Gaming Disorder: A cross-sectional study

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Abstract

Introduction: The role of technology is intended to aid rather than distract. Gaming Addiction has been recognized by the World Health Organization (WHO) as a disorder in the ICD11, diagnosed when behavior significantly impairs crucial aspects of life for at least 12 months. Notably, the use of technological devices, particularly smartphones and computer screens, affects the endogenous circadian clock or chronotype. Chronotype classifies individuals into three groups: early, intermediate, and late types, each with distinct sleep patterns and preferences. Cognitive flexibility involves suppressing interference from automated tasks, a skill evaluated through the Stroop effect in task-switching designs. **Methodology:** A quantitative cross-sectional survey was conducted over a 2-month duration on undergraduate students in a southern Indian medical college. Using convenient sampling, 600 Internet Gaming Disorder (IGD) Short Form questionnaires were distributed, achieving an 81.5% response rate across all three student phases. Google play store-based app 'App Usage Tracker (AUT)' was used to assess the amount of time spent by the individual on each application. Chronotype of medical students was assessed using, Morningness and Eveningness questionnaire (MEQ). Cognitive flexibility was measured using a) Stroop Colour and Word Test and b) Trail Making Test (TMT). **Results:** Among 489 participants, the prevalence of IGD was 4.9%, with 24 individuals meeting the IGD9-SF endorsement criterion. Subsequent assessments for chronotype and cognitive flexibility in IGD students showed no significant association with Chronotypes. Higher IGD scores correlated with elevated TMT (B-A) scores, indicating reduced task-switching ability. More hours spent on gaming correlated with higher IGD scores, while productive online hours exhibited a negative correlation.

Keywords: Chronotype, Cognition, Gaming addiction, smartphone addiction
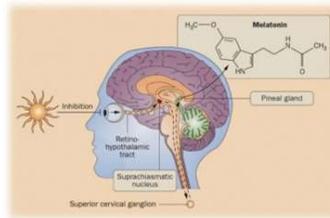
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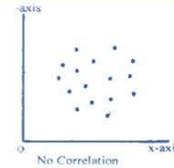Email: drjayamala2013@gmail.com

Graphical Abstract

Internet Gaming disorder (IGD) among young adults

Chronotype

Chronotype- No correlation

4.9% prevalence of IGD in our study

Cognitive flexibility

Cognitive flexibility reduces

Introduction

The role of technology should be that of an aid, not a distraction. Unfortunately, people worldwide are increasingly being drawn away from their real-life responsibilities by the allure of mobile phones. The global escalation of nomophobia, or the fear of being without a mobile phone, serves as a testament to this phenomenon. Recognizing the potential harm associated with technology-related behaviors, the World Health Organization (WHO) has classified Gaming Addiction as a disorder in the ICD11. This disorder is diagnosed when the behavioral pattern results in significant impairment in personal, family, social, educational, occupational, or other essential areas of functioning, persisting for a minimum of 12 months [1]. A study conducted in South India revealed a prevalence of 4.25% of Internet Gaming Disorder (IGD) among medical students [2].

The impact of different technological devices, especially smartphones and computer screens, has been found to influence the endogenous circadian clock, known as chronotype [3]. Chronotype categorizes individuals into three groups: early-type or morning types, who wake up early but feel fatigued in the early evening; intermediate types, who fall between early and late types in terms of waking and sleeping patterns; and late-type or evening types, who stay up late at night and wake up late the next day.

Cognitive flexibility refers to the ability to suppress cognitive interference that arises from automated tasks when individuals are required to engage in novel or less automated tasks. This challenge in inhibiting the more automated process is commonly referred to as the Stroop effect, often assessed through a task-switching design [4]. Individuals with IGD tend to exhibit impaired cognitive flexibility compared to healthy controls [5]. This

cognitive skill is a fundamental aspect of executive function, reflecting an individual's capacity to swiftly transition between tasks. Moreover, cognitive flexibility influences academic achievement, cognitive abilities, and creativity in learners. In the context of IGD, gamers need to swiftly shift between tasks during gameplay.

Research on chronotype assessment has suggested that individuals with an evening-type preference are more susceptible to Internet Gaming Disorder (IGD) [6]. Among medical students, those who are active during phases that are either out-of-phase or in-phase with their circadian rhythm types (or chronotypes) may potentially impact cognition. In the context of circadian rhythms, being "in-phase" refers to being aligned with the typical 24-hour cycle, while being "out-of-phase" indicates a misalignment or deviation from this standard cycle. Comparatively, late chronotypes exhibit notably higher daytime sleepiness in contrast to early chronotypes and tend to perform less effectively in the morning across various cognitive and physical measures [7]. Neurobehavioral deficits, such as decreased alertness and an increase in unintentional sleep episodes due to disruptions in the circadian rhythm, are more pronounced in younger participants as opposed to older adults [8]. Although some studies have failed to establish a correlation between chronotype and academic performance [9], it remains an area of ongoing investigation.

Studies exploring cognitive flexibility have indicated that prolonged gaming can enhance brain synchronization in regions related to sensory-motor coordination and visual-spatial processing. However, several other studies have highlighted impaired executive functions among individuals with internet addiction. Considering the contradictory findings, the assessment of cognitive flexibility among individuals with IGD was deemed necessary.

Despite existing research on internet addiction among medical students, there is a notable lack of literature specifically addressing the prevalence of IGD and chronotype within this population. This study aims to investigate the impact of chronotype on cognitive flexibility among medical students affected by IGD. Notably, based on our thorough literature search in PUBMED and Google Scholar up until February 2022, we found no published data from India that evaluated the relationship between IGD, chronotype, and cognitive flexibility in medical students. Hence, this novel study was initiated as a pilot project.

Aims & Objectives

To determine the prevalence of IGD among medical students

To correlate Chronotype and its association with IGD score

To correlate between Cognitive flexibility and IGD score

Materials & methods

The present research is a quantitative cross-sectional survey conducted at a medical college in southern India, targeting undergraduate medical students over a period of 2 months from July 2022 to September 2022.

The study was commenced after obtaining the Scientific Research Committee & Institutional Ethics Committee clearance. After explaining the purpose of the study, informed written consent was taken from all the subjects. Six hundred paper-and-pencil questionnaires of

Internet Gaming Disorder Scale 9– Short-Form (IGDS9-SF) were distributed in class using convenient sampling and data was collected from all three phases of students (MBBS phase I, II, III Part 1 & 2) within the same day. In (IGDS9-SF), out of 9 criterions, if 5 criterions are answered as very often (which is considered as endorsement of criterion), the participant was considered as disordered gamer. The overall response rate was 81.5%.

Internet Gaming Disorder Scale – Short-Form (IGDS9-SF) was used to assess the severity of IGD as proposed by the American Psychiatric Association in the latest edition of the diagnostic and statistical manual of mental disorders (DSM-5). It is a 9-item scale which assess the gaming activity in the past 12 months. Each item is scored from 1 to 5, higher scores indicating greater severity. Scores are summed to determine a total score, which ranges from 9 to 45, with higher scores indicating of higher degrees of gaming disorder. The participant is considered as disordered gamer, If he answers five out of nine criterions as very often (which is considered as endorsement of criterion) [10]. Its reliability and validity have been verified in Indian population. It assesses the degree of severity of IGD and its detrimental effects by accounting for both online and offline gaming activities. Higher scores were associated with greater severity of IGD (includes both online and offline gaming) among study participants.

In our institute 24 undergraduate student across all phases of MBBS were categorized as having Gaming disorder. All the students with IGD were included for the next part of the study. Participants with a history of any neuropsychiatric disorder or on medications for the same were excluded. Participant using an Android operating system-based smartphone were asked to download Google play store-based free app "App Usage Tracker©" to objectively measure the average amount of time spent in gaming per week.

"App Usage Tracker©" is installed from Google play store

Google play store-based app 'App Usage Tracker (AUT)' was used to assess the amount of time spent by the individual on each application. Smartphone user can track the duration in minutes spent on all the apps by him/her. The app displays the duration of usage in minutes and seconds. AUT does not track any personal communications. The smart phone app does not store confidential data of users. Participants were shown the working of the app and were assured that their data would not be deleted or shared. Participants were advised to continue using their smartphone in a regular manner and were advised to follow-up after 7 days. During follow-up, readings from the "*App Usage Tracker©*" was recorded. Participants were then advised to uninstall the tracker app if they wished. For ease of analysis, the data obtained from AUT was categorized into number of hours per week spent on Gaming, Social networking and Productivity time. No monetary or special benefits was received from the smart phone app [11].

Chronotype was measured for all the 24 students with IGD using Morningness and Eveningness-Questionnaire (MEQ)

Chronotype of medical students was assessed using, Morningness and Eveningness questionnaire (MEQ) which is developed by James A. Horne and Olov Ostberg [12]. Institutional pre-validation was carried out before the administration of

MEQ. MEQ is a 19-item questionnaire with four to five options against each question and with specific score for each option and these scores are from zero to six. It evaluates individual's sleep pattern over the last month. Students should mark only one suitable option for each question. The total score on the overall MEQ items ranges between 16 and 86. Based on the total score, individuals can be divided into three behavioral categories: Evening-types (score = 16–41), intermediatetypes (score = 42–58) and morning-types (score = 59–86).

The Stroop colour and word test

This test consists of three cards (Card W, Card C, Card CW), with one hundred stimuli in each card. In card W, stimuli are the written names of four colours (red, blue, green, yellow). The subject reads the word loudly. Card C shows coloured squares (red, blue, green, yellow) and the subject is asked to name the colours of the squares. Cards CW display words referring to the names of the above colours, printed in a conflicting ink colour. The number of correct responses in the fixed time of 45s is recorded. The correct answers achieved in the first 45s for each table, generating three scores, namely word items (W), color items (C), and color word items (CW) (Figure 1) [4].
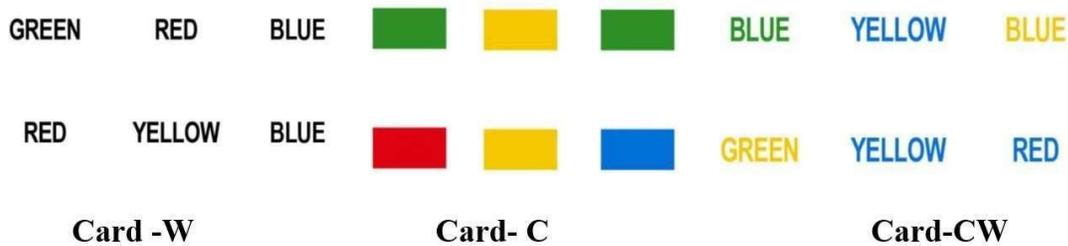

Figure 1. Cognitive flexibility was measured for all the 24 students with IGD using a) Stroop Colour and Word Test and b) Trail Making Test

Trail Making Test (TMT)

TMT assesses visual scanning, numeric and alphabetic sequencing, motor speed, and cognitive flexibility. TMT consists of two parts. In TMT-A subject has to draw lines connecting 25 encircled numbers sequentially which are randomly distributed on a sheet of paper as fast as possible. Similarly in TMT-B, the subject has to connect numbers and letters instead (e.g., 1, A, 2, B, 3, C) and it evaluates mental flexibility. Demonstration of the test to the participant was done using the sample sheet (Trail Making Part A& B) before the start of test proper. The score on each part represents the amount of time required to complete the task. Time taken by the participant on each test without lifting up pen or pencil in ascending order was noted. If he/she made an error, mistakes were pointed out and asked them correct it. Time to correct mistake was also included in completion time for task. Time was limited to 480 s in this study. Trail making test B-A score is considered as a better indicator of task switching ability [13].

Results

Out of the 600 students approached, 489 provided responses to the IGD9-SF questionnaire. Among the respondents, 223 (45.60%) were male and 266 (54.39%) were female, resulting in an overall response rate of 81.5%. The prevalence of IGD was 4.9% (24 participants), with 20 males (83.3%) and 4 females (16.6%) meeting the IGD9-SF criteria, as outlined in Tables 1-4.

Table 1: General characteristics of participants

	IGD (n=24)	No IGD(n=465)
Prevalence	**4.9%**	**95.9%**
IGD score	40.38±1.28	13.29±4.77
Gender		
Male	83.3% (n=20)	43.6% (n=203)
Female	16.6% (n=4)	56.3% (n=262)
Age	20.2±1.84	20.14±2.46
Nature of stay		
Hosteller	62.5% (n=15)	13%(n=61)
Days scholar	37.5% (n=9)	86.88% (n=404)

All data are represented as mean ±SD, Frequency is expressed in percentage %, IGD- Internet Gaming Disorder

Table 2: Association of various types of chronotype with IGD score:

Variable (Type of Chronotype)	r value	F	P
Evening type(E) (n=13)	-0.4779	3.256	0.0986
Morning type (M) (n=3)	-0.5000	0.3333	0.6667
Intermediate type (I) (n=8)	-0.6255	3.857	0.0972

No statistically significant difference was noted between IGD score among different Chronotype individuals

Table 3: Correlation of Cognitive flexibility test score with IGD score

Variables	Mean ± SD	r	F	P value
TMT-A	30.04±5.97	- 0.1234	0.3404	0.5655
TMT-B	68.04±12.90	0.0228	0.0114	0.9159
TMT(B-A)	38±9.95	0.1036	0.2388	0.6299
Stroop color task (W) @ 45secs	84.95±5.87	0.1871	0.7979	0.3814
Stroop color task (C) @ 45secs	73.66±9.35	0.0437	0.0421	0.8393
Stroop color task (CW) @ 45secs	44.62±8.90	0.1100	0.2692	0.6090
All data are represented as mean ±SD, TMT – Trail Making Test, W- Word, C – Color, CW-Color Word				

A Pearson correlation coefficient was computed to assess the linear relationship between Trail Making Test scores, Stroop colour task scores with IGD score. Negative correlation was found ((r- 0.1234) between TMT – A and IGD score but the difference was not significant p -value 0.6299.

Table 4: Correlation between the number of hours spent per week and IGD score

	IGD (n=24)	r value
Game time (hrs/week)	34.43±11.48	0.0258*
Social networking time(hrs/week)	40.42±13.78	-0.0699
Productivity time (hrs/week)	14.67±5.14	-0.0452

All data are represented as mean ±SD, *P- value <0.05 was considered significant, IGD- Internet Gaming Disorder

Discussion

The main objective of this research was to examine the frequency of Internet gaming disorder (IGD) and its connection to chronotype and cognitive flexibility, measured using Stroop color task and TMT (Trail Making Test) scores among undergraduate medical students. Our study revealed a 4.9% prevalence of IGD (24 out of 489) among medical students as displayed in Table 1. No significant association was observed between the IGD score and various chronotypes, nor was there any connection between the IGD score and cognitive flexibility.

Numerous studies have examined the occurrence of IGD in various groups. In our research, the prevalence of IGD among medical students was 4.9% (24 out of 489), In a study by Swarndeep Singh et al., the

prevalence of IGD was 3.6% among medical students [14]. Similarly, another study demonstrated a prevalence of 4.25% in a south Indian medical college [2]. These findings are consistent with a recent meta-analysis that reported the prevalence of IGD in India to be between 2.7% and 5.5% [15]. Notably, a study conducted in north India among medical and dental students revealed a prevalence of 9%, with a higher prevalence among males, despite the greater number of female participants [16]. In our study, IGD was found to be more prevalent in males than in females. The combined prevalence of IGD among medical students from different countries was 6.2%, approximately double the prevalence in the general population [15].

In our research, the male population constituted 83.3%, indicating a notably high prevalence of IGD among males. Research has elucidated the variance in internet addiction rates between genders by emphasizing that males are inclined towards gaming [15], while females tend to favor the use of social networking sites. The meta-regression analysis indicated that the male gender was not a substantial moderator and did not explain the considerable heterogeneity in the combined prevalence of IGD [15]. The diverse cultural roles and expectations for males and females are evident in the content of video games, which are primarily tailored for males in the form of action games, while female participants often lean towards simulation games [17].

In our investigation, no correlation was identified between the IGD score and individuals of different Chronotypes. Among the IGD subjects, the distribution of Chronotypes was as follows: Evening type (n=13 out of 24), Intermediate type (n=8), and Morning type (n=3) as shown in Table

2. Several studies have reported an association between evening Chronotype and internet addiction, along with other addictive behaviors [18,19]. As part of an individual's personality, preferences for morningness-eveningness differ. Previous research has extensively explored the relationship between Chronotype and internet addiction. However, the association of IGD, a subtype of internet addiction, with Chronotype, has not been thoroughly examined. In this study, the lack of a significant association may be attributed to the limited sample size of IGD.

The cognitive flexibility of individuals is evaluated through the Trail Making Test and Stroop color task. TMT-A primarily assesses visuo-perceptual abilities, while TMT-B primarily reflects working memory and, to a lesser extent, task-switching ability. On the other hand, B-A minimizes the demands on visuo-perceptual and working memory, serving as a relatively pure indicator of executive control abilities and task-switching ability [20]. In our study, a positive correlation was observed between TMT-B, TMT B-A scores, and Stroop color task scores, except for TMT-A. Additionally, a higher IGD score was positively associated with higher TMT (B-A) test scores, as demonstrated in Table 3. The increasing TMT B-A score with a rise in the IGD score suggests reduced task-switching ability among IGD subjects. These findings align with other studies that indicate the frequent Internet Gamer group shows improved multitasking efficiency when assessed using a more natural task but not when evaluated using a conventional laboratory multitasking task [21].

In our research, a positive correlation was observed between the weekly hours spent using smart phones for

gaming and the IGD score, indicating a higher likelihood of Internet gaming disorder among individuals who dedicate more time to online gaming compared to social networking, as depicted in Table 4. Conversely, the number of hours spent online on productive activities per week exhibited a negative correlation with the IGD score, suggesting the detrimental impact of excessive gaming on academic performance.

The prevalence of IGD among medical students corresponded to that observed in young adults. Consequently, based on the prevalence results in the medical student population, counselling sessions were administered by a psychiatrist. Students with IGD were advised on various available cognitive-behavioural treatment strategies, such as implementing new schedules to disrupt internet usage patterns and setting limits on the amount of time spent online, with a specific focus on gaming. The utilization of an application for tracking screen time provided students with insights into their gaming habits. Moreover, a proposal was made to the Medical Education Unit to organize awareness programs for MBBS students regarding the adverse effects of Internet addiction.

A notable strength of our study is the notably high response rate for the IGD9-SF questionnaire, with no dropouts during the subsequent stages of the study. The use of a mobile application for objectively assessing the number of hours spent on online games offered students a clear understanding of the amount of valuable time consumed by gaming rather than productive activities. However, the results cannot be extrapolated to the general population as the study was conducted solely among medical students.

Additionally, due to the small sample size, the representation of chronotype and cognitive flexibility reports is limited. Furthermore, variations in prevalence might arise based on the subjects' urbanization and socioeconomic status, impacting the affordability of gaming setups, factors that were not accounted for in this study.

Conclusion

The observed prevalence of IGD among medical students is a cause for concern, emphasizing the urgency for timely intervention and early identification of affected individuals. There is a pressing need to raise awareness about Internet addiction and Internet gaming disorder. A positive correlation was observed between the weekly hours spent and the IGD score. Further research is imperative to delve into the diverse factors influencing addiction, its impact on cognition, and to identify effective intervention strategies for addressing gaming addiction among young individuals. Furthermore, exploring the potential benefits of concept-based academic internet games could be an avenue worth investigating.

Summary

Among 489 participants, the prevalence of IGD was 4.9%, with 24 individuals meeting the IGD9-SF endorsement criterion, of which 20 were males (83.3%) and 4 were females (16.6%). Further assessments of students with IGD were conducted for chronotype and cognitive flexibility. Notably, no significant association was found between the IGD score and different Chronotypes. The study revealed a positive correlation between TMT-B, TMT B-A scores, and Stroop color task scores, except for TMT-

A. Higher IGD scores were positively correlated with elevated TMT (B-A) test scores, suggesting a reduced task-switching ability among IGD subjects. Additionally, a positive correlation was observed between the weekly hours spent using smart phones for gaming and the IGD score, signifying a heightened risk of Internet gaming disorder among individuals dedicating more time to online gaming than social networking. Conversely, the number of productive hours spent online per week showed a negative correlation with the IGD score, highlighting the adverse consequences of excessive gaming. Timely intervention measures are crucial for individuals affected by IGD among medical students. It is imperative to prioritize primary prevention by promoting awareness of internet addiction and internet gaming disorder. Moreover, further research is warranted to develop effective intervention strategies for addressing gaming addiction among the youth.

Statements and declarations

Funding

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Conflict of Interest

Ethics approval, consent to participate, consent to publish, availability of data and material, code availability

Author Contribution

Acknowledgment

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