



Development and Verification of a Web Board Game Scale

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Objective Our previous study suggested that monitoring online board gamers may be an efficient approach to curb illegal gambling. We aimed to invent and validate a behavioral scale for assessing the risk of problematic web-based board gaming.

Methods The sample included 300 Korean adults, representing a response rate of 3.1%. All participants were asked to complete a set of questionnaires, which included questions on demographic variables, patterns of online board gaming, and the web-based board game scale score. Exploratory factor analysis was performed to determine whether the items on the new behavioral scale would indicate a risk of pathologic web-based board gaming behavior.

Results The internal consistency of the 17-item scale was high (Cronbach's $\alpha=0.89$). The test-retest reliability of the 17-item scale in a randomly selected sample of 100 participants in 2 weeks was $r=0.77$ ($p<0.001$). The criterion-related validity based on a comparison of the total behavioral scale scores between the high-risk group and low-risk group was relatively high. The data obtained from the 300 participants were acceptable for a factor analysis. After removing 7 items from the 17-item scale, internal consistency (Cronbach's α) of the 10-item scale increased to 0.936.

Conclusion These results showed that the 10-item version of the scale appeared to be more valid than the 17-item version. We suggest that the 10-item web-based board game behavioral scale is a useful tool for assessing the risk of pathologic web-based board gaming.

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Key Words Web-based board game, Exploratory factor analysis, Reliability, Validity.

INTRODUCTION

Web-based board games are real-time board games that are played using a web browser.¹ Well-known board games including chess, backgammon, monopoly, and dice or poker card games are played online. For example, in Korea, a poker card game called "flower cards" is played using a web browser. However, the characteristics of money differ between web-based board games and internet-based gambling (virtual vs. real). Web-based board gamers use virtual money (i.e., not real money), which can be purchased on the game websites. In Korea, the government has strictly limited the amount of virtual money (up to \$500 a month) that users can purchase for playing online board games across the country.² However, in some in-

stances, a small number of online board gamers have illegally converted virtual money into real money through illegal websites.³ Internet-based gamblers use real money, typically through credit card transactions. In Korea, internet-based gambling is illegal. Korean internet-based gamblers access illegal gambling sites to bet real money using their personal computers at home.

In our previous study⁴ we compared the characteristics of online board gamers with those of online and offline gamblers; we found that online board gamers have more positive reasons for gaming than internet-based gamblers and offline gamblers. In addition, the behavior of online board gamers was less risky, in terms of gambling patterns, compared to that of offline gamblers, and less introverted, compared to that of internet-based gamblers.^{5,6} Based on these results, we suggested that monitoring online board gamers may be an efficient approach to curb illegal gambling.

The first step in the monitoring of online board gamers is screening for risky behaviors. The characteristics of online board gamers, which we referred to as gambling behaviors and psychological status, include impulsivity, mood, and attention.^{7,8} Online gamblers are thought to have an introverted personality and depressed mood.⁸ Based on an online survey, which in-

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of the three scales, including the Gambling Abstinence Self-efficacy Scale (GASS),¹³ Korean Gambling Behavior Scale (KGBS),^{15,16} and Center for Epidemiological Studies-Depression Scale (CES-D),^{12,17} 17 items with a Cronbach's α value of 0.70 or higher were extracted.^{18,19}

The GASS is thought to assess the confidence of gamblers when they quit gambling.¹³ It consists of 21 items with a six-point Likert scale as well as good internal (Cronbach $\alpha=0.93$) and retest reliability (intraclass correlation=0.86).¹³ With both low and high factors, the KGBS was developed to assess the interest (low factors) and high-risk behaviors (high factors) in gambling. It consists of 20 items with a four-point Likert scale and has good internal reliability (Cronbach 0.90–0.91).^{15,16} CES-D is widely used to assess depressive symptoms in the general population. It consists of 10 items with a four-point Likert scale and has good validity (convergent validity=0.91, Divergent validity=0.89).

Among the 17 items included in WBGS, 6 items were from GASS [(1) I want to play web board games suddenly sometimes, (2) I play web board games when I am sad, (3) I play web board games when I worry about interpersonal relationships with others, (4) I think about web board games when I bet with someone, (6) I tend to play web board games because I want to continue winning, and (7) I tend to play web board games to overturn all the games that I have lost so far], 6 items were from KGBS [(5) I play web board games more than most people, (8) I play web board games to make up for the game money I have lost from web board gaming, (14) I hardly ever think about playing web board games, (15) I play web board games for leisure, (16) I hide the fact that I am addicted to web board games, and (17) I do not communicate with my family or participate in social activities as much because of web board games], and 5 items were from CES-D [(9) I usually have difficulty concentrating whenever I do something, (10) I often get tired whenever I do something, (11) I am usually happy, (12) I usually enjoy life, and (13) I suddenly tend to cry].

For the 17 original items, confirmatory factor analysis (CFA) was performed to estimate acceptable model fit for one-latent factor solution [CFI and/or TLI>0.90, root mean square error of approximation (RMSEA)<0.08] using AMOS.²⁰ However, the data did not meet these criteria: CFI=0.754, TLI=0.719, RMSEA=0.151. Since the original 17 items did not meet the one-factor latent structure, a series of additional exploratory factor analyses (EFA) was used to identify and determine the best factor structure of the scale. After considering the results of factor analysis and the content validity of the items, we extracted 10 items from the 17 original items. Total scores of the 10 items on WBGS were compared between the high-risk group and low-moderate risk group using the independent t test (Figure 1).

Statistical analysis

Demographic characteristics of participants were analyzed using the independent t-test and chi-square test. The factor analysis for the items of WBGS included principal axis factoring, oblique rotation, and sub-factor analysis (internal consistency coefficient, Cronbach's α).

A k-means cluster analysis was performed to segregate all the participants into either the risk-user group or general-user group. In addition, k-means cluster analysis was performed to segregate risk-user group into high-risk group and low-moderate risk group. Receiver operating characteristic (ROC) curves were used for calculating sensitivity, specificity, and area under the curve (AUC) and to determine the cut-off points for the individuals of risk-user group with problematic web-based board gaming. The best cut-off point was considered as the one with the highest values of sensitivity+specificity. All the data analyses were carried out using SPSS ver. 21.0 (IBM Corp., Armonk, NY, USA).

Ethics statement

The study protocol was approved by the Institutional Review Board of the Chung Ang University (IRB Number: 1041078-201901-HRBM-002-01). Informed consent was obtained from the participants and confirmed by the board.

RESULTS

Demographic and web-based board gaming characteristics

The mean age and sex ratio (male:female) of the 300 participants were 38.7 ± 8.4 years and 80:20, respectively. Most participants had an undergraduate degree, a job, and an annual income of \$20,000–40,000. There were no significant differences in age, sex ratio, marital state, education level, and job status between excessive users and general users. However, the income level of excessive users was higher than that of general users (Table 1).

The mean time of online board gaming was 2.5 ± 2.2 h/session and the mean amount of money spent for a web-based board game/session was $\$12.9\pm 38.9$. In addition, 17.7% of the gamers in the current study had a history of interpersonal problems in their family, school, or workplace. Seventy-eight percent of excessive users played web-based board games every day and 66.0% of general users played 2–3 sessions of web-based board games per week. Forty-one percentage of excessive users played web-based board games for 20–30 h/week and 90.7% of general users played web-based board games for less than 10 h/week (Table 2).

Reliability and validity of the web-based board game behavioral scale

The internal consistency of the WBGs was high (Cronbach's $\alpha=0.89$). Test-retest reliability of 17 item WBGs was $r=0.77$ ($p<0.001$). Relatively high criterion-related validity ($t=16.1$, $p<0.001$) of the 17-item WBGs was observed when the WBGs total scores between the high-risk group (44.9 ± 7.6) and low-risk group (32.3 ± 5.7) were compared.

Factor analysis for the items of the web-based board game behavioral scale

The acquired data was acceptable based on factor analysis (Kaiser-Meyer-Olkin Measure of Sampling Adequacy=0.918; Bartlett's Test of Sphericity, $\chi^2=3351.714$, $df=136$, $p<0.001$). Explanatory factor analysis revealed that the 17 items of WBGs could be characterized as three factors. Among the 12 items of factor 1, the factor loading values were acceptable for all the

Table 1. Demographic characteristics

	Total	Excessive users	General users	Statistics
Age	38.7 \pm 8.4	38.0 \pm 8.5	39.4 \pm 8.2	$t=1.38$, $p=0.17$
Sex (male/female) (%)	240/60 (80.0/20.0)	120/30 (80.0/20.0)	120/30 (80.0/20.0)	
Marriage (married/single) (%)	178/122 (59.3/40.7)	88/62 (58.7/41.3)	90/60 (60.0/40.0)	$\chi^2=0.01$, $p=0.90$
Education (%)				$\chi^2=0.43$, $p=0.72$
High school	46 (15.3)	23 (15.3)	23 (15.3)	
College/University	231 (77.1)	117 (78.0)	114 (76.0)	
Graduate	23 (7.6)	10 (6.7)	13 (8.7)	
Job (%)				$\chi^2=0.03$, $p=0.87$
Students	16 (5.3)	9 (6.0)	7 (4.6)	
Officers	177 (59.0)	85 (56.7)	92 (61.3)	
Service	36 (12.0)	21 (14.0)	15 (10.0)	
Owners	52 (17.3)	28 (18.7)	24 (16.0)	
Non-job	19 (6.4)	7 (4.6)	12 (8.0)	
Income (%)				$\chi^2=5.99$, $p=0.01$
<\$20,000	21 (7.0)	8 (8.0)	13 (8.7)	
\$20,000–39,999	103 (34.4)	44 (29.3)	59 (39.3)	
\$40,000–59,999	96 (32.0)	51 (34.4)	45 (30.0)	
>\$60,000	80 (26.6)	47 (31.3)	33 (22.0)	

Table 2. Web board gaming pattern

	Total	Excessive users	General users	Statistics
Frequency (%)				$\chi^2=244.3$, $p<0.01$
Everyday	117 (39.0)	117 (78.0)	0 (0.0)	
4–5/week	33 (11.0)	33 (22.0)	0 (0.0)	
2–3/week	99 (33.0)	0 (0.0)	99 (66.0)	
1/week	42 (14.0)	0 (0.0)	42 (28.0)	
1/month	9 (3.0)	0 (0.0)	9 (6.0)	
Play time (hours/week) (%)				$\chi^2=249.4$, $p<0.01$
<10	136 (45.3)	0 (0.0)	136 (90.7)	
10–20	14 (4.7)	0 (0.0)	14 (9.3)	
21–30	62 (20.7)	62 (41.3)	0 (0.0)	
31–40	45 (15.0)	45 (30.0)	0 (0.0)	
>41	43 (14.3)	43 (28.7)	0 (0.0)	
Play time (hours/session)	2.5 \pm 2.2	3.4 \pm 2.2	1.5 \pm 1.7	$t=8.42$, $p<0.01$
Spent money (\$/session)	12.9 \pm 38.9	24.6 \pm 52.4	1.2 \pm 3.3	$t=8.45$, $p<0.01$
Social problems (yes/no)	53/247 (17.7/82.3)	53/97 (35.3/64.7)	0/150 (0/150)	$\chi^2=64.2$, $p<0.01$

items except for items 9 and 10 (factor loading<0.4). In a second analysis, all 10 items were characterized as one factor. Factor loading scores were high (0.639–0.841). After removing 7 items, Cronbach’s α value increased from 0.89 (17-item WBGs) to 0.94 (10-item WBGs) (Table 3).

Cluster analysis of the study sample

In the k-means cluster analysis of the participants (300), the highest total 10-item WBGs score (40) in the risk-user group and the lowest total 10-item WBGs score (10) in the general-user group were selected as initial seeds (centroids of respective groups). Final centroid and mean±standard deviation (SD) of the total 10-item WBGs score of the risk-user group were 29 and 29.47±3.76, respectively. The corresponding values of the general-user group were 17 and 17.28±4.27, respectively. The final Euclidean distance between the two groups was 12.189. After k-means cluster analysis, the 300 participants were classified into a risk-user group (119) and general-user group (181).

In the k-means cluster analysis of the risk-user group (119), the highest total 10-item WBGs score (40) in the high-risk group and the lowest total 10-item WBGs score (24) in the low-moderate risk group were selected as initial seeds (cen-

troids of respective groups). Final centroid and mean±SD of the total 10-item WBGs score of the high-risk group were 34 and 33.67±2.04, respectively. The corresponding values of the low-moderate risk group were 27 and 27.09±1.99, respectively. The final Euclidean distance between the two groups was 6.582. After k-means cluster analysis, the 119 participants were classified into a high-risk group (43) and low-moderate risk group (78).

Receiver operating characteristic curve analysis of the web-based board game behavioral scale score

Among the 300 participants, the cut-off 10-item WBGs score (total) of the risk-user group was set at 22 with an AUC of 0.916 (95% CI: 0.884–0.947) (Figure 2). As shown in Table 4, the sensitivity and specificity values were the highest for the 10-item WBGs scores of 21.5 and 22.5, respectively.

Among the individuals in the risk-user group (119), the cut-off WBGs score (total) of the high-risk group was set at 31 with an AUC of 0.864 (95% CI: 0.797–0.911) (Figure 2). As shown in Table 4, the sensitivity and specificity values were the highest for the 10-item WBGs score of 30.5 and 31.5, respectively.

Table 3. Factor loading for problematic web board gaming: 17 items vs. 10 items

Items No.	17 items			10 items
	Factor 1	Factor 2	Factor 3	
1 I want to play web board games suddenly sometimes	0.622			0.639
2 I play web board games when I am sad	0.788			0.765
3 I play web board games when I worry about interpersonal relationships with others.	0.803			0.772
4 I think about web board games when I bet with someone	0.750			0.754
5 I play web board games more than most people	0.807			0.822
6 I tend to play web board games because I want to continue winning	0.805			0.836
7 I tend to play web board games to overturn all the games that I have lost so far	0.818			0.841
8 I play web board games to make up for the game money I have lost from web board gaming	0.810			0.829
9 I usually have difficulty concentrating whenever I do something	0.354			-
10 I often get tired whenever I do something	0.351			-
11 I am usually happy		0.897		-
12 I usually enjoy life		0.936		-
13 I suddenly tend to cry			-0.341	-
14 I hardly ever think about playing web board games			0.582	-
15 I play web board games for leisure			-0.532	-
16 I hide the fact that I am addicted to web board games	0.716			0.687
17 I do not communicate with my family or participate in social activities as much because of web board games	0.775			0.748
Eigen value	7.60	1.85	0.89	5.96
Variance extracted	44.7	10.9	5.22	59.6

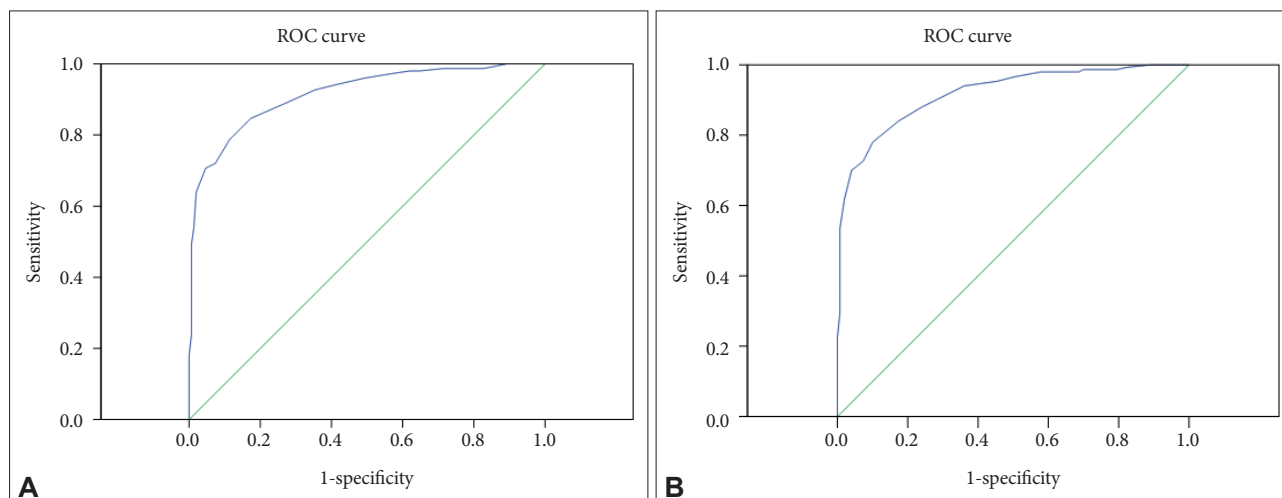


Figure 2. Receiver operating characteristic (ROC) curves for the low- and high-risk web-based board game groups. A: Risk web-based board game group, B: High-risk web-based board game group. WBS: web-based board game behavioral scale.

Table 4. Sensitivity and specificity of web board game scale in risk and high risk user groups

Cut off value	Sensitivity	1-specificity	Specificity	Sensitivity+specificity
Risk group				
9.0000	1.000	1.000	0.000	1.000
		...		
17.5000	0.960	0.493	0.507	1.467
18.5000	0.940	0.407	0.593	1.533
19.5000	0.927	0.353	0.647	1.573
20.5000	0.893	0.280	0.720	1.613
21.5000	0.847	0.173	0.827	1.673
22.5000	0.787	0.113	0.887	1.673
23.5000	0.720	0.073	0.927	1.647
24.5000	0.707	0.047	0.953	1.660
25.5000	0.640	0.020	0.980	1.620
		...		
41.0000	0.000	0.000	1.000	1.000
High risk group				
23.000	1.000	1.000	0.000	1.000
		...		
26.5000	1.000	0.526	0.474	1.474
27.5000	1.000	0.421	0.579	1.579
28.5000	1.000	0.289	0.711	1.711
29.5000	1.000	0.197	0.803	1.803
30.5000	1.000	0.000	1.000	2.000
31.5000	0.800	0.000	1.000	1.860
32.5000	0.628	0.000	1.000	1.628
33.5000	0.535	0.000	1.000	1.535
34.5000	0.326	0.000	1.000	1.326
		...		
41.0000	0.000	0.000	1.000	1.000

DISCUSSION

Using a sample of 300 web-based board game users, a behavioral assessment (WBGs) with reasonable reliability and validity was created. Our results revealed that the 10-item WBGs had better internal consistency and validity, compared to those of the 17-item WBGs.

In the current study, the participants showed significant differences in frequency, duration, gaming time, money spent, and social problems between the excessive-user group and general-user group. Notably, the SD of the money spent was larger and the number of users with social problems due to web-based board gaming was higher in the excessive-user group than in the general-user group. These results may be associated with impulsivity.^{21,22} The Norwegian government helped gamblers control their impulsivity using limit-setting tools, voluntary self-exclusion, and personalized feedback.²²

The internal consistency (Cronbach's $\alpha=0.89$) and test-retest reliability of the WBGs ($r=0.77$, $p<0.001$) were relatively good and were accepted as reasonable. The criterion-related validity comparing the high-risk group and low-risk group was also statistically significant. However, the WBGs did not have a good fit in the CFA analysis. With that result, we suggest that the 17-items of WBGs cannot be categorized as one factor.

Based on the EFA, the 17-item WBGs had 3 factors; factor 1 (items 1–9 and items 16–17), factor 2 (items 11–12), and factor 3 (items 13–15). Among them, all the items of the 17-item WBGs achieved acceptable factor loading scores except for items 9 and 10. However, the 10-item WBGs lacked the 5 items extracted from CES-D (items 9–13) and the items of factor 3 (items 13–15) present in the 17-item WBGs; consequently, the internal consistency was higher in the former than in the latter. The five items from CES-D were ruled out due to low factor loading or due to other dimensions associated with the factors in the current study. Many studies on gambling or internet-based games have suggested that mood status is associated with the aggravation of gambling or gaming behaviors.²³ In the WBGs results, mood status assessed according to CES-D was not closely correlated with web-based board gaming. Items 14 and 15 were extracted from the low-risk factors of KGBS. The low-risk factors of KGBS were associated with the positive functions associated with gambling and disinterest in gambling.^{15,16} According to these results, individuals playing web-based board games may have different psychological characteristics, compared to those involved in gambling or internet gaming. The words “web-based board” were absent in the sentence extracted from CES-D. This may affect the categorization of the 17 items as three factors. Several studies have suggested that item-wording and the dimensionality in scale could affect the consequences of the survey and response of partici-

pants.^{24–26} Moreover, Greenberg et al.²⁵ reported that item-wording in the 10-item Rosenberg Self-Esteem Scale could affect the responses of the survey.

The cut-off point (>22) of the risk-user group for problematic web-based board gamers was obtained using an ROC curve of the 10-item WBGs. In the k-means cluster analysis, the centroid (17.28) and SD (4.27) of the risk-user group for problematic web-based board gamers was almost 22. The cut-off point (>31) of the high-risk group for problematic web-based board gamers was obtained using an ROC curve of the 10-item WBGs. In the k-means cluster analysis, the centroid (33.67) and SD (2.04) of high-risk group for problematic web-based board gamers was almost 31. In both the analyses, the cut-off points elucidated by ROC curves and k-means analyses coincided.

The current study had several limitations. First, because the results of the online surveys are based on a relatively small sample size and low response rate, readers should be cautious when interpreting the results. That is, there might be a small sample bias and nonresponse bias. Second, the participants in the current study were not screened by a structured clinical interview. Psychological status and comorbidities of the participants may have affected the analysis and corresponding results. Future studies should focus on the development of scales that include psychological status and comorbidities.

The current results indicate that the 10-item WBGs appeared to have greater validity than the 17-item WBGs. In addition, we suggest that the 10-item WBGs can be a useful tool for screening individuals with risk or high risk of problematic web-based board gaming behavior. Monitoring web-based board gamers may be important step for preventing illegal internet-based gambling or offline gambling. A web-based board game behavioral scale may be an effective simple screening method for assessing the behavior of excessive online game players.

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Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

Author Contributions

Conceptualization: Doug Hyun Han. Data curation: Choongmeong Lee. Formal analysis: Jae Chan Jin. Funding acquisition: Sujin Bae. Investigation: Jae Jun Nam. Methodology: Doug Hyun Han. Project administration: Choongmeong Lee. Resources: Choongmeong Lee. Software: Jae Jun Nam. Supervision: Doug Hyun Han. Validation: Jae Chan Jin. Visualization: Sujin Bae. Writing—original draft: Doug Hyun Han. Writing—review & editing: Doug Hyun Han.

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