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Effect of internet addiction on sleep quality and cognitive function: A comparison between healthy males and females

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Abstract

Objective(s): Internet is a new tool which is developing into an essential part of everyday life all over the world. In spite of its widely perceived advantages, its excessive use can lead to physical and psychological problems. The commonest among these is internet addiction which can affect sleep quality and cognitive functions. Aim: to compare the effect of internet addiction on sleep quality and cognitive functions in healthy males and females.
Method(s): In this cross-sectional study 204 subjects aged 18-35years participated. Internet addiction was assessed by Internet Addiction Test, Sleep quality by Pittsburgh Sleep Quality Index and cognitive functions by Cognitive Failure Questionnaire.
Result(s): Sleep quality of males is affected less than the females and as males are more addicted to the internet their cognitive functions are also affected more than the females.
Conclusion(s): As the internet addiction scores increase, significant reduction in the sleep quality scores is found in the males. Increased internet addiction causes significantly increased decline in the cognitive functions in both males and females. We encourage randomized controlled trials to evaluate the effect of different physical activity and psychological interventions to treat internet addiction so as to improve the quality of sleep, cognition and overall health in otherwise healthy internet-addicted adults.
Keywords: Internet addiction, internet addiction test, PSQI, CFQ.

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1. Introduction

The internet is a tool which is developing into an essential part of everyday life all over the world [1]. In spite of the widely perceived advantages of this tool, psychologists and educators have been aware of the negative impacts of its use, especially the excessive or misuse and the related physical and psychological problems [2]. One of the most common among these problems is internet addiction [3]. Internet addiction is an umbrella term that refers to the compulsive need to spend a great deal of time on the internet, to the point where relationships, work and health are allowed to suffer [4].

Pathological gambling was viewed as similar to the pathological nature of internet use. By using pathological gambling as a model, Internet addiction can be

defined as an impulse-control disorder which does not involve an intoxicant [5,6]. Young produced a short eight-item questionnaire that altered criteria for pathological gambling to provide a screening instrument for addictive internet use. Patients were considered as "addicted" when they answered "yes" to five (or more) of the questions and when their behavior could not be better accounted for by a manic Episode. The proposed diagnostic criteria include the following core symptoms: preoccupation (obsessive thoughts about the Internet), loss of control (internet usage more than intended, internet use regardless of the negative consequences), tolerance and withdrawal symptoms [5,6].

Time is not a direct function in defining Internet addiction; addicted users use the Internet from forty to eighty hours per week, with a single session lasting up to twenty hours [7]. The term internet denotes all types of contact which the individual has with web based services which includes websites, Internet- based games, social media and online entertainment on all types of computers, screens, devices, phones, portable electronic devices and other forms of technology [7]. To adapt to such excessive use, sleep patterns get disturbed because of late night log-ins. The patient remains awake past normal bedtime hours and stays online till two, three, or four in the morning with the reality of having to wake for work or college at six a.m. In extreme cases, caffeine pills are used to facilitate longer Internet sessions. This sleep deprivation produces excessive fatigue often making academic or occupational functioning impaired and may decrease one's immune system, leaving the patient susceptible to disease increasing the risk of poor diet and exercise [6].

The sleep–wake cycle is one of our biological rhythms which are driven by a circadian timing system which is influenced by some factors such as physiological function, school and work schedules. Sleep problems and internet addiction are common among children and adolescents, and are a main concern of parents [6]. Sleep problems are usually considered negative outcomes or complications of internet addiction, which was supported by many assessment tools of internet addiction, such as the Pittsburgh sleep quality index (PSQI)[6].

Cognitive control is defined as the ability to control one's own actions, behavior, and even thoughts [8]. Decrease in cognitive control is sometimes referred to as the main component of impulsivity, in neuropsychological research control mechanisms are ascribed to executive functions. It has been argued that sleep quality affects the functioning of the prefrontal cortex of the brain which is connected to cognitive activities, such as creativity, integration and planning [9]. This approach has seen different investigations using neuroimaging techniques to verify alterations in the prefrontal cortex in subjects with excessive internet use, which results in problems of cognitive flexibility, decision making [10], working memory [11] and executive control [7]. Internet related stimuli intervene with control processes that are controlled by the prefrontal cortex [12]. There are some recent findings from neuropsychological research which emphasize that internet-related stimuli intervene with decision making and many prefrontal functions, such as working memory and other executive functions [12]. The major role in developing and maintaining an addictive use of the internet is reductions of prefrontal control processes. Conditioning also plays an important role in building a strong relationship between Internet related stimuli and positive or negative reinforcement [12].

Researchers and the public have been increasingly interested in problems arising from excessive use of technology, including Internet use. Internet addiction is a rising phenomenon which is affecting people with varying frequency around the world and has produced various negative impacts on academic, relationship, financial, and occupational life [13]. Compared to females, males' are technologically sophisticated and their social skills and social abilities are not well formed which makes them susceptible to excessive involvement in interactive activities such as online games and chat lines and they feel more competent and comfortable online [14]. Males spend most of the time reading news, checking social media, sending and reading emails excluding working hours. Also, males do not have much more awareness of the social environment around them as compared to females.

The study hypothesizes that there is a significant difference between males and females in sleep quality and cognitive functions due to internet addiction. Thus, the aim of the study is to compare the effect of internet addiction on sleep quality and cognitive function in healthy males and females.

2. Materials and Methods

2.1 Ethical approval and consent to participate

The study was approved by the Institutional Ethical Committee, Jamia Hamdard, New Delhi, India. All procedures followed were in accordance with the institutional ethical standards for human experimentation and the Helsinki Declaration. All participants were given an information sheet explaining the study purpose, methodology as well as their rights as research subjects and written consent was obtained.

2.2 Participants

204 participants with age 18-35 years were recruited for the study on the basis of inclusion and exclusion criteria through a sample of convenience. The participants were then divided into two groups i.e. Group A

(Male, n=102) and Group B (Female, n=102). The participants were selected from the Department of Rehabilitation Sciences, and other departments of Jamia Hamdard, New Delhi. Participants were recruited for the study if they were aged 18-35 years, with normal BMI and able to understand and communicate English. Participants with a history of neurological, psychiatric or medical diseases, on medications, having any inflammatory joint disease or any other musculoskeletal and vestibular disorder were excluded from the study.

102 Males and 102 Females were enrolled in the study and assessed for internet addiction, sleep quality and cognitive functions to quantify the effect of internet addiction on the sleep quality and cognitive functions. Internet addiction was assessed by the Internet Addiction Test. Sleep quality was assessed by Pittsburgh Sleep Quality Index. Cognitive functions were assessed by the Cognitive failures questionnaire. All the questionnaires were filled by the participants correctly. Total scores were obtained and the results were analyzed.

2.3 Internet Addiction Test

The Internet Addiction Test (IAT) is a valid and reliable measure of addictive use of the internet which was developed by Dr. Kimberly Young [15]. IAT consists of 20 self-report questions that measure mild, moderate and severe levels of Internet Addiction which are to be filled by participants. After reading each question carefully participants select the most appropriate response from a 5-point likert- scale that ranges from 0,1,2,3,4,5 where 0= does not apply, 1= rarely, 2= occasionally, 3= frequently, 4= often and 5= always. Totaling of score is done, the higher the score, greater level of addiction is. Maximum score of IAT is 100 points. Scores ranging from 20-49 points are considered as average online users, scores of 31-49 are considered as presence of a mild level of Internet addiction; scores of 50- 79 are considered as the presence of a moderate level; and scores of 80-100 indicate a severe dependence upon the Internet.

2.4 Pittsburgh Sleep Quality Index

The Pittsburgh Sleep Quality Index (PSQI) is a self- report questionnaire that measures sleep quality during the past month. PSQI consists of 19 individual items, creating seven components that produce one composite score. Each item is measured on an 0-3 interval scale. The composite PSQI score is then calculated by totaling seven component scores producing scores ranging from 0-21, where lower scores indicate healthy sleep quality. PSQI has high test- retest reliability and a good validity [16].

2.5 Cognitive Failure Questionnaire

The 'Cognitive Failures Questionnaire' (CFQ) was first described by Broadbent et al. (1982). Participants respond on a five-point Likert scale, ranging from 0 (never) to 4 (very often), and the CFQ is scored by summing the ratings for 25 items (the highest possible total is 100). A high score indicates increased possibility of cognitive failure. The questionnaire is a reliable tool which is simple to administer and understood by the participants easily [17].

2.6 Statistical analyses

Data are presented as Mean ± Standard Deviation in Table 1. Statistical analysis was done by using the SPSS version 22.0 software. Descriptive statistics was used to analyze and find out mean and standard deviation of subject characteristics. The present study used independent t- tests to compare mean values of all outcome variables. Pearson's correlation tests were used to assess correlations between different outcome variables upon testing the normality of the data. Level of significance was set at $p<0.05$.

3. Results

Participants were found to be comparable in terms of age only. According to the comparison of internet addiction between males and females (Table 1), males are significantly more addicted to the internet as compared to females. But the sleep quality of males is affected less than females and the cognitive functions of males are affected more than the females (Table 1).

Table 1: Comparison of demographic characteristics and outcome variables

Variables	Females Mean ±SD n=102	Males Mean ±SD n=102	t- value	p- value
Age (yr)	22.11±2.6	22.26±2.7	0.417	0.677
Height (cm)	160.26±6.6	171.39±9.0	10.006	<0.001*
Weight (kg)	54.60±6.0	65.32±6.8	11.817	<0.001*
BMI (kg/m2)	21.29±1.8	22.12±1.8	3.229	0.001*
IAT	52.91±16.8	63.65±11.7	5.281	<0.001*
PSQI	6.21±3.0	5.15±2.1	2.893	0.004*
CFQ	50.86±17.7	58.71±13.9	3.53	0.001*
BMI: body mass index, IAT: internet addiction score, PSQI: sleep quality score, CFQ: cognitive function score, *: significant p- value (<.005)				

3.1 Correlation of internet addiction and sleep quality

Internet addiction in males correlates significantly with the quality of sleep in a negative manner. As the internet addiction scores increased, reduction in the sleep quality scores was found. However, no such significant correlation exists in females (Table 2).

Table 2: Correlation of internet addiction and sleep quality

IAT	PSQI	
	FEMALES	MALES
Correlation coefficient (r)	0.127	-0.244
p- value	0.204	0.014*
IAT: internet addiction score, PSQI: sleep quality score, *: significant p- value (<0.005)		

3.2 Correlation of internet addiction and cognition function

Internet addiction in females correlated significantly with the cognitive function scores more strongly than their male counterparts. As the internet addiction scores increased, a decline in the cognitive functions was found as indicated by increasing CFQ scores (Table 3).

Table 3: Correlation of internet addiction and cognition function

IAT	CFQ	
	FEMALES	MALES
Correlation coefficient (r)	0.516	0.323
p- value	<0.001**	0.001*
IAT: internet addiction score, CFQ: cognitive function score, *: significant p- value (<0.005), **: significant p- value (<0.001)		

4. Discussion

The result of the present study revealed that males are more addicted to the internet than the females and their sleep quality is less affected than females and their cognitive functions are more affected than the females.

Previous research states that object-oriented introvert males become computer addicted [18] and as females are technically less updated and have lower self-efficacy than men when asked about their use of information technology [19]. Compared to females, males' are technologically sophisticated and their social skills and social abilities are not well formed which makes them susceptible to excessive involvement in interactive activities such as online games and chat lines and they feel more competent and comfortable online[14]. Males spend most of the time reading news, checking social media, sending and reading emails excluding working hours. Also, males do not have much more awareness of the social environment around them as compared to females. Young (1998)[8] observed that males try to search for dominant activities or content online. These interactive online games which rely on power, dominance, control, and/or violence attract men more than females. On the other hand, females look out for virtual communities that give women a sense of belonging and they are able to share their feelings and emotions and hide their appearance. These might well explain the findings of the present study related to greater internet addiction scores in the male collegiates as compared to their female counterparts (Table 1).

In 1997 Scherer [20] stated that dependent internet users indicate a significantly larger proportion of men to women (71% men and 29% women, respectively). Morahan-Martin and Schumacker (2000)[14] reported that males were more likely to become pathological users than females (12% vs. 3%), whereas females were more likely to have no symptoms (28% vs. 26%) or have limited symptoms (69% vs. 61%) of behavioral pathology than males.

This study shows that the sleep quality of males is affected less than females (Table 1). The data has shown statistically significant results (p= 0.004). Female subjects are found to have higher prevalence of poor sleep quality (65.1% vs. 49.8%) and all other sleep problems than males due to higher prevalence of depression in females, and socio demographic lifestyle factors [21]. Lesser internet addiction scores might be a reason for non-significant correlations between internet addictions and sleep quality in female subjects (Table 2). The association between sleep and affective disorders is well established and disturbed sleep is considered as one of the main symptoms of clinical anxiety and depressive disorders [21]. Along with socio-demographic and affective disorders, lifestyle has also emerged as a significant predictor of sleep problems [21].

It is seen that physical inactivity, alcohol consumption and long computer screen hours are linked to higher odds of sleep problems. Internet addiction was also reported to be associated to mood disorders, poor sleep quality, low self-esteem, impulsivity, suicide, lower levels

of physical activity, and health problems (migraines, back pain, obesity). The co-existence of internet addiction and poor sleep quality may lead to physical and psychological symptoms. Sleep problems are usually considered negative outcomes or complications of internet addiction. Increased use of the internet may simply disturb sleep, thus reducing sleeping time [22]. Hence, significant negative correlation between the internet addiction scores and sleep quality scores in male subjects of the present study can be justified. Research has suggested that internet addiction causes insomnia and other sleep disturbances. Excessive time spent on the internet disturbed the sleep–wake schedule and increased rate of insomnia was found among heavy internet users [23].

Executive functions are control systems allowing us to regulate behavior that is planned, goal oriented, flexible, and effective [24,25]. The present study also shows that as males are more addicted to the internet their cognitive functions are more affected than the females (Table 1). The data has shown a statistically significant difference (p= 0.001). Patients with internet addiction may have reductions in prefrontal control and other executive functioning [12]. Surrounding with internet technologies, individuals report "shallow" information processing behaviors denoting rapid shifts in attention and reduced thinking. Males engage in increased multitasking behaviors that are linked to increased distractibility and poor executive control abilities. Cognitive flexibility is the ability that allows a person to adapt to different situations rapidly and efficiently [12]. Males do not show an effortful control that can efficiently shift their attention from negative stimuli to use more positive coping styles such as problem-solving when they face the challenge of stressful life events. Internet addiction causes reductions in decision-making performance, because they need more endeavor to executive functions [12].

The results of the current study found that males are more addicted to the internet as compared to females. Also, the sleep quality of males is affected less than the females and as males are more addicted to the internet their cognitive functions are also affected more than the females. As the internet addiction scores increase, reduction in the sleep quality scores is found in the males. Increased internet addiction causes increased decline in the cognitive functions in both males and females.

Clinical implications and future perspective

Internet addiction could be a consequence of reduced physical activity. Physical inactivity in itself could lead to inadequate sleep and poor sleep quality. The present study emphasizes the importance of assessing physical activity, internet addiction and sleep quality in otherwise healthy adults.

We encourage randomized controlled clinical trials evaluating the effect of different physical activity programs on internet addiction, sleep quality and cognition in otherwise healthy adults. Not only physical intervention but psychological intervention too might play a role in treating internet addiction thus improving sleep quality and overall health.

Limitations of the study

Firstly, the sample size of the study was small. Secondly, a particular age group i.e. 18-35 years was taken in this study so the result cannot be generalized to all other age groups.

Conflict of interests

The authors declare that they have no competing interests.

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