Validation of the Internet Addiction Test in Students at a Pakistani Medical and Dental School

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Abstract

Despite growing concerns over pathological internet usage, studies based on validated psychometric instruments are still lacking in Pakistan. This study aimed to examine the psychometric properties of the Internet Addiction Test (IAT) in a sample of Pakistani students. A total of 522 students of medicine and dentistry completed the questionnaire, which consisted of four sections: (a) demographics, (b) number of hours spent on the Internet per day, (c) English version of the IAT, and (d) the Defense Style Questionnaire-40. Maximum likelihood analysis and principal axis factoring were used to validate the factor structure of the IAT. Convergent and criterion validity were assessed by correlating IAT scores with number of hours spent online and defense styles. Exploratory and confirmatory factor analysis reflected the goodness of fit of a unidimensional structure of the IAT, with a high alpha coefficient. The IAT had good face and convergent validity and no floor and ceiling effects, and was judged easy to read by participants.

Keywords: *Internet; Validation; Pakistani; Students; Addiction*

Introduction

The internet provides an accessible way of engaging in a wide range of pleasurable activities such as exchanging ideas, socializing including memberships of forums and social networks, and shopping, gaming and gambling. Its accessibility together with the types of activities that it enables makes the internet a reinforcing and potentially addictive medium. In recent years the notion of internet addiction has emerged as health concern, with studies in the USA, Europe and Asian countries [1] identifying problems of excessive and problematic use, particularly among young people including students.

A diagnostic classification of problematic internet use was first proposed in the mid-1990s [2], but the status of this condition remains uncertain. Despite more than 200 publications [3] relating to this behavioral syndrome, it is currently not included as a mental disorder in DSM-5 [4]. Gambling disorder is the only non-substance addiction condition currently classified as a mental disorder; however, internet gaming disorder – the focus of most of the extant literature – has been listed as a condition for further study [3]. Despite these uncertainties, problematic internet use remains an important concern for many researchers and clinicians, as well as for the public. There are widely varying estimates of the numbers of people affected, ranging from 1% to 14% or higher depending on the criteria applied and the population examined [5]. The problematic, uncontrollable and impulsive use of the internet has been conceptualized as a behavioral addiction comparable to pathological gambling [6], and the etiology of this behavioral addiction is believed to be rooted in

processes such as conditioned learning and the brain's reward system, with certain behaviors which elicit short-term rewards promoting continued behavior and diminished control [7].

Different criteria have been proposed to clarify our understanding of this problem and aid empirical studies. Some researchers conceptualize it as a compulsive-impulsive spectrum disorder [6] entailing at least three domains: gaming, pornography and emailing/text messaging [8]. Putative criteria for internet addiction include (a) maladaptive and excessive use of the internet for longer times than planned, (b) significant impairment in social, occupational and other domains of functioning, and (c) excessive use that cannot be accounted for by any axis I disorders [9]. Previous studies have delineated the harmful effects of problematic internet use in different populations. Such use has been associated with significant psychosocial impairment leading to low work performance, relationship problems, loneliness, self-destructive behaviors and several psychiatric disorders such as depression, anxiety, social phobias and attention deficit hyperactivity disorder [9–15].

Despite growing concerns over pathological internet use, studies based on validated psychometric instruments are still lacking in Pakistan. This study aimed to examine, in a sample of the Pakistani population, the psychometric properties of the Internet Addiction Test (IAT) [15]. The IAT is one of the most extensively used validation tools to study IAD in different populations, and in both clinical and nonclinical settings. This test was selected for analysis because it is based on diagnostic criteria of substance abuse and pathological gambling, and takes several dimensions of internet addiction into account such as time management, impulsivity, loss of control, neglecting relationships, school, job and leisure interests, tendency to indulge in online romantic relationships, behavioral and cognitive salience, escapism, mood disturbances and low self-esteem [6, 15].

Methods

Study Design This study was conducted at CMH Lahore Medical College (CMH LMC) and Institute of Dentistry, Lahore, Pakistan from 1 March, 2015 to 30 May, 2015. Ethical approval was sought from and granted by the Ethical Review Committee of CMH LMC. A total of 550 questionnaires were distributed among medical and dental students enrolled in all years of the medical or dental degree program. All respondents read and signed a consent form, and were ensured anonymity and that only group findings would be reported.

Before starting the survey, a pilot study was conducted at CMH LMC in a sample of 20 medical students selected by convenience sampling. We received positive comments from the participants that the English (official language of Pakistan) version of the IAT was easily comprehensible. All colleges of medicine and dentistry in Punjab follow a 5-year syllabus for the medical degree program and a 4-year syllabus for the dental degree program. The medium of instruction is English, a language that students understood easily. Therefore, we did not feel the need to translate the instrument into Urdu (the language most commonly spoken in the home in our setting).

The questionnaire consisted of four sections: (a) demographics of the respondents, (b) a categorical question to document the estimated number of hours spent on the internet per day, (c) the Defense Style Questionnaire-40 (DSQ-40), and (d) the IAT developed by Young [6, 16]. This instrument has shown excellent psychometric properties [17–22] in a variety of settings. It consists of 20 items that investigate the respondent's potentially problematic use of the internet and disruption in psychosocial functioning [16]. Responses are recorded on a 6- point Likert scale, ranging from 'does not apply' (0) to 'always' (5). For purposes of analysis, a global score is obtained by adding the scores for responses to each item.

Sample Size Calculation Previous studies to validate the IAT have used the rule of thumb that 5 to 20 participants are generally recommended per item in factor analytic studies. However, evidence-based practices indicate that sample size calculations should be based on expected effect sizes, the number of factors and variable-to-factor ratio, the strength of factor loadings, and variability in the study sample. Previous studies to validate the IAT have reported broad communalities and factor loadings (0.2 to 0.8), and factor structures ranging from one to six factors. Rigorous studies Psychiatr Q Author's personal copy with evidence-based techniques to determine the number of factors to be retained, such as Horn's parallel analysis and the Velicer MAP test, favor a uni-dimensional or bi-dimensional model of the IAT [17, 19, 23, 24]. Mundfrom et al. recommend a minimum sample size of 55 for a two-factor solution consisting of 10 variables per factor and 300 for a four-factor solution consisting of 5 variables per factor [25]. A sample size of 500 respondents was judged to be appropriate for this study based on above recommendations.

Data Analysis All data were analyzed in SPSS v. 20 (IBM Chicago, IL, USA). Frequencies were calculated for demographic variables, and descriptive statistics were obtained for total scores on the IAT. Assumptions of normality and floor and ceiling effects of IAT scores were verified by plotting histograms and Q-Q plots. Floor and ceiling effects were assessed by examining response patterns for both IAT scores and individual items. Scores were plotted as histograms and the percentages of individuals with the lowest and highest possible score on the IAT and individual items were inspected. Values <20% are considered as floor and >20% as ceiling effects [26]. When a significant percentage of respondents obtains the lowest (floor) or the highest score (ceiling), this indicates that the psychometric instrument will not necessarily measure change and hence is of limited use [26].

Internal consistency of the IAT was evaluated with Cronbach's alpha reliability analysis, and an alpha coefficient > 0.70 was considered acceptable [27]. Item total correlations were analyzed with Pearson's product moment correlation coefficient, and values from 0.2 to 0.8 were considered acceptable [27]. Test-retest reliability analysis for the IAT was done by calculating the intraclass correlation coefficient with a two-factor mixed effects model and type consistency. For this purpose, 51 students were recruited who completed the IAT twice within a 7-day period.

Exploratory factor analysis with maximum likelihood and orthogonal rotation was conducted to analyze factor structure of the IAT. The suitability of exploratory factor analysis for this purpose was determined with the following criteria: correlation coefficient > 0.3 for all variables, Kaiser-Meyer-Olkin (KMO) value greater than 0.6, and a statistically significant Barlett test of sphericity (P < 0.05). We used exploratory factor analysis with the maximum likelihood method of extraction based on a correlation matrix to delineate the factor structure of the IAT. The maximum number of components to be retained was determined with three methods: Horn's parallel analysis, the Velicer MAP test, and the Hull method. Factor loading values >0.3 were considered significant. Then confirmatory factor analysis was done in SPSS AMOS 20 to verify the factor structure of the IAT as determined by exploratory factor analysis. Several indices for goodness of fit were used: the chi-squared test, $\chi2/df$, root mean square error of approximation (RMSEA), root mean squared residual (RMR), standard root mean squared residual (SRMR), comparative fit index (CFI), normed fit index (NFI), Tucker-Lewis index (TLI), incremental fit index (IFI), goodness-of-fit index (GFI) and adjusted goodness-of-fit index (AGFI). Cut-off values for goodness of fit indices were >0.90 for CFI and TLI, <0.08 for RMSEA, and <0.10 for SRMR [28]. Then we ran a series of confirmatory factor analyses (CFA) for different factor structures reported in the literature. These were compared with our unidimensional structure.

Criterion and convergent validity of the IAT were evaluated by analyzing the association between IAT scores and (a) estimated number of hours spent on the internet per day and (b) mature, immature and neurotic defense styles as assessed with the DSQ-40. This association was analyzed with

Spearman correlation. Readability of the questionnaire was recorded as the Flesch Reading Ease score and Flesch-Kincaid Grade level function [29].

Results

Of the 550 questionnaires distributed, 522 (94.90%) were returned. Most of the respondents were female medical students 328 (62.8%) enrolled in preclinical years 296 (56.7%) of their degree program. Median age of the respondents was 20 years (range 17 to 25 years). Most respondents (414, 79.3%) were enrolled in the medical degree program. Most students were average users who spent 1 h to 3 h (220, 42.1%) and >3 to 6 h or more (157, 30.1%). The independent sample t-test showed that male students scored significantly higher on the IAT than females (t value = 5.4, P < 0.001). Most participants (320, 61.3%) scored 20 to 49 (average users) followed by 193 (37%) who scored 50 to 79 (frequent problems) and 6 (1.1%) who scored 80 to100 (serious internet addiction).

Normality and Floor and Ceiling Effects & Readability The mean IAT score (mean = 2.19, SD = 0.86), skewness (−0.03, std. deviation = 0.11), kurtosis (−0.49, std. error = 0.21) and histogram showed that IAT scores did not deviate significantly from normality, and no floor or ceiling effects were found in IAT scores for the present sample (*Fig. 1*). Only 1 respondent (0.2%) scored the lowest mean IAT score (mean = 0.20) and 1 (0.2%) obtained the highest mean score (4.75). Item-level analysis of mean scores (SD), skewness, kurtosis and histograms showed that mean scores on items 1, 12, 14 and 16 were significantly kurtotic (*Table 1*). The IAT demonstrated easy readability, with a Flesch Reading Ease value of 71.1 (fairly easy) and a Flesch-Kincaid level of 7.1, indicating that it was easy to understand by readers 13 to 15 years old [29].
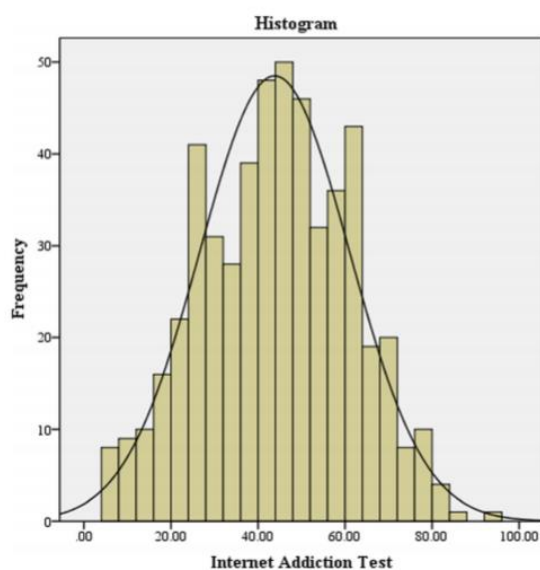
Fig. 1 Histogram exhibiting distribution of scores on internet addiction tests among medical and dental students (n = 522)

Reliability and Validity Analysis The IAT consists of 20 items. Cronbach's alpha value for a one-factor structure of the IAT was 0.896, which indicates excellent reliability of this tool in the present study sample. Item total statistics for the IAT are detailed in Table 2. For all items, corrected item total correlations adjusted for overlap ranged from 0.31 (item 1) to 0.61 (item 20), which reflect substantial and moderate correlation, with corrected item correlations greater than 0.3 (*Table 1*). All inter-item correlations were positive except for items 1 and 4, with an inter-item correlation of

−0.02, thus exhibiting the same construct. Test-retest reliability analysis for the pretest sample of 51 medical students was 0.52 (95% confidence interval = 0.28 to 0.69), indicating fair agreement.

The overall KMO value for sample adequacy was 0.929, considered meritorious according to Kaiser's criteria (1974). The Bartlett test of sphericity was significant (P < 0.001). Therefore, the data in the present study were suitable for exploratory factor analysis. Inspection of the correlation matrix

Table 1 Item level analysis of the Internet Addiction Test (n = 522)

Statements	Factor Loadings (ML)	Factor Loading (PAF)	Alpha if item deleted	Total item correlations	Mean	SD
1: How often do you find that you stay on-line longer than you intended?	.313	.322	.896	.309	3.025	1.5
2: How often do you neglect household chores to spend more time on-line?	.470	.481	.891	.469	2.695	1.4
3: How often do you prefer the excitement of the Internet to intimacy with your partner?	.466	.464	.893	.435	1.548	1.6
Item 4: How often do you form new relationships with fellow on-line users?	.473	.469	.892	.436	1.480	1.5
5: How often do others in your life complain to you about the amount of time you spend on-line?	.564	.568	.889	.540	2.188	1.5
6: How often do your grades or school work suffers because of the amount of time you spend on-line?	.584	.593	.889	.567	2.161	1.4
7: How often do you check your email before something else that you need to do?	.428	.435	.893	.419	2.163	1.5
8: How often does your job performance or productivity suffer because of the Internet?	.532	.539	.890	.512	1.998	1.5
9: How often do you become defensive or secretive when anyone asks you what you do on-line?	.574	.575	.889	.544	1.983	1.4
10: How often do you block out disturbing thoughts about your life with soothing thoughts of the Internet?	.578	.578	.889	.545	2.315	1.5
11: How often do you find yourself anticipating when you will go on-line again?	.604	.601	.889	.563	2.073	1.4
12: How often do you fear that life without the Internet would be boring, empty, and joyless?	.451	.452	.893	.430	2.757	1.5
13: How often do you snap, yell, or act annoyed if someone bothers you while you are on-line?	.647	.641	.888	.598	2.055	1.4
14: How often do you lose sleep due to late-night log-ins?	.588	.592	.889	.564	2.402	1.6
15: How often do you feel preoccupied with the Internet when off-line, or fantasize about being on-line?	.666	.657	.887	.611	1.907	1.4
16: How often do you find yourself saying "just a few more minutes" when online?	.541	.544	.890	.518	2.796	1.5
17: How often do you try to cut down the amount of time you spend on-line and fail?	.574	.573	.889	.541	2.465	1.5
18: How often do you try to hide how long you've been on-line?	.613	.609	.889	.569	2.070	1.5
19: How often do you choose to spend more time on-line over going out with others?	.629	.622	.888	.578	1.881	1.5
20: How often do you feel depressed, moody or nervous when you are off-line, which goes away once you are back on-line?	.659	.652	.887	.608	1.852	1.5

showed that all variables had at least one correlation coefficient greater than 0.30 with the highest being 0.526; hence there was no multicollinearity or singularity. In the anti-image of the correlation matrix, most of the items had measures of individual sampling adequacy ranging from 0.840

(meritorious) to 0.951 (excellent). The determinant of correlation matrix was >0.001 and all items exhibited adequate values for communality (>0.20).

Initially, maximum likelihood analysis extracted three components/factors with an eigenvalue >1 and a high degree of cross-loading of statements on different factors. Most of the variance in IAT scores was explained by the first factor (34.13%), while the second factor was associated with a modest variance of 7.69%, and the third with a variance of 5.77%. However, Horn's parallel analysis, the Velicer MAP test and Hull method for selecting the number of factors to be retained suggested a one-factor solution for the IAT. Factor loadings for all items included in a one-factor structure of the IAT were greater than 0.30, explaining a total variance of 34.13%. Exploratory factor analysis was also conducted with principal axis factoring, which is robust to the assumption of multivariate normality, unlike maximum likelihood analysis, and hence, more suitable for the present study [23]. Detailed results are given in *Table 2*.

Table 2 Goodness of fit indices for the Internet Addiction Test

Model	CMIN	P value	CMIN/DF	RMR	GFI	AGFI	NFI	TLI	CFI	RMSEA	SRMR	PCLOSE	AIC
Model 1	513.2	.001	3.02	.13	.87	.85	.80	.84	.85	.07	.06	.000	593.2
Model 2	384.92	.000	2.32	.11	.91	.88	.85	.89	.91	.06	.05	.049	472.9
Model 3 (Item 1 removed)	338.70	.000	2.27	.11	.91	.89	.86	.90	.92	.06	.05	.09	420.7
Bangla (Rezaul Karim and Nigar, 2014)	351.2	.000	2.72	.12	.91	.88	.84	.87	.89	.07	.05	.001	435.2
German (Barke et al., 2012)	452	.000	2.70	.12	.89	.87	.82	.86	.88	.07	.06	.000	537.9
Italian (Faraci et al., 2013)	350.7	.000	2.62	.13	.91	.88	.84	.88	.89	.06	.06	.003	424.7
Greek (Tsimtsiou et al., 2014)	421.7	.000	2.53	.12	.90	.88	.83	.88	.89	.06	.05	.004	507.7

Confirmatory factor analysis was then conducted with structural equation modeling in IBM SPSS Amos Graphics 20.0 to test model fit for a one-factor structure of the IAT, as suggested by

exploratory factor analysis. Internet addiction was entered as an endogenous variable whereas the 20 items were considered exogenous variables. To evaluate goodness of fit, we calculated several indices. The chi-squared value for a one-factor model was calculated as 513.2, P < 0.001 which was excessive; however, this measure is greatly affected by sample size [30]. Similar trends were observed in NFI (0.80) due to its dependence on sample size. Evaluation of CMIN/DF, RMR, GFI, AGFI, NFI, TLI, CFI, RMSEA, SRMR and PCLOSE indicated that the model was a reasonably approximate fit. The CMIN/DF value was 3.019 with an acceptable range of 1 to 3, and values of other absolute and incremental indices close to 0.90 indicated that the model was a possible fit. Similarly, RMSEA was greater than 0.05, with a PCLOSE value 2 were removed between items 1, 2, 6, 8, 18 and 20. This led to a significant improvement in goodness of fit indices for the second model. The RMSEA value decreased to 0.06 with a marginally significant PCLOSE value, indicating that RMSEA was not significantly greater than 0.05, which suggested a close fit. The CMIN/DF value decreased to an acceptable 2.32. Similarly, values of CFI and GFI were greater than 0.90, and SRMR decreased to an acceptable value of 0.05. Model 2 was thus a better fit than model 1. Further exploration revealed that item 1 had the lowest standardized estimate (0.33), and its exclusion from model 2 led to a better fit as shown in *Table 2*.

Thereafter, we ran a series of CFA to test various factor structures reported in the literature. We compared the goodness of fit indices of the unidimensional model with those of two-factor [17, 31], three-factor [22] and four-factor structures [21]. Model 3 (one-factor structure) was again found to have the best fit for our study sample. Detailed results are presented in *Table 3*.

Internet Addiction Test scores were positively associated with the number of hours spent on the internet per day (r = 0.279, P < 0.001) and immature defense styles (r = 0.270, P < 0.001). The IAT scores were not significantly associated with a mature defense style (r = 0.08, P = 0.062) or a neurotic defense style (r = 0.04, P = 0.406).

Discussion

The English version of the IAT was judged easy to read, and had good face, content, criterion and convergent validity and high internal reliability in our sample of Pakistani medical and dental students. In addition, our analysis detected no floor or ceiling effects in IAT scores.

Initial exploratory factor analysis revealed a three-factor structure based on Kaiser's criterion of eigenvalues >1. However, the factor structure of the IAT was not clear cut, with a few items cross-loading on different factors. Further exploration with Velicer's MAP test, Horn's parallel analysis and Hull's method suggested that only one factor should be retained. This factor structure is in accordance with that identified for the Arabic [19], French [36] and Portuguese [34] versions of this test. In contrast, studies that evaluated the psychometric properties of the IAT in Germany [17], Korea [33], USA [35], Bangladesh [21], Malaysia [32], Italy [31], Greece [22] and China [20] have reported non-unidimensional factor structures for the IAT.

Factor models ranging from two to six components have been proposed in different studies with different factor loadings and constructs, with very high internal consistency for this instrument. These discrepancies may be due to the use of different factor analysis techniques, and/or to variations in demographics, culture and age groups of the respondents. A number of studies that reported psychometric properties of the IAT retained different numbers of factors based on Kaiser's criterion of an eigenvalue >1 or Cattell's scree plot. These approaches to validation of the factor structure of the IAT should be discouraged, as use of the eigenvalue >1 criterion can lead to over-

extraction of factors, and the interpretation of Cattell's scree plot is subject to bias [37]. Horn's parallel analysis and the Velicer MAP test are often recommended for deciding the number of factors to retain [24]. Similarly, a number of studies used principal component analysis, which is a variable reduction technique and thus not appropriate for identifying the number of latent constructs and underlying factor structure of psychometric instruments [23]. *Table 3* summarizes the factorial models and statistical techniques employed in previous studies.

Table 3 Comparison of psychometric properties of different versions of the Internet Addiction Test

Version	Characteristics of study sample	Factor analysis method	Criteria for retaining number of factors	Names of factors and reliability
Arabic [19]	817 intermediate and secondary	Principal component analysis (PCA) with oblimin rotation, confirmatory factor analysis (CFA)	Two components with eigenvalue >1 but only one of these retained parallel analysis and MAP test	One factor, α = 0.921
Malay [32]	162 undergraduate medical	PCA with varimax rotation method	Five factors with eigenvalue >1	Lack of control, neglect of duty, social relationship disruption, problematic use, email primacy, factor-wise α = 0.55–0.89, for all items: α = 0.91
Bengali [21]	177 internet users, mean age 22.33 (2.01) years	PCA with varimax rotation	Four based on Cattell scree plot	Neglect of duty, online dependence, virtual fantasies, and privacy and self-defense, α = 0.89 for the IAT, and 0.60–0.84 for the factors
Italian [31]	485 college students, mean age 24.05 (7.3) years	Principal axis factoring (PAF) with oblique rotation CFA	Parallel analysis, scree plot, eigenvalue >1, CFA favored two dimensions instead of one	Emotional and cognitive preoccupation with the internet and loss of control and interference with daily life, one-factor solution α = 0.91, and two-factor solution α = 0.88 and 0.79
Chinese [20]	844 Hong Kong Chinese adolescents (37.7% boys), mean age 15.9 (3.5) years	CFA results indicated 18-item second-order three-factor model	Tested various factor structures as identified in the literature	Withdrawal and social problems, time management and performance and reality substitute. α = 0.93. Factor wise α = 0.87, 0.86 and 0.70
Korean [33]	279 college students at a national university	PCA with varimax rotation	Eigenvalue >1 Four factors retained	Excessive use, dependence, withdrawal, and avoidance of reality, α = 0.91
Portuguese [34]	593 Portuguese students, average age 19.9 (2.7) years	CFA, with robust maximum-likelihood estimates (MLR)	Tested one-factor model structure of IAT	One factor α = 0.90
Greek [22]	151 postgraduate and undergraduate medical students	EFA with varimax rotation	Visual examination of a scree plot and eigenvalues >1. 3 factors retained	Psychological/Emotional conflict, time management and neglect work, α = 0.91
English (US) [35]	215 Undergraduate students selected through Facebook	EFA with varimax rotation	Scree plot and eigenvalues >1. Two factors retained	Dependent use and Excessive use, α = 0.90–0.93
German [17]	Online (ON) sample (n = 1041, age 24.2–7.2 years) and Offline (OF) sample, n = 841, age: 23.5–3.0 years	EFA with varimax rotation, CFA	Horn's parallel analysis. 2 factors retained	Emotional and cognitive preoccupation with the internet; loss of control and interference with daily life, α = 0.91 (ON) and α = 0.89 (OF)
French [36]	246 adults, mean age 24.11 (9) years	EFA and CFA	Velicer minimum average partial (MAP) test	One factor, α = 0.93

In our study, the first model was amended by removing residual covariances between items 1, 2, 6, 8, 18 and 20. These items pertain to time management, intimacy in relationships, low self-esteem/escapism (hiding time spent online) and mood disturbances associated with problematic

internet use. Item 1 was removed from the final model because it was deemed problematic for a variety of reasons. The factor loading was adequate (0.32) but was the lowest of all loadings, and total item correlation (0.31) was also comparatively low. The alpha coefficient increased when item 1 was excluded from the scale, and inter-item correlation was −0.02 with item 4. Moreover, we found significant kurtosis in it.

The IAT showed good criterion and convergent validity as assessed by correlating IAT scores with hours of internet use per day and defense styles according to the DSQ-40. Two similar studies that analyzed psychometric properties of the IAT in a Greek and a French population sample used the same method to determine convergent validity [22, 36]. Convergent validity assesses the association of a psychometric construct with underlying theories, including how closely the questionnaire is related to other measures of the same construct. Hours of internet use and usage of online games, pornography sites and online gambling correlated positively with higher scores on the Greek IAT [22]. Similarly, defense styles have been shown to be significantly associated with IAT scores [38]. In our sample, IAT scores correlated positively with an immature defense style and negatively with a mature defense style.

Conclusion

The English version of the Internet Addiction Test demonstrated good psychometric properties in a sample of Pakistani students. However, future studies are encouraged to assess the psychometric properties of the Urdu version of this instrument in the general Pakistani population.

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