Predicting depression among internet addicted students

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Abstract
Introduction: Internet has been easily accessible to students living in urban areas. With its unprecedented development and many benefits, it also leads to Internet addiction (IA) among people. Though IA is a disorder in itself, there can be other disorders associated with it as well. One such association of IA is with depression.
Objective: The aim of this paper is to show a potential relationship between internet addiction and depression among students belonging to the urban setting.
Materials and Methods: The research sample consisted of 228 students aged between 11-27 doing their schooling or graduation. To assess the study, a self-administered questionnaire consisting of three parts was given to them. The first part comprised of socio-demographic information and pattern of internet usage. Second part consisted assessment of internet addiction using Young's 20 item Internet addiction test (IAT) and the third module comprised of Birleson's depression self-rating scale (DSRS) questionnaire.
Results: The 228 study participants were classified based on their scores obtained on IAT and DSRS scales. They were divided into two class labels: Depression Yes and Depression No. 99 were classified to the "YES Depression class" and 129 were classified to the "No Depression class" and overall classification accuracy achieved was 85.5%.
Conclusion: Students get addicted to the internet due to its easy availability and accessibility. The current study showed that this addiction is associated with depression. It also showed that internet addiction and depression is more prevalent above the age of 19.

Keywords: Internet addiction, Internet addiction test, Depression, Depression self-rating scale, Logistic regression.

Introduction
Explosive growth has been seen in the usage of the internet across the globe. With its widespread availability and easy access, it has been used for many purposes like browsing for information, a gaming,[1,2] social networking,[3-5] online chatting, etc.[6,7] However, the internet is responsible for many problems as well. As there is no control on the number of hours being spent on it in a day, young children to adults are getting hooked onto it. The most common problem faced by youngsters is internet addiction, which without one's knowledge is taking their valuable time. Internet addiction among students has been studied for several reasons.[8-10] Due to its easy accessibility via computers, cyber cafes, smartphones, and smart televisions, students generally use it often. The American Psychiatric Association has defined internet addiction as a pattern for using the internet which can cause dysfunction and unpleasant internal reactions during a period of two months.[11,12] Although according to DSM-5,[13] internet addiction is not treated as a disorder, it has been included under Section 3 called, Emerging Measures and Models, which requires further clinical research before it can be formally considered as a disorder. Having said this, internet addiction has been considered as a serious health issue in terms of changes in an individual's behavior and poor mental health.[14-16]

Research has shown the correlation between internet use and psychiatric symptoms.[17-22] Several researchers have studied the impact of internet addiction across different populations. Orsal et. Al[23] and Othman et al[24] analyzed the correlation using Young's Internet Addiction Scale (IAT) and Beck's Depression Inventory (BDI-II 1996) among university students. By using Pearson correlations, the results revealed that there is a significant positive correlation between levels of depression and internet addiction. Bhat et al[25] assessed internet addiction using the internet addiction test (IAT), whilst depression and anxiety by using the hospital anxiety and depression scale. Results from these studies done in this field showed that internet addiction was associated with depression among students.[23-25]

The present study is in line with the existing research in this field. The work focuses on showing the correlation between internet addiction and depression using Young's IAT and Birleson's depression self-rating scale.

Aims and Objectives
1. To study the relationship between internet addiction and depression among students
2. To study the difference in internet addiction and depression among students based on gender.

Materials and Methods
This cross-sectional study was conducted by the department of psychiatry of a tertiary care hospital and college, after receiving prior approval from the institution's ethical committee. The study was conducted on students of nearby schools and colleges from December 15, 2017, to January 15, 2018. Six schools, two engineering colleges, two dental colleges, and two pharmacy colleges were approached out of which, two schools, two pharmacy colleges, and one dental college granted permission for conducting the study on their students. School students studying in ninth and tenth standard, who chose to participate in the study were included. Pharmacy and dental students who were present on the day

of the visit to the college and who were willing to participate in the study were included.

Consent from students above 18 years and assent from students under 18 years was obtained. The students were then gathered in classrooms and informed about the subject and purpose of the study. A three-page questionnaire was filled by the students under guided supervision. The procedure took approximately 20-30 minutes. In total, 250 participants had filled the questionnaire out of which 228 had given completely filled forms. Thus, the population of study considered was *n=228* students.

Tools

A three-page questionnaire was developed based on the purpose of the study in line with the literature given by Orsal et. al and Othman et al.[23,26] The questionnaire consisted of items related to socio-demographic details (age, gender, education status, academic performance, substance abuse in parent, height, weight, hours of sleep per day), students' pattern of internet usage(place of access, device used, activity online, number of hours spent per day, number of text messages sent per day, number of calls made per day), Young's Internet Addiction Scale (IAT) score[27] and Birleson's Depression Self-Rating Scale (DSRS).[28]

IAT score was used to test the level of internet addiction among the study group. This test consists of 20-Likert type questions based on the five-point Likert scale designed by Kimberley Young.[27] Each question contains six options ranging from 0(never) to 5(always) After answering all the questions, numbers for each response were added to obtain a final score which suggests the severity of Internet addiction. Higher the score indicates higher levels of internet addiction.

The Depression Self-Rating Scale for Children was developed in 1978 as part of a Masters of Philosophy Thesis at the University of Edinburgh. It is used to test depression among children.[28] The test consists of 18 questions with 3 options ranging from 1(mostly) to 2(never). Questions 3,5,6,10,14,15,17 and 18 were considered negative questions. For these questions, higher the score more depressed is the person. The rest of the questions were considered as positive questions and lower the score, more depressed is the person. With regards to positive questions, the score is taken directly. However, for the negative questions, we took the score by subtracting the marked score from two.

Statistical Analysis

All the data was entered and tabulated using SPSS version 25.0 software (IBM SPSS Inc., Chicago, IL). Descriptive statistics (percentage, mean, standard deviation) were calculated to summarize baseline characteristics of the study subjects. Correlations among variables are performed by using the Pearson correlation test. The significance obtained was of $\rho < 0.05$ which means variables are strongly correlated with each other. Association between each variable was analyzed by using student's 2-tailed t-test with student's $\rho < 0.01$.

Results

Table 1 shows the socio-demographic details of the participants. For categorical variables, the number of samples, *n* with its corresponding percentage and for continuous variables, mean with standard deviation is shown. Of the 228 students present in the study, 140 were female and 88 were male. Their age ranged from 11 to 27 years with a mean age of 17.97 ± 3.00 and 18.93± 1.30 years respectively. The score on the IAT ranged from 0 to 66, with a mean score of 37.39 ±18.50. The score on DSRS ranged from 0 to 24 with the mean score to be 14.45 ± 5.35.

Table 1: Socio-demographic characteristics of the study participants

Name	Socio-demographic variables	count (n) or Mean ± Standard deviation	%
Gender	Female	140	61.4
	Male	88	38.6
	Age	17.97 ± 3.00	NA
Education	Graduation	130	57
	Schooling	98	43
Academic performance	Poor	5	2.2
	Average	53	23.2
	Good	150	65.8
	Excellent	22	9.6
Substance abuse in parent	Yes	65	28.5
	No	163	71.5
Physical characteristics	Hours of sleep	7.57 ± 1.92	NA
	Weight	51.99 ± 8.10	NA
	Height	162.43 ± 8.15	NA

NA-Not applicable

Table 2 gives the complete details of the pattern of internet usage among students of study with different variables and their corresponding count, percentage.

Table 2: Pattern of Internet usage among study participants

Pattern	Variables	count (n)	%
Place of internet access	Home	202	88.6
	Cyber Café	13	5.7
	Other	3	1.3
	Home & Cyber Café	26	11.4
	Home & Others	7	3.1
	Home, Cyber Café & Others	9	3.9
Device used	Smartphone	197	86.4
	Tablet	14	6.1
	PC	26	11.4
	Laptop	28	12.3
	Others	8	3.5
	Smartphone & Tablet	115	50.4
	Smartphone & Laptop	98	43
	Smartphone & PC	12	5.3
	Laptop & PC	27	11.8
Activity online	Chatting	125	54.8
	Social networking	103	45.2
	Gaming	85	37.3
	Gambling	0	0
	Shopping	54	23.7
	Info. Searching	111	48.7
	Web surfing	33	14.5
	Others	15	6.6
	Chatting & Social networking	176	77.2
	Chatting, Social networking & Shopping	186	81.6
	Chatting, Social networking & Info. Searching	105	46.1
	Chatting, Social networking, Web surfing & Gaming	95	41.7
	All the above	37	16.2
Hours of Internet usage/day	<= 1 Hour	86	37.7
	between 2 to 5 hours	119	52.2
	between 6 to 9 hours	15	6.6
	>= 10 hours	8	3.5
No. of text messages sent /day	0	28	12.3
	between 10 to 50	137	60.1
	between 50 to 100	32	14
	above 100	31	13.6
No. of voice calls made /day	0	29	12.7
	Between 1 to 10	160	70.2
	above 100	39	17.1

The baseline parameters are shown in Table 3. The parameters are used to predict the class of internet addiction and depression among study participants separated by female and male. The parameters include Young's IAT score[27] and Depression score[28] (Birleson's DSRS score) along with mean and standard deviation.

Table 3: Baseline parameters of study participants

Variables	Mean	Standard deviation
Age		
Female	17.92	3.02
Male	18.93	1.29
Hours of Internet usage /day		
Female	3.04	1.48
Male	3.67	1.41
Young's Internet Addiction test score (IAT)		
Female	34.77	3.53
Male	41.55	8.19
Depression score (DSRS score)		
Female	13.755	2.82
Male	13.23	1.41

The general descriptive statistics with mean and standard deviation are given in Table 4 and correlation statistics with significance value ρ is given in Table 5.

Table 4: Overall Baseline parameters of descriptive statistics

	Mean	Std. Deviation	N
Internet usage hours /day	3.2877	2.48227	228
IAT Score	37.39	18.500	228
DSRS Score	14.45	5.355	228

Table 5: Overall baseline parameters of pearson correlation statistics

		Internet usage hours/day	IAT Score	DSRS score
Internet usage hours/ day	Pearson Correlation	1	.784**	.334**
	Sig. (2-tailed)		**.000**	**.000**
	n	228	228	228
IAT Score	Pearson Correlation	.784**	1	.411**
	Sig. (2-tailed)	**.000**		**.000**
	n	228	228	228
DSRS Score	Pearson Correlation	.334**	.411**	1
	Sig. (2-tailed)	**.000**	**.000**	
	n	228	228	228
**. Correlation is significant at the 0.01 level (2-tailed).				

As there is a significant difference between baseline parameters of female and male participants, an independent sample t-test was performed with group variable as Gender (Female, Male) and significance achieved for the parameters IAT score and DSRS score was $\rho < 0.05$. However, the parameter Internet usage hours/day was not statistically significant as its ρ value is 0.06. Nevertheless, this parameter was included for the classification of Internet addiction and depression as it is strongly correlated with other baseline parameters. Table 6 shows the independent sample t-test values for baseline parameters.

Table 6: Independent sample t- test values for baseline parameters

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Internet usage Hours /day	Equal variances assumed	0.08	0.76	1.88	226	0.06	0.63	0.33	-0.02	1.29
	Equal variances not assumed			1.85	175.38	0.06	0.63	0.34	-0.04	1.30
IAT Score	Equal variances assumed	4.59	0.03	2.73	226	0.00	6.78	2.48	1.89	11.67
	Equal variances not assumed			2.82	204.61	0.00	6.78	2.40	2.05	11.51
DSRS Score	Equal variances assumed	20.75	0.00	-2.74	226	0.00	-1.96	0.71	-3.38	-0.55
	Equal variances not assumed			-2.97	223.92	0.00	-1.96	0.66	-3.27	-0.66

Prediction of Depression using Logistic regression

In statistics, Logistic Regression (LR) is a regression technique used for estimating the parametric values in a given logistic model. It is generally taken to apply to a binary dependent variable where the outcomes of the dependent variable are "0" or "1". These outcomes can represent dead/live, pass/fail, win/lose, tumor malignant/benign.

In this study, Logistic regression (LR) is used to predict whether the person is suffering from depression or not. The technique calculates the predicted probability and estimates the corresponding predicted group by using the given baseline parameters. To start the regression analysis, first, the class labels to group the samples are required for identification. To obtain class labels, the K-means clustering algorithm is used which gives cluster class for each sample and also the distance of each sample from its cluster class. Table 7, 8 shows the cluster center for each baseline parameter at the initial stage and final stage respectively.

Table 7: Initial cluster centers

	Cluster	
	1	2
Internet usage hours/day	8.00	2.00
IAT Score	72	3
DSRS Score	14	19

Table 8: Final cluster centers

	Cluster	
	1	2
Internet usage hours/day	5.00	1.75
IAT Score	54	22
DSRS Score	17	12

Using K-means clustering technique two cluster centers 1 and 2 are obtained. out of which 108 samples were grouped under cluster 1, and 120 samples came under cluster 2. The number of samples in each of the cluster is given in Table 9.

Table 9: Number of samples in each cluster

Cluster	1	108.000
	2	120.000
Valid		228.000
Missing		.000

After identifying cluster centers for each sample, Logistic regression was applied on the baseline parameters along with new parameters i.e. Cluster distance as covariant and Cluster class as a grouping variable. Samples with the value of the probability of depression above 0.5 are predicted as Depression class labeled as YES = 1 and samples below 0.5 are predicted as Depression class labeled as NO = 0. The results show that 99 were predicted as YES and 129 were predicted as NO and the achieved classification accuracy was 85.5%. Classification table (Table 10) contains True Negative (TN) = 102, False Positive (FP) = 6, False Negative (FN) = 27, True Positive (TP) = 93 of final classification values and classification accuracy.

The comparison between two age groups of 11 to 18 and 19 to 27 years was also considered to identify the addiction and depression association. It is observed that the mean and standard deviation is higher for the age group of 19 to 27 with respect to IAT score, depression score and probability values obtained from logistic regression, which indicates that internet addiction (indirectly depression) is more prevalent in students above the age of 19 years. Table 11 shows the strong significance and the mean and standard deviation among the said age clusters.

The regression graphs showing the regression line by taking the predicted probability of depression on the x-axis and IAT score and DSRS score on the y-axis is shown in Fig. 1 and Fig. 2 respectively. It is observed that in both the graphs probability of depression increases with increase in IAT score and DSRS score and depression is slightly on the higher side for female than in the male.

Table 10: Classification table

	Observed		**Predicted**		
			Depression Class		**Percentage Correct**
			0	1	
Step 1	Depression Class	0	102	6	94.4
		1	27	93	77.5
	Overall Percentage		85.5		
a. The cut value is .500					

Table 11: Overall statistics

Age group	**Count (n)**	**IAT Score**			**DSRS Score**			**Predicted probability**		
		Mean	**Std. dev.**	**t-test**	**Mean**	**Std. dev.**	**t-test**	**Mean**	**Std. dev.**	**t-test**
11 to 18	127	35.81	19.263	5.58461E-39	13.62	6.184	7.99947E-19	0.379	0.168	1.9E-190
19 to 27	101	**39.37**	**13.435**		**14.91**	**4.24**		**0.414**	**0.176**	

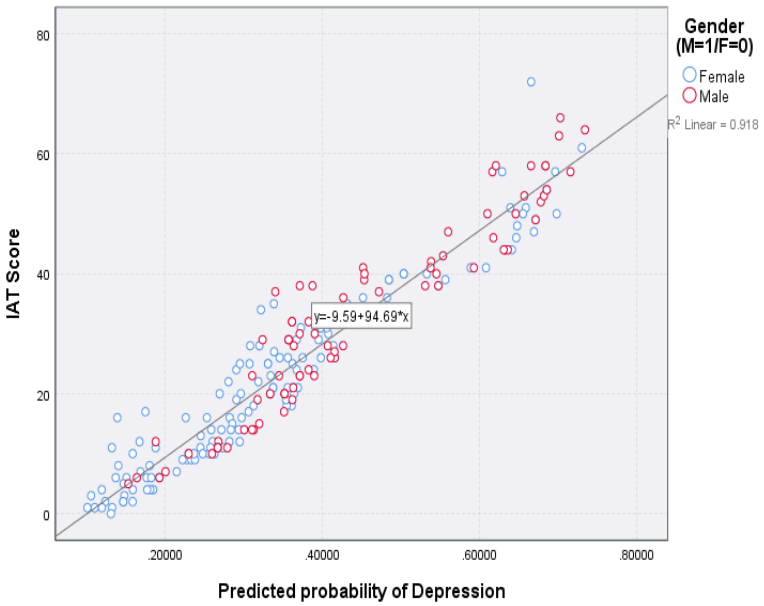

Fig. 1: Regression line for IAT score versus predicted probability of depression of the participants

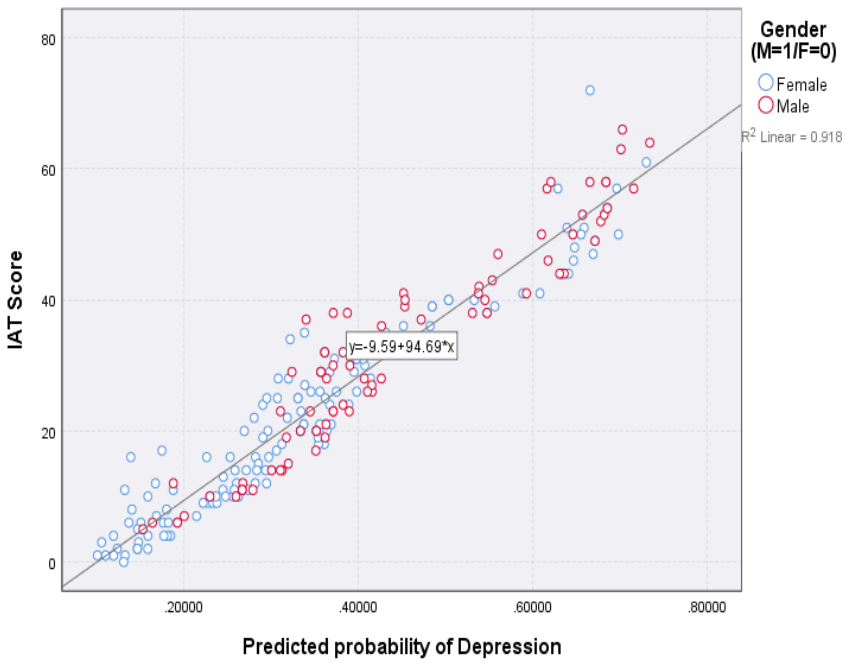

Fig. 2: Regression line for DSRS score versus predicted probability of depression of the participants

Discussion

The participants in the current study were all students studying in schools and colleges near the tertiary care hospital. The sample considered for study was *n*=228, out of which 140 were female and 88 were male. The purpose of the study was to show that internet addiction leads to depression. The study is in accordance with the research done by Orsal et al[23] and Othman et al.[24] Both the researchers have used Young's scale for internet addiction and Beck's depression inventory scale for finding out the correlation between internet addiction and depression. Othman et al[24] have also said that anxiety is not related to internet addiction.

Inline to this, the current work focusses on calculating the correlation between internet addiction and depression and also classifies the participants into depression and non-depression groups (classes). These classification classes can be used to predict in the near future if a person suffering from internet addiction is also currently suffering from depression or may suffer from depression. The present research also proves that depression can occur at any age and at any stage in life.

Conclusion

A questionnaire containing socio-demographic details, patterns of internet usage, Young's IAT and Birleson's DSRS was filled by school going and college going students. This survey form served the purpose of the study of the connection between internet addiction and depression. Based on scores obtained from IAT and DSRS and other baseline parameters, it can be concluded that internet addiction leads to depression. The age group falling prey to the addiction and depression is between 19 to 27 years. One limitation of this study is that the data is static in nature hence may not give better accuracy over large datasets. Thus in future work, we would like to address this limitation by taking the fMRI scans of the participants which would lead us to provide better classification results even with large data.

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