Validation of the Internet Gaming Disorder Scale–Short-Form and the Gaming Disorder Test in Singapore

Abstract

Introduction: Given that 90% of younger Singaporeans play video games, there is an urgent need for psychometrically valid instruments as a screening tool for problematic gaming. The Internet Gaming Disorder Scale-Short-Form (IGDS9-SF) and the Gaming Disorder Test (GDT) have not been validated for use among Singaporeans. The current study aimed to examine the psychometric properties of both instruments among Singaporeans. Methods: Participants were a representative sample of 1001 adults (aged 18-40 years) in Singapore recruited using stratified sampling. The study used a correlational design. Participants completed instruments that assess Internet gaming disorder (IGD), gaming disorder (GD), and negative emotional states. Data collection was conducted and completed in August 2023. The data were analyzed using (multigroup) confirmatory factor analyses, reliability analyses, Pearson's correlation coefficient, and t-tests. Results: The results provided support for the one-factor model of the IGDS9-SF (Comparative Fit Index [CFI] = 0.972) and GDT (CFI = 0.996). Both instruments also had configural, metric, scalar, and strict invariances across gender (Δ CFI was <0.010). The instruments were also reliable, with a Cronbach's alpha of 0.93 and 0.90, respectively. Finally, the instruments were significantly correlated with each other (r = 0.83) and with depression, anxiety, and stress (r ranged from 0.65 to 0.71). Conclusion: Overall, both instruments are reliable and valid among Singaporeans. Future research could recruit samples with a wider age range to include children and adolescents and those over the age of 40 years and to compare scores of the instruments against clinician-administered assessments.

Keywords: Behavioral addiction, Internet gaming disorder, psychometrics, reliability, Singapore, validity

Introduction

The Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5) added Internet gaming disorder (IGD) to Section III as a condition that warrants further studies and defined it as "a pattern of excessive and prolonged Internet gaming that results in a cluster of cognitive and behavioral symptoms, including progressive loss of control over gaming, tolerance, and withdrawal symptoms, analogous to the symptoms of substance use disorders."[1] It should be noted that despite its name, IGD encompasses both online and offline gaming behavior. The nine criteria of IGD are (1) preoccupation with gaming, (2) withdrawal symptoms like irritability or anxiety when unable to play games, (3) tolerance - the need to increase time spent on games, (4) unsuccessful attempts to reduce or stop gaming, (5) loss of interest in other

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activities because of gaming, (6) continued gaming despite problems, (7) deceiving family members or others about amount of gaming, (8) gaming to escape or to relive negative moods, and (9) risk or loss of a relationship, job, or educational or career opportunity because of gaming. Individuals who meet five or more criteria during the past 12 months would meet the diagnostic criteria for IGD. Meta-analyses found a prevalence rate of 3.05% for IGD,^[2] with a higher prevalence rate of 10.10% in Asian countries.^[3]

Since IGD's inclusion in the DSM-5, the correlates of IGD have been well documented. For example, the correlates of IGD include age (i.e. younger participants are at higher risk),^[2] gender (i.e. males are at higher risk),^[4] and personality (i.e. conscientiousness, extraversion, agreeableness, and neuroticism).^[5] IGD is also correlated with a range of negative consequences such as depression and anxiety^[6] and poor sleep quality.^[7]

How to cite this article: Chew PK, Naidu KN, Shi J, Zhang MW. Validation of the internet gaming disorder scale-short-form and the gaming disorder test in Singapore. Asian J Soc Health Behav 2025;8:125-32.

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Received: 25 September, 2024. Revised: 18 December, 2024. Accepted: 03 February, 2025. Published: 30 May, 2025.

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New designed instruments to assess the nine criteria of IGD based on the DSM-5 have been reviewed.^[8] These instruments include the IGD Scale-Short-Form (IGDS9-SF),^[9] the Ten-Item Internet Gaming Disorder Test,^[10] and the IGD Scale.^[11] The current study focused on the IGDS9-SF because it has been validated in both Asian^[12] and Western^[13] samples. Overall, a systematic review of 21 studies encompassing 15 language versions concluded that the IGDS9-SF has excellent psychometric properties.^[14]

In addition to the DSM-5, the International Classifications of Diseases, 11th edition (ICD-11) officially recognized gaming disorder (GD) and defined it as a pattern of persistent gaming behavior, either online or offline, that includes the following features: (1) impaired control over gaming, (2) increased priority given to gaming over other activities, (3) continued gaming despite problems, and (4) impairment in various life domains (e.g. family, educational, and occupational).^[15] Individuals who meet all of the criteria during the past 12 months would meet the diagnostic criteria for GD. One study involving 560 participants from China and the UK found a prevalence rate of 1.80% for GD.^[16]

Due to the recency of the ICD-11 criteria, there are relatively fewer instruments designed to assess the four criteria of GD. These instruments include the Gaming Disorder Test (GDT),^[16] the GAMing Engagement Screener test,^[17] and the Assessment of Criteria for Specific Internet-use Disorders.^[18] The current study focused on the GDT because it has been validated in both Asian^[19] and Western^[20] samples. Overall, a meta-analysis of 17 studies encompassing 14 language versions concluded that the GDT has excellent internal consistency reliabilities.^[21] More important, a review found that the GDT was the only instrument to adequately assess all ICD-11 GD criteria.^[22]

Overall, multiple studies have provided support for the psychometric properties of the IGDS9-SF^[14] and the GDT.^[16] However, both instruments have not been validated for use among Singaporeans. A recent survey found that 76% of Singaporeans play games, with the percentage increasing to 90% among younger Singaporeans (aged 18–24 years).^[23] Given the high percentage of gamers, it is likely that some might play games excessively. This emphasizes the importance of having psychometrically valid instruments as a screening tool for IGD and GD in Singapore.

The current study aimed to examine the psychometric properties of the IGDS9-SF and GDT among Singaporeans. First, it was expected that the instruments would be valid.^[14,16] Specifically, it was hypothesized that the IGDS9-SF and GDT would have a unidimensional structure (H1a), and there would be measurement invariance across gender (H1b). Second, it was expected that the instruments would be reliable.^[14,16] Specifically,

they should have an acceptable Cronbach's alpha and McDonald's omega of more than 0.70, and the standard error of measurement should be \leq standard deviation (SD)/2 (H2). Third, it was expected that the instruments would demonstrate convergent validity by sharing a strong positive correlation with each other (H3a). Furthermore, the known correlates of IGD and GD will be used to examine the concurrent validity and known-group validity of the instruments. Specifically, it was expected that the instruments would be significantly correlated with depression (H3b), anxiety (H3c), and stress (H3d).^[6] Finally, it was expected that males would have higher IGD and GD scores than females among Singaporeans (H3e).^[4]

Methods

Participants

Participants were a representative sample of adults recruited by a survey panel based on the inclusion and exclusion criteria. Specifically, participants should be (a) Singaporeans or permanent residents, (b) played at least one game in the past 12 months, and (c) between 18 and 40 years of age. A total of 1560 participants were recruited. However, 559 (35.83%) cases were removed because they did not meet the inclusion criteria, resulting in a total sample of 1001 participants.

Instruments

The Background Information Form

The Background Information Form was developed for the purposes of the current study to collect demographic and gaming-related information. Demographic variables included nationality, age, gender, ethnicity, housing type, occupation, and current/highest education level, whereas gaming-related variables included the average amount of time (in hours) spent playing games in a typical weekday and weekend.

The Internet Gaming Disorder Scale–Short-Form

The IGDS9-SF is a 9-item instrument designed to assess the nine criteria of IGD in the DSM-5.^[9] Participants are asked to report their gaming activity during the past 12 months. Responses were made on a 5-point Likert scale that ranged from 1 = never to 5 = very often. The item scores were summed, with higher scores indicating high levels of IGD.

The Gaming Disorder Test

The GDT is a 4-item instrument designed to assess the four criteria of GD in the ICD-11.^[16] Participants were also asked to report their gaming activity during the past 12 months. Responses were made on a 5-point Likert scale that ranges from 1 = never to 5 = very often. The item scores were summed, with higher scores indicating high levels of GD.

The Depression Anxiety Stress Scale

The Depression Anxiety Stress Scale is a 12-item instrument designed to assess depression, anxiety, and stress.^[24]

Responses were made on a 4-point Likert scale that ranges from 1 = did not apply to me at all to 4 = applied to me very much or most of the time. Appropriate item scores were summed for each factor, with higher scores indicating higher levels of the respective negative emotional state.

Procedure

The current study is part of a larger study to examine gaming behavior among young adults in Singapore. Participants completed the study online via Qualtrics. Upon providing informed consent, participants completed a screener question to ensure they played games in the past 12 months and the Background Information Form. Subsequently, participants completed the IGDS9-SF,^[9] the GDT,^[16] the Depression Anxiety Stress Scale,^[24] and two instruments unrelated to the aims of the current study. All instruments are in English and were administered in a randomized order to control for fatigue and order effects. Data collection was conducted and completed in August 2023. This procedure was approved by the first author's institutional Human Research Ethics Committee (Approval number: H9100).

Statistical analyses

The results were analyzed using JASP Version 0.18.1. First, confirmatory factor analyses (CFAs) were conducted to test the one-factor model of the IGDS9-SF and GDT. Given the tendency of the Chi-square test to be significant in large sample sizes, alternative fit indices like the Comparative Fit Index (CFI)^[25] and the Root Mean Square Error of Approximation (RMSEA) were used to evaluate model fit. Specifically, a CFI \geq 0.950 and a RMSEA <0.080 were considered indicators of good fit.^[26]

Second, multigroup CFAs (MGCFA) were conducted for the IGDS9-SF and GDT across gender based on current best practices.^[27-29] The one-factor model of the instruments was first tested separately for males and females. If required, the model was modified accordingly before being used to test for equivalence across gender. Subsequently, the model was tested for measurement invariance in the following order: configural, metric, scalar, and strict invariance. Similarly, alternative fit indices like the CFI and RMSEA were used. A Δ CFI <0.010 and a Δ RMSEA <0.015 indicated a nonsignificant change in model fit and provided evidence of invariance.^[30]

Third, Cronbach's alpha, McDonald's omega, and the standard error of measurement were calculated to examine the reliability of the instruments. A Cronbach's alpha >0.70 and a McDonald's omega >0.70 were considered acceptable levels of internal consistency. The standard error of measurement was calculated by multiplying the SD by $\sqrt{(1-\text{Cronbach's alpha})}$. A standard error of measurement \leq SD/2 was indicative of an acceptable level of measurement error.^[31]

Finally, Pearson's correlation coefficient and *t*-tests were conducted to examine the validity of the instruments. Convergent validity was examined by correlating scores between the IGDS9-SF and GDT. Concurrent validity was examined by correlating scores of the IGDS9-SF and GDT with scores of the Depression Anxiety Stress Scale. Finally, known-group validity was examined by comparing scores of the IGDS9-SF and GDT across gender.

Results

The sample consisted of 1001 participants (50.15% females, 74.43% Chinese, 13.29% Malays, 9.29% Indians, and 3.00% others). Their age ranged from 18 to 40 years (mean = 28.47, SD = 6.21). The gender and ethnic distribution is similar to the Singaporean population (51.10% females, 74.30% Chinese, 13.50% Malays, 9.00% Indians, and 3.20% others).^[32] The males consisted of 499 participants (74.55% Chinese, 13.23% Malays, 9.22% Indians, and 3.01% others). Their age ranged from 18 to 40 years (mean = 29.12, SD = 5.76). The females consisted of 502 participants (74.30% Chinese, 13.35% Malays, 9.36% Indians, and 2.99% others). Their age ranged from 18 to 40 years (mean = 27.84, SD = 6.57). The demographic and gaming-related information of the samples are presented in Table 1.

Confirmatory factor analysis of the Internet Gaming Disorder Scale–Short-Form

A CFA was conducted to test the one-factor model of the IGDS9-SF (Model 1). While Model 1 provided a satisfactory fit to the data, an inspection of the Modification Indices suggested that the model can be improved by specifying one error covariance between Items 7 and 9 (Modification Index = 104.997; Model 1a). This covariance is justified since the items belong to the same factor. The results showed that Model 1a represented a better fit to the data than Model 1. All factor loadings were significant, and they ranged from 0.67 to 0.84 [Figure 1]. The fit indices of the CFA are presented in Table 2.

Multigroup confirmatory factor analyses of the Internet Gaming Disorder Scale–Short-Form

Two CFAs were conducted to test the one-factor model of the IGDS9-SF separately for males and females (Models 2 and 3, respectively). While Models 2 and 3 provided a satisfactory fit to the data, an inspection of the Modification Indices suggested that the models can be improved by specifying one error covariance between Items 7 and 9 (Modification Index = 40.193 for males and 58.588 for females; Models 2a and 3a). This covariance is justified since the items belong to the same factor. The results showed that Models 2a and 3a represented a better fit to the data than Models 2 and 3, respectively. Consequently, this model with one error covariance was used to test for equivalence across gender. MGCFA was conducted to test for measurement invariance in the



Figure 1: Standardized estimates for the modified one-factor model of the Internet Gaming Disorder Scale–Short-Form with one error correlation (Model 1a)

Table 1: Dem	Table 1: Demographic and gaming-related information of samples, n (%)								
Variables	Total sample (<i>n</i> =966–1001)	Male sample (<i>n</i> =478–499)	Female sample (<i>n</i> =488–502)						
Nationality									
Singaporean	880 (87.91)	446 (89.38)	434 (86.45)						
Permanent resident	121 (12.09)	53 (10.62)	68 (13.55)						
Age, mean (SD)	28.47 (6.21)	29.12 (5.76)	27.84 (6.57)						
Gender									
Male	499 (49.85)	-	-						
Female	502 (50.15)	-	-						
Ethnicity									
Chinese	745 (74.43)	372 (74.55)	373 (74.30)						
Malay	133 (13.29)	66 (13.23)	67 (13.35)						
Indian	93 (9.29)	46 (9.22)	47 (9.36)						
Others	30 (3.00)	15 (3.01)	15 (2.99)						
Housing type									
1-Room HDB flat	12 (1.20)	8 (1.60)	4 (0.80)						
2-Room HDB flat	31 (3.10)	15 (2.81)	17 (3.39)						
3-Room HDB flat	275 (27.50)	129 (25.85)	146 (29.14)						
4-Room HDB flat	312 (31.20)	162 (32.47)	150 (29.94)						
5-Room HDB flat	180 (18.00)	87 (17.44)	93 (18.56)						
Condominium	159 (15.90)	82 (16.43)	77 (15.37)						
Landed properties	28 (2.80)	14 (2.81)	14 (2.79)						
Others	3 (0.30)	3 (0.60)	0 (0.00)						
Occupation status									
Student	177 (17.72)	49 (9.82)	128 (25.60)						
Employed	768 (76.88)	431 (86.37)	337 (67.40)						
Unemployed	34 (3.40)	10 (2.00)	24 (4.8)						
Others	20 (2.00)	9 (1.80)	11 (2.20)						
Education level									
Below secondary	1 (0.10)	0	1 (0.20)						
Secondary	37 (3.76)	19 (3.87)	18 (3.66)						
Postsecondary (nontertiary)	59 (6.00)	30 (6.11)	29 (5.89)						
Diploma and professional qualification	211 (21.47)	103 (20.98)	108 (21.95)						
University	675 (68.67)	339 (69.04)	336 (68.29)						
Gaming time, mean (SD)									
Weekday	2.98 (2.73)	3.31 (3.15)	2.66 (2.21)						
Weekend	4.29 (3.18)	4.80 (3.44)	3.78 (2.81)						

The sample sizes varied due to missing data on some variables. SD: Standard deviation

following order: configural, metric, scalar, and strict invariance. For all levels, the Δ CFI was <0.010 and the Δ RMSEA was <0.015, providing evidence of metric, scalar, and strict invariances. The fit indices of the MGCFA are presented in Table 2.

Confirmatory factor analysis of the Gaming Disorder Test

A CFA was conducted to test the one-factor model of the GDT. The results showed that the model represented a good fit to the data. All factor loadings were significant, and they ranged from 0.79 to 0.87[Figure 2]. The fit indices of the CFA are presented in Table 3.

Multigroup confirmatory factor analyses of the Gaming Disorder Test

Two CFAs were conducted to test the one-factor model of the GDT separately for males and females. Both models represented a good fit to the data. Consequently, this model was used to test for equivalence across gender. MGCFA was conducted to test for measurement invariance in the following order: configural, metric, scalar, and strict invariance. For all levels, the Δ CFI was <0.010 and the Δ RMSEA was <0.015, providing evidence of metric, scalar, and strict invariances. The fit indices of the MGCFA are presented in Table 3.

Reliability of the Internet Gaming Disorder Scale– Short-Form and Gaming Disorder Test

The IGDS9-SF had a Cronbach's alpha of 0.93, 95% confidence interval [CI] (0.92–0.93] and a McDonald's omega of 0.93, 95% CI [0.92–0.93]. The GDT had a Cronbach's alpha of 0.90, 95% CI [0.89–0.91] and a McDonald's omega of 0.90, 95% CI [0.89–0.91]. These statistics were >0.70, providing evidence of internal consistency. In addition, the standard error of measurement of both instruments was \leq SD/2, indicating an acceptable level of measurement error. The descriptives of the variables are presented in Table 4.

Validity of the Internet Gaming Disorder Scale–Short-Form and Gaming Disorder Test

The IGDS9-SF and GDT share a strong positive correlation, r (999) = 0.83, P < 0.001. In addition, both the IGDS9-SF and GDT had strong positive correlations that ranged from 0.65 to 0.71 with depression, anxiety, and stress, all P < 0.001. Finally, males had higher

Table 2: Confirmatory factor analyses and multigroup confirmatory factor analyses for the Internet Gaming Disorder
Scale–Short-Form

Model	Baseline						Difference			
	χ^2	df	Р	CFI	RMSEA (90% CI)	$\Delta \chi^2$	$\Delta \mathbf{d} \mathbf{f}$	Р	ΔCFI	ΔRMSEA
Total sample										
Model 1	290.662	27	< 0.001	0.953	0.099 (0.089-0.109)	-	-	-	-	-
Model 1a	186.308	26	< 0.001	00.972	0.078 (0.068-0.089)	-	-	-	-	-
Males										
Model 2	163.589	27	< 0.001	0.956	0.101 (0.086-0.116)	-	-	-	-	-
Model 2a	123.749	26	< 0.001	0.968	0.087 (0.072-0.102)	-	-	-	-	-
Females										
Model 3	150.265	27	< 0.001	0.947	0.095 (0.081-0.111)	-	-	-	-	-
Model 3a	91.472	26	< 0.001	0.972	0.071 (0.055-0.087)	-	-	-	-	-
Configural	215.221	51	< 0.001	0.970	0.080 (0.069-0.091)	-	-	-	-	-
Metric	234.338	59	< 0.001	0.968	0.077 (0.067-0.088)	19.117	8	0.014	0.002	0.003
Scalar	260.976	68	< 0.001	0.964	0.075 (0.066-0.085)	26.638	9	0.002	0.004	0.002
Strict	286.356	78	< 0.001	0.962	0.073 (0.064-0.082)	25.38	10	0.005	0.002	0.002

Models 1, 2, and 3: One-factor model; Models 1a, 2a, and 3a: One-factor model with one error covariance between items 7 and 9. CFI: Comparative Fit Index, RMSEA: Root Mean Square Error of Approximation, CI: Confidence interval

Table 3: Confirmatory factor analyses and multigroup confirmatory factor analyses for the Gaming Disorder Test										
Model	Baseline					Difference				
	χ^2	df	Р	CFI	RMSEA (90% CI)	$\Delta \chi^2$	∆df	Р	ΔCFI	ΔRMSEA
Total sample	12.289	2	0.002	0.996	0.072 (0.037-0.112)	-	-	-	-	-
Males	4.665	2	0.097	0.998	0.052 (0.000-0.115)	-	-	-	-	-
Females	8.427	2	0.015	0.994	0.080 (0.030-0.139)	-	-	-	-	-
Configural	13.092	3	0.004	0.996	0.082 (0.040-0.130)	-	-	-	-	-
Metric	25.469	6	< 0.001	0.992	0.081 (0.050-0.114)	12.377	3	0.006	0.004	0.001
Scalar	34.442	10	< 0.001	0.989	0.070 (0.045-0.096)	8.973	4	0.062	0.003	0.011
Strict	50.438	14	< 0.001	0.984	0.072 (0.051-0.094)	15.996	4	0.003	0.005	0.002

CFI: Comparative Fit Index, RMSEA: Root Mean Square Error of Approximation, CI: Confidence interval

Asian Journal of Social Health and Behavior | Volume 8 | Issue 3 | July-September 2025



Figure 2: Standardized estimates for the one-factor model of the Gaming Disorder Test

Table 4: Descriptives and intercorrelations of the										
Variable 1 2 3 4 5										
1. IGD	-									
2. GD	0.83***	-								
3. Depression	0.68***	0.65***	-							
4. Anxiety	0.71***	0.67***	0.79***	-						
5. Stress	0.71***	0.68***	0.84***	0.81***	-					
Mean	20.67	8.96	8.00	7.78	8.19					
SD	8.24	4.01	3.39	3.07	3.12					
Cronbach's alpha	0.93	0.90	0.90	0.83	0.84					
McDonald's omega	0.93	0.90	0.90	0.84	0.85					
SEM	2.18	1.27	-	-	-					
SD/2	4.12	2.01	-	-	-					
Number of items	9	4	4	4	4					
Actual range	9–45	4–20	4–16	4–16	4–16					
Potential range	9–45	4–20	4–16	4-16	4–16					

****P*<0.001. GD: Gaming disorder, IGD: Internet GD, SEM: Standard error of measurement, SD: Standard deviation

scores on the IGDS9-SF (mean = 22.47, SD = 8.69) than females (mean = 18.88, SD = 7.35), t (999) = 7.06, P < 0.001. Males also had higher scores on the GDT (mean = 9.79, SD = 4.19) than females (mean = 8.13, SD = 3.65), t (999) = 6.67, P < 0.001.

Discussion

First, the results of this study supported the hypotheses that the IGDS9-SF and GDT would have a unidimensional structure (H1a), and there would be measurement invariance across gender (H1b). Our CFAs showed that the modified one-factor model of the IGDS9-SF and the one-factor model of the GDT provided a satisfactory fit to the data. This was consistent with previous studies that found a unidimensional structure for the IGDS9-SF^[9,14] and GDT.^[16] Furthermore, our MGCFAs showed that both instruments had configural, metric, scalar, and strict invariances

across gender. This was consistent with previous studies that found measurement invariance across gender for the IGDS9-SF.^[14] In addition, the results extended on previous studies^[16] by providing the first evidence of measurement invariance across gender for the GDT.

Second, the results supported the hypothesis that the IGDS9-SF and GDT are reliable (H2). The IGDS9-SF and GDT had Cronbach's alpha and McDonald's omega of 0.93 and 0.90, respectively. These statistics were >0.70 and consistent with previous studies that found a Cronbach's alpha of 0.87 for the IGDS9-SF^[9] and 0.84 for the GDT.^[16] Furthermore, both instruments had an acceptable level of measurement error since their standard error of measurement were \leq SD/2.^[31] Taken together, both instruments are reliable.

Finally, the results supported the hypotheses that the IGDS9-SF and GDT shared a strong positive correlation with each other (H3a), were significantly correlated with depression (H3b), anxiety (H3c), and stress (H3d), and were higher among males than females (H3e). The IGDS9-SF and GDT were strongly and positively correlated with each other (r = 0.83). This was consistent with previous studies that found a correlation of r = 0.83.^[16] Both instruments were positively correlated with depression, anxiety, and stress (r ranges from 0.65 to 0.71). This was consistent with previous studies on the negative consequences of IGD (e.g. depression and anxiety).^[6] Finally, the finding that males had higher IGD and GD than females was consistent with previous studies that found males at higher risk for IGD than females.[4] Overall, consistent with psychometric research among Asian samples,^[12,19] both instruments demonstrated excellent psychometric properties in our Singaporean population.

Limitations

Limitations of the study should be noted. First, the current sample consisted of adults between 18 and 40 years of age. The methodology is justified since they are a group at risk for IGD.^[2] However, this precluded an examination of the structure of the instruments among adolescents and older adults. Second, the current study did not examine the clinical validity of the instruments. Consequently, it is unclear if the instruments, using the diagnostic criteria for IGD^[1] and GD,^[15] are able to distinguish between problematic and nonproblematic gamers. In the future, these limitations might be controlled by recruiting samples with a wider age range and comparing scores on the instruments against clinician-administered assessments such as a structured clinical interview with people who experience problems with gaming.^[33]

Conclusion

This study conducted a comprehensive evaluation of the psychometric properties of the IGDS9-SF and the GDT among Singaporeans, demonstrating its robustness in assessing IGD and GD. Our findings affirm the unidimensional structure, measurement invariance across gender, and reliability for both instruments. Our findings also attested to the instruments' convergent validity and concurrent validity. The results add to the growing body of psychometric evidence of the IGDS9-SF^[14] and provide support for the relatively newer GDT.^[16] Given the high percentage of gamers among Singaporeans,^[23] it is timely and important to have psychometrically valid instruments to screen for IGD and GD.

Author Contributions

- Peter K. H. Chew: Conceptualization, methodology, formal analysis, writing original draft, writing review and editing
- Kuhanesan N. C. Naidu: conceptualization, writing original draft, writing review and editing
- Jing Shi: Conceptualization, writing review and editing
- Melvyn W. B. Zhang: Conceptualization, writing review and editing.

Data availability Statement

The data are available upon request.

Financial support and sponsorship

The study was funded by James Cook University's Internal Research Grant Scheme (Number: IRG20230005).

Conflicts of interest

There are no conflicts of interest.

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