Screening for Internet Addiction: An Empirical Study on Cut-off Points for the Chen Internet Addiction Scale

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The aim of this study was to establish the optimal cut-off points of the Chen Internet Addiction Scale (CIAS), to screen for and diagnose Internet addiction among adolescents in the community by using the well-established diagnostic criteria of Internet addiction. This survey of 454 adolescents used screening (57/58) and diagnostic (63/64) cut-off points of the CIAS, a self-reported instrument, based on the results of systematic diagnostic interviews by psychiatrists. The area under the curve of the receiver operating characteristic curve revealed that CIAS has good diagnostic accuracy (89.6%). The screening cut-off point had high sensitivity (85.6%) and the diagnostic cut-off point had the highest diagnostic accuracy, classifying 87.6% of participants correctly. Accordingly, the screening point of the CIAS could provide a screening function in two-stage diagnosis, and the diagnostic point could serve as a diagnostic criterion in one-stage massive epidemiologic research.

Key Words: Internet addiction, screen instrument, cut-off point, Chen Internet Addiction Scale
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Internet use is a convenience in modern life. However, 11.67–19.8% of adolescents have developed an addiction to Internet use, which impairs these individuals' psychological well-being, peer and family interactions, and academic performance [1–3]. Males, adolescents with higher sensation seeking, and boys with lower self esteem are at higher risk for Internet addiction [1,4]. Early detection of adolescents with Internet addiction and execution of intervention programs are necessary.

In a previous empirical study, we proposed diagnostic criteria for Internet addiction that provide healthcare professionals with a means to communicate and make comparisons of adolescent cases with Internet addiction [3]. However, it is time-consuming and impractical to conduct face-to-face diagnostic interviews for Internet addiction in a large sample of adolescents in the community. To survey adolescent Internet addiction in the community, it would be optimal to conduct a one-stage investigation using a brief self-reported instrument with high diagnostic accuracy, or to conduct a two-stage diagnostic process in which administering a brief self-reported instrument with a high sensitivity to the whole sample is the first step [5].

Previous studies have developed self-reported questionnaires to measure the severity of Internet addiction [6,7]. The Chen Internet Addiction Scale (CIAS) is a 26-item self-reported measure with good reliability and validity [7], and has been used to measure the severity of adolescent Internet addiction [4]. However, no empirical study has

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been designed to examine the fitness of the CIAS for screening for or diagnosing of Internet addiction among adolescents. The aim of this study was to establish the optimal cut-off points of the CIAS for screening for and diagnosing of Internet addiction among adolescents in the community, according to well-established diagnostic criteria for Internet addiction.

Methods

Instruments

The Diagnostic Criteria of Internet Addiction (DC-IA) was modified from diagnostic criteria for pathologic gambling and substance dependence in Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV-TR) [8]. There are three main criteria: nine characteristic symptoms of Internet addiction (Criterion A), functional impairment secondary to Internet use (Criterion B), and exclusive criteria (Criterion C) [3]. The cut-off point with six of the nine characteristic symptoms in Criterion A gives best diagnostic accuracy (95.4%) [3].

The CIAS is a four-point, 26-item self-reported scale assessing five dimensions of Internet-related symptoms and problems, including symptoms of compulsive use, withdrawal, tolerance, and problems in interpersonal relationships and health/time management [7]. The total score of the CIAS ranges from 26–84. Higher CIAS scores indicate increased severity of addiction to Internet activity. The internal reliability of the scale and the sub-scales in the original study ranged from 0.79–0.93 [7]. Correlation analyses yielded significantly positive correlation of total scale and subscale scores of CIAS with weekly hours spent on Internet activity.

Participants and procedure

The participants were randomly selected by cluster sampling from two junior high schools and one senior high school in Kaohsiung City, Taiwan. Informed consent was obtained from all participants. All participants completed the CIAS and a questionnaire assessing the frequency of Internet use and time spent online every week. Seven psychiatrists conducted diagnostic interviews based on the structured interview schedule for all participants and determined the existence of Internet addiction according to the DC-IA.

Statistical analysis

We used several indicators to examine the fitness of CIAS cut-off points for screening for and diagnosis of Internet addiction, including sensitivity, specificity, diagnostic accuracy, positive predictive rate (PPR), negative predictive rate (NPR), likelihood ratio for a positive (LRP) and negative test (LRN) [9,10], Cohen's Kappa [11], and diagnostic odds ratio (DOR) [12]. Cohen's Kappa was used to compare the proportion of correct test-based classifications with the proportion of correct classifications expected with random assignment of diagnoses [13]. Kappa values indicated if the agreement between measurement was poor (< 0.20), fair (0.21–0.40), moderate (0.40–0.60), good (0.61–0.80), or very good (0.81–1.00) [14]. The DOR of the cut-off point is calculated as the LRP/LRN ratio, with higher values indicating better discriminatory test performance; it does not depend on the prevalence of the target disease [12].

A CIAS cut-off point was optimal for diagnosis in a one-stage investigation if it resulted in high diagnostic accuracy, Cohen Kappa, and DOR. A CIAS cut-off point was optimal in a two-stage diagnostic process if it resulted in a high sensitivity and specificity greater than 75% [15]. In addition, the area under the receiver operating characteristic (ROC) curve was used to measure the diagnostic efficacy of the CIAS [9].

To confirm the validity of the CIAS cut-off points proposed in this study, participants were further divided into a case group and non-case group according to their scores on the CIAS. The demographic data and characteristics of Internet use were further compared between these two groups by a Chi-squared test. A p value of less than 0.05 was considered statistically significant.

Results

A total of 468 adolescents (318 males, 150 females) were recruited into this study from two junior high schools (262 adolescents), and one senior high school (206 adolescents). Two adolescents refused to undergo a diagnostic interview and 14 adolescents did not complete the CIAS. A total of 454 adolescents (309 males, 145 females) completed both the CIAS and diagnostic interview. Their mean age was 15.25 ± 1.36 years (range, 12–19 years) and average duration of education was 9.45 ± 1.19 years (range, 8–11 years). The mean CIAS score was 51.77 ± 14.94. Cronbach's α for the CIAS was 0.94. The mean Cohen Kappa for diagnosis of Internet addiction among the seven psychiatrists was 0.83 (range, 0.70–1.00).

A total of 90 participants (19.8%) were identified as having Internet addiction by the systemic diagnostic

interview based on the DC-IA. The ROC analysis for the CIAS gave an area under the curve of 89.6% (Figure), indicating that the CIAS had good diagnostic efficiency. The sensitivity, specificity, PPR, NPR, diagnostic accuracy, LRP, LRN, Cohen Kappa, and DOR of different CIAS cut-off points are shown in Table 1. The cut-off point of 63/64 was best for discriminating cases of Internet addiction from non-cases, with a high diagnostic accuracy (87.6%), Cohen Kappa (0.61), DOR (26.17), and specificity (92.6%). A CIAS cut-off point of 57/58 resulted in a high sensitivity (85.6%) and NPR (95.7%) and an acceptable specificity (78.6%), efficiency (80.0%), and Cohen Kappa (0.50), showing that this was an optimal cut-off point for screening for possible cases of Internet addiction.

All participants were further divided into screening-positive (n = 155) and screening-negative groups (n = 299), using the CIAS screening cut-off point, as well as into case (n = 88) and non-case groups (n = 366) using the diagnostic cut-off point. Adolescents in the screening-positive and case groups were more likely to be males (χ^2 = 17.14, $p < 0.001$ and χ^2 = 6.62, p = 0.01, respectively), use the Internet every day (χ^2 = 46.09 and χ^2 = 47.80, respectively, $p < 0.001$), spend 20 hours or more per week on Internet use (χ^2 = 32.14 and χ^2 = 29.65, respectively, $p < 0.001$), and play online games (χ^2 = 49.25 and χ^2 = 39.90, respectively, $p < 0.001$) than those in the screening-negative and non-case groups (Table 2). These results show that the screening and diagnostic cut-off points can identify higher frequency users and heavier users efficiently.

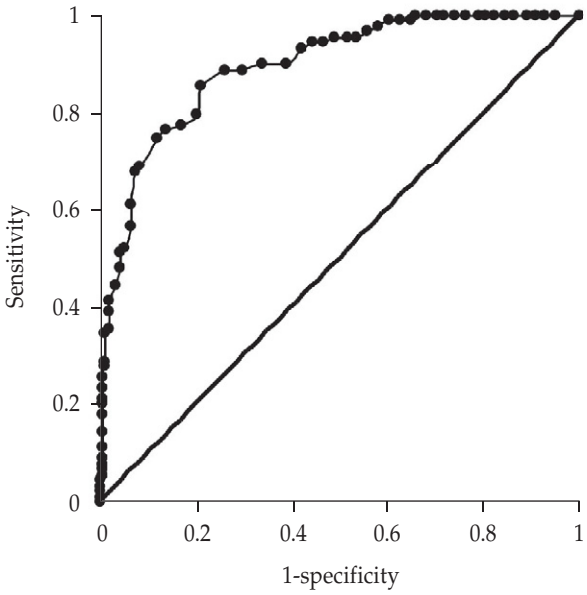

Figure. *Receiver operating characteristic curve calculated for the Chen Internet Addiction Scale.*

Table 1. Sensitivity, specificity, positive predictive rate (PPR), negative predictive rate (NPR), diagnostic accuracy (DA), likelihood ratio positive (LRP) and negative (LRN), Cohen's Kappa (K), and diagnostic odds ratio (DOR) of cut-off points

Cut-off point	Sensitivity (%)	Specificity (%)	PPR (%)	NPR (%)	DA (%)	LRP	LRN	K	DOR
55	90.0	66.2	39.7	96.4	70.9	2.66	0.15	0.38	17.70
56	88.9	70.3	42.6	96.2	74.0	3.00	0.16	42.0	18.75
57	88.9	73.9	45.7	96.4	76.9	3.41	0.16	0.46	21.31
58	85.6	78.6	49.7	95.7	80.0	4.00	0.18	0.50	22.22
59	80.0	79.7	49.3	94.2	79.8	3.94	0.25	0.48	15.76
60	77.8	83.0	47.0	93.8	81.9	4.58	0.27	0.52	16.96
61	76.7	86.3	58.0	93.7	84.4	5.60	0.27	0.56	20.74
62	75.6	88.2	61.3	93.6	85.7	6.40	0.28	0.59	22.86
63	68.9	91.8	67.4	92.3	87.3	8.40	0.34	0.60	24.71
64	67.8	92.6	69.3	92.1	87.6	9.16	0.35	0.61	26.17
65	61.1	93.4	69.6	90.7	87.0	9.26	0.42	0.57	22.05
66	56.7	93.7	68.9	89.7	86.3	9.00	0.46	0.54	19.57
67	52.2	95.1	72.3	88.9	86.6	10.65	0.50	0.53	21.3

Table 2. Comparisons of characteristics of Internet user and Internet use between case and non-case groups according to candidate cut-off point

Cut-off point	Screening (57/58)			Diagnosis (63/64)		
Variable	Case (n = 155)	Non-case	χ^2	Case (n = 88)	Non-case	χ^2
Gender						
Male	125	184	17.14 †	70	239	6.62 *
Female	30	115		18	127	
Age (yrs)						
≥ 16	72	126	0.77	32	166	2.32
< 16	83	173		56	200	
Internet use every day‡						
Yes	71	49	46.09 †	49	71	47.80 †
No	83	250		39	294	
Time spent on Internet						
≥ 20 hours/week	54	37	32.14 †	36	55	29.65 †
< 20 hours/week	101	262		52	311	
Play online games						
Yes	98	87	49.25 †	62	123	39.90 †
No	57	212		26	243	

*$p < 0.05$; †$p < 0.001$. ‡1 case did not complete the question about frequency of Internet use.

Discussion

Optimally, the cut-off selection procedure constitutes an informed decision that takes into account the epidemiologic situation and the related consequences of false-negative and false-positive test results [11]. Scales used as screening instruments or diagnostic tools require different kinds of cut-off points. Having a screening function seems to be essential for a scale to be used in clinical practice. In the two-stage approach, a lower false-negative rate in the first screening step is desirable. As such, the sensitivity of the screening questionnaires should be greater than the specificity. Following these principles, we suggest a cut-off point of 57/58 in the CIAS, to provide higher sensitivity and acceptable specificity. Under this circumstance, 85.6% of potential cases would be screened out of the second-stage diagnosis.

In contrast to the two-stage approach, optimizing diagnostic efficacy would be essential for a one-stage investigation in the community. Thus, the cut-off point should provide the best diagnostic accuracy. In the present study, the diagnostic cut-off point (63/64) gave the best diagnostic accuracy, Cohen Kappa, and DOR. Using this point, 87.6% of cases were correctly classified. This discriminative potential makes the scale appropriate for use as a reliable diagnostic tool in a massive epidemiologic survey, as it can provide the estimated prevalence and identify the case group.

In this study, the 'gold standard' chosen was the psychiatrist interview. Generally, clinician-administered schedules based on DSM-IV [16] are often considered the gold standard in epidemiologic research. Because there is a lack of formal diagnostic criteria for Internet addiction in DSM-IV, we determined the diagnosis according to the DC-IA developed by Ko et al [3]. Compared with other forms of assessment, such as with paper and pencil, telephone interview, or computer-assisted tools, psychiatrist face-to-face interview provides accessible information about appearance- and comportment-relevant information necessary for a diagnostic standard.

The diagnostic questionnaire developed by Young is the most widely used instrument for Internet addiction in Western samples [2]. It provides a cut-off point modified from the diagnostic criteria of pathologic gambling in DSM-IV. Lacking a diagnostic standard to develop a cut-off point, it cannot provide important diagnostic profiles,

such as sensitivity and specificity. The present study demonstrated that the CIAS is the first self-reported instrument for Internet addiction with reliable cut-off points consolidated by psychiatrists' diagnostic interview. It can provide a comprehensive diagnostic profile for researchers to evaluate Internet addiction. However, information from other observers, for example, parents or teachers, was not collected in this study. Further research using information from long-term observers is needed to re-evaluate the validity and reliability of the cut-off point.

In this study, 19.4% of adolescents were diagnosed as addicted to the Internet by diagnostic cut-off points. The result revealed that Internet addiction is prevalent among adolescents. Similar to previous studies [1,4], males in the present study were at greater risk for Internet addiction. Our results are also similar to the epidemiologic research for pathologic gambling and substance dependence [17,18]. Previous studies have suggested that the different properties of social roles between males and females account for the gender differences in online gaming addiction [4]. The gender differences of Internet addiction suggest that different preventive strategies for Internet addiction should be provided for boys and girls.

In this study, adolescents with Internet addiction spent more time on Internet activities than those not addicted. Time consumption is one of the most important causes of functional impairment for Internet addicts. Of the 88 adolescents with Internet addiction, 62 spent most of their online time on online gaming. The pleasure of control and perceived fluidity of identity has been reported to predict online gaming [19]. The control feeling, synchronous interactive quality, the mask of identity, and the freedom of self representation from online gaming may attract adolescents. They can escape from real-life troubles to find excitement, intimacy, friendship, and respect in online gaming. However, the gratification obtained from online gaming is typically in proportion to the time consumed. The results of this study suggest that online gaming should be an important issue in the preventive strategy. How to limit or monitor online gaming is essential to prevent Internet addiction among adolescents, and warrants future study.

Conclusion

Based on the screening and diagnostic cut-off points determined from this empirical study, the CIAS appears to be a convenient tool, useful for both clinical screening and epidemiologic research, providing psychometrically sound reliability and validity. The results of the present study suggest the use of this self-report scale as a first screening instrument in clinical practice. The developed cut-off points of the CIAS make massive surveying of Internet addiction more possible, providing useful information for further intervention and prevention. It can also be used in risk factor studies of Internet addiction in the future.

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網路成癮量表應用於篩選及診斷網路成癮疾患之切分點研究

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本研究之目的在依據網路成癮診斷準則來建立網路成癮量表之切分點，依據不同之研究需求分別建立篩檢切分點及診斷切分點，以作為青少年網路成癮社區調查之工具。本研究以 **454** 名在校國高中生為研究對象，依據精神科醫師診斷性會談之結果求取網路成癮量表之適合切分點。**ROC** 分析的曲線下面積比例為 **89.6%**，顯示網路成癮量表具有良好之區辨力。進一步分析顯示 **57/58** 為最佳之篩檢切分點，具有 **85.6%** 之敏感度，可作為兩階段診斷研究方式之適當篩檢工具。同時 **63/64** 為最佳診斷切分點，可以正確診斷 **87.6%** 之個案，可作為單階段調查之適當診斷工具。

關鍵詞：網路成癮，篩檢工具，切分點，網路成癮量表

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