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FULL-LENGTH REPORT

The Gaming Disorder Identification Test (GADIT) – A screening tool for Gaming Disorder based on ICD-11

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ABSTRACT

Background: Gaming Disorder was included as an addictive disorder in the latest version of the International Classification of Diseases (ICD-11), published in 2022. The present study aimed to develop a screening tool for Gaming Disorder, the Gaming Disorder Identification Test (GADIT), based on the four ICD-11 diagnostic criteria: impaired control, increasing priority, continued gaming despite harm, and functional impairment. *Method:* We reviewed 297 questionnaire items from 48 existing gaming addiction scales and selected 68 items based on content validity. Two datasets were collected: 1) an online panel (N = 803) from Australia, United States, United Kingdom and Canada, split into a development set (N = 589) and a validation dataset (N = 214); and 2) a university sample (N = 408) from Australia. Item response theory and confirmatory factor analyses were conducted to select eight items to form the GADIT. Validity was established by regressing the GADIT against known correlates of Gaming Disorder. *Results:* Confirmatory factor analyses of the GADIT showed good model fit (RMSEA=<0.001–0.108; CFI = 0.98–1.00), and internal consistency was excellent (Cronbach's alphas = 0.77–0.92). GADIT scores were strongly associated with the Internet Gaming Disorder Test (IGDT-10), and significantly associated with gaming intensity, eye fatigue, hand pain, wrist pain, back or neck pain, and excessive in-game purchases, in both the validation and the university sample datasets. *Conclusion:* The GADIT has strong psychometric properties in two independent samples from four English-speaking countries collected through different channels, and shown validity against existing scales and variables that are associated with Gaming Disorder. A cut-off of 5 is tentatively recommended for screening for Gaming Disorder.

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KEYWORDS

gaming disorder, psychometrics, reliability, validity, scale development, screening tool

INTRODUCTION

With the proliferation of personal computers, home consoles, smartphones and hand-held devices, video gaming has penetrated all age groups from young children to retirees, and almost every corner of the world. There are over 3 billion regular video game players worldwide (Statista, 2023). Individuals play video games for fun, challenge, and relaxation (King & Delfabbro, 2018). In difficult times, video games can be a source of comfort and consolation, providing a novel means to connect and socialize (King, Delfabbro, Billieux, & Potenza, 2020; Zhu, 2021). During the COVID-19 pandemic, video game play increased by over 70%, providing a much-needed means through which isolated individuals could build social connections and overcome newfound feelings of loneliness (King, Delfabbro, et al., 2020; Zhu, 2021).

However, with strong integration of immersive technology and enhanced interactivity, unrestricted gaming can be highly absorbing and interfere with routines and important responsibilities, leading to addiction and experiences of harm among vulnerable individuals. With gaming becoming near-universal among young people, it has disproportionally impacted the well-being of some individuals. Young people who are addicted to gaming often disengage from education and employment, and experience a range of physical and mental problems (Beranuy, Carbonell, & Griffiths, 2013; Chan, Hou, Kelly, Leung, & Tisdale, 2021). Physical, mental, and social impairments due to unhealthy gaming are increasingly recognised and include musculoskeletal pain, muscle weakness, nutritional disturbance, thromboembolism, depression, anxiety, suicide, failure to progress academically, and increasing social isolation (Chan et al., 2021; Kelly & Leung, 2021; King et al., 2019; Lindberg et al., 2020; Saunders et al., 2017).

The growing recognition of unhealthy gaming culminated in the inclusion of a new entity, "Gaming Disorder", as an addictive disorder in the latest revision of the International Classification of Diseases (ICD-11) by the World Health Organization (WHO) (World Health Organization, 2022). This represents a paradigm shift in our understanding of this condition and the acceptance of this diagnostic entity by international authorities. An aligned condition, Internet Gaming Disorder (IGD), was introduced into DSM-5 as a "condition for further study" (American Psychiatric Association, 2013, 2022). Scales and screening tools have been developed for IGD but many contained at least one item that may pathologise normal gaming (King, Billieux, Carragher, & Delfabbro, 2020). The remainder of this paper will focus on Gaming Disorder under the ICD-11 definition unless specified otherwise. For detailed information about the definition of Internet Gaming Disorder, the readers can refer to the DSM-5 manual (American Psychiatric Association, 2013, 2022).

Gaming Disorder is defined in the ICD-11 as a pattern of persistent gaming behaviour, typically evident over 12 months and characterised by four diagnostic requirements (criteria): 1) impaired control over gaming behaviour, 2) increasing priority of gaming over other activities and responsibilities, 3) continuing gaming despite negative consequences and 4) functional impairment. The first three represent the addictive features, and the presence of all three plus functional impairment, together with the time criterion, fulfils the diagnosis of Gaming Disorder. However, the above ICD-11 criteria for Gaming Disorder are not sufficiently elaborated to form the basis of a questionnaire and need to be operationalised for diagnosis and screening.

The inclusion of Gaming Disorder in ICD-11 is not without criticism (Aarseth et al., 2017). The major one is that it might over-pathologize a recreational activity, creating stigma for the billions who enjoy video gaming (Aarseth et al., 2017), although available research on this proposition is limited (Galanis, Weber, Delfabbro, Billieux, & King, 2023). Nearly all existing screening and assessment tools for unhealthy gaming do not adequately address this issue and contain at least one item which pathologizes normal gaming (King, Billieux, et al., 2020). The rise of eSports further blurs the line between passion and addiction (Chan et al., 2021). Young people who are passionate about gaming and aspire to become professional eSport players may display a persistent pattern of gaming with minimal or no negative consequences (Slack, Delfabbro, & King, 2022).

A recent review (King, Chamberlain, et al., 2020) highlighted other problems with existing screening and assessment tools which might be employed for Gaming Disorder under the ICD-11 definition. The majority of existing tools predated the ICD-11 definition and do not appropriately capture all ICD-11 diagnostic criteria. A glaring example is the criterion "continue gaming despite negative consequences", which was only included in 9 out of 32 assessment tools evaluated, and this criterion was tested in a mere 1.9% of all representative samples identified by the review (King, Chamberlain, et al., 2020). Many existing tools also lack sufficient psychometric testing. Since the adoption of ICD-11 by the World Health Assembly in 2019, a few screening tools have been developed. They are limited in various ways. For example, The Gaming Disorder Symptom Questionnaire (Zhang et al., 2022) and the Three-item Gaming Disorder Test-Online-Centred questionnaires (Jo et al., 2020) are exclusively focused on children and young people. The Gaming Disorder Test consists of four questions that rephrased the four ICD-11 diagnostic criteria (Pontes et al., 2021). This test may share the same limitations of the ICD-11 that the criteria were not clearly operationalised. The GAMES test consists of nine questions (Higuchi et al., 2021) and was developed systematically from a Japanese sample. It has not been validated in culture outside Asia. The ACSID-11 has been developed for a range of internet-based behaviors, using ICD-11 Gaming Disorder as a framework (Müller et al., 2022).

The present study

A reliable and valid screening tool for Gaming Disorder developed using data from multiple countries with validation

in independent samples is needed. Such a tool will need to detect moderate to severe levels of unhealthy gaming without pathologizing normal gaming and be validated using independent samples. In the present study, we described the development of the 8-item Gaming Disorder Identification Test (GADIT) and testing of its reliability and validity.

METHOD

Procedure

The procedure for developing the Gaming Disorder Identification Test (GADIT) involved eight steps, which included six steps for scale development, and two steps for scale validation (Fig. 1). From 297 items within 48 existing scales (See Supplementary Table 2 for the full list) of unhealthy gaming and gaming addiction we identified 68 items that aligned with the four ICD-11 diagnostic criteria by content validity. Empirical testing in a four-country survey identified eight items, two from each diagnostic criterion, to form a screening tool for Gaming Disorder under the ICD-11 definition.

Scale development:

1. **Initial item selection**: A panel of experts, which comprised four clinical psychologists (JC, LH, AW and DK), one addiction medical specialist (JBS), one neuroscientist (DS), one epidemiologist (JKL) and one biostatistician (GCKC), evaluated an initial pool of 297 items representing Gaming Disorder's four diagnostic requirements (three addictive features and one functional impairment criterion), and selected 68 items based on their content validity and interpretability.
2. **Data collection:** Through the International Gaming Survey 2022 (online panel sample), 955 participants completed a survey containing the 68 selected items.
3. **Confirmatory factor analyses:** Four confirmatory factor analyses were conducted to check if the items for each criterion were unidimensional. This procedure ensures that all items for each criterion measure a single construct consistently, which is a key assumption for the subsequent Item Response Theory analyses.
4. **Item response theory analyses**: Item response theory analyses were conducted to identify items that were sensitive to detect moderate to severe levels for each diagnostic criterion.
5. **Refined item selection:** Selection of items was further refined based on the item difficulty (see explanation in the analysis section) of the items and their semantic clarity.
6. **Final item selection:** Based on steps 4 and 5, two items from each criterion were selected, totalling 8 selected items to form the GADIT screening tool.

Scale validation:

7. **Confirmatory factor analysis – scale validation:** The eight selected items underwent a series of confirmatory factor analyses to verify their structural validity using two data sources (online panel and university sample). Cronbach's alpha was also calculated.
8. **Validity and reliability testing:** Regression analyses were conducted to validate the GADIT scale against an existing scale (IGDT-10 scale for Internet Gaming Disorder) and variables that are expected to be associated with Gaming Disorder (gaming intensity, negative physical symptoms, excessive in-game purchases). We examined different cut-off point for GADIT against the IGDT-10 using a cut-off of 5. While there are substantial differences in the diagnostic requirement for IGD under the DSM-5 and GD under ICD-11, we expected that there would be moderate agreement between IGDT-10 and GADIT .

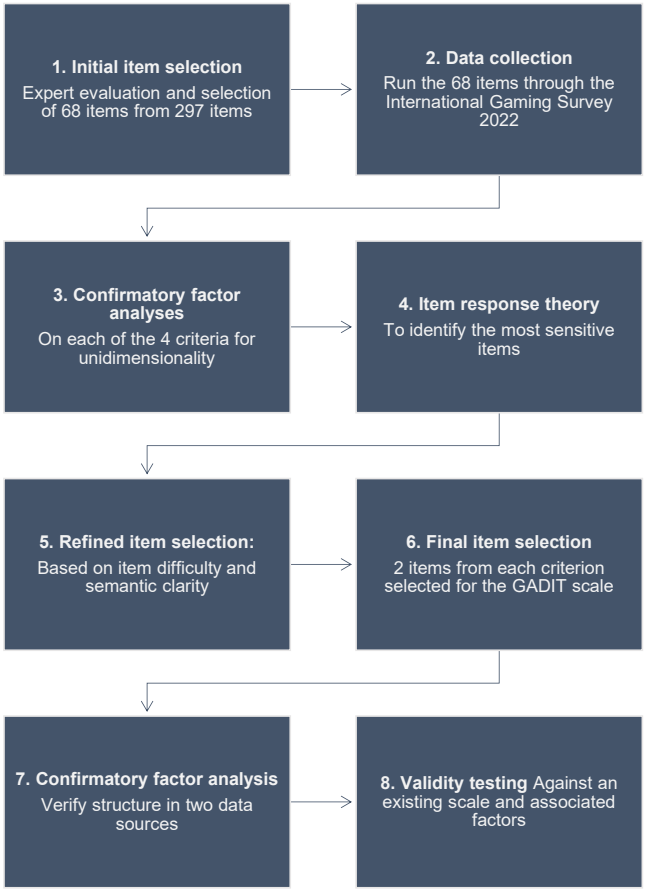

Fig. 1. The 8-step approach for developing and validating the 8-item Gaming Disorder Identification Test (GADIT)

Participants

Two sets of data were collected for this study. First, an online panel dataset was collected from participants in four predominantly English-speaking countries, namely Australia, United States, United Kingdom and Canada; 75% of this dataset was used for scale development and 25% was used for validation. These two split datasets are referred to as the development set and validation set throughout this paper. A second independent dataset collected from a university sample was used for scale validation. All participants

provided written informed consent prior to commencement of data collection. Participants were informed of their right to withdraw from the study at any point during the questionnaire, and to withdraw following completion of the questionnaire using a randomly generated participant code. No personally identifiable information was collected and data were therefore anonymous from the point of collection.

Online panel. As part of the International Gaming Survey 2022, 955 English speaking participants who played video games for at least 3 h per week were recruited through the Nielsen Global Insight online panel in Australia, United States, United Kingdom and Canada. The initial sample screening was completed by Nielsen prior to data collection. This was confirmed by secondary screening within the survey where an exclusionary response to age (<18 years) or hours of video gaming played per week (<3 h) would terminate the survey. Our research team considered that Gaming Disorder among older adults is likely to be manifested differently because of changes in lifestyle and responsibility, therefore, this study focused on participants who were under 65 ($N = 803$). This sample was further split into a development set ($N = 589$; 75% of the data) and a validation set ($N = 214$; 25%).

University recruitment. 408 participants under 30 who played at least 3 h of video games a week were recruited through university newsletters, online course notice boards, and flyers on campus at The University of Queensland. Participants self-selected into the study with information about the inclusion criterion. As with the Nielsen sample, we confirmed that participants met inclusion criteria by collecting age and hours of video game play per week. Participants who did not satisfy the inclusion criteria did not complete the survey and were not included in analysis. Undergraduate psychology students received course credit for their participation.

The sample descriptive statistics are shown in Table 1. The university sample was substantially younger than the online sample, and they are more likely to have higher gaming intensity. A higher proportion of the participants from the online panel were not in education, training or paid employment.

The GADIT scale was developed using the development set from the online panel and validated using the validation set from the panel and the university sample. This can demonstrate the generalisability of our scale to a new sample (university sample) that represented a very different demographic and were recruited using different methodology.

Measures

Gaming disorder items. These 68 items selected by the expert panel comprised 22 for impaired control, 16 for increasing priority, 9 for continued gaming despite harm, and 21 for functional impairment. Each referred to the respondent's experience in the past 12 months, with the exception of the present state items for impaired control which referred to a 3-month period. For impaired control, increasing priority and continued gaming despite harm, the response scale was a 5-point scale "Every day/Most days/Some days/Rarely/Never". There is an additional option "Not applicable" for increasing priority and continued gaming as some items might not be applicable for everyone.

Table 1. Sample characteristics

	Online panel sample		University sample
	Development set ($N = 589$) N (%)	Validation set ($N = 214$) N (%)	Validation analysis ($N = 408$) N (%)
Gender			
Male	261 (44.31)	93 (43.46)	208 (50.98)
Female	325 (55.18)	121 (56.54)	176 (43.14)
Other	3 (0.51)	0 (0.00)	24 (5.88)
Age (M; SD)	40.78 (12.60)	42.88 (13.17)	19.40 (2.45)
Gaming intensity – playing more than 3 h in one session			
Never	69 (11.71)	37 (17.29)	14 (3.43)
Less than monthly	99 (16.81)	40 (18.69)	50 (12.25)
Monthly	135 (22.92)	44 (20.56)	144 (35.29)
2–3 times per week	139 (23.60)	42 (19.63)	123 (30.15)
4 or more times a week	44 (7.47)	17 (7.94)	50 (12.25)
Daily	79 (13.41)	27 (12.62)	21 (5.15)
More than once a day	24 (4.07)	7 (3.27)	6 (1.47)
Location			
Australia	75 (12.80)	17 (7.94)	408 (100)
Canada	119 (20.31)	47 (21.96)	—
USA	264 (45.05)	103 (48.13)	—
UK	128 (21.84)	47 (21.96)	—
Studying/training	71 (12.05)	22 (10.28)	359 (83.88)
In paid employment	359 (60.95)	126 (58.88)	145 (33.88)
Other/Voluntary work	180 (30.56)	72 (33.64)	33 (7.71)

For example, the item "How often have you forgotten or neglected school, college, or other educational activities in order to play video games?" would not be applicable to those who were not studying. "Not applicable" was treated as missing data in all analyses. For functional impairment, the response scale was "Yes/No". A full list of items is shown in Supplementary material 1.

Measures used for validation. Measures used in the validation analysis included the IGDT-10 scale for measuring Internet Gaming Disorder, gaming intensity, physical symptoms, and excessive in-game purchasing. The IGDT-10 scale has demonstrated strong reliability (Cronbach's alpha = 0.97, 0.97 and 0.90 in the training set, validation set, and university sample respectively) and validity in various populations (Király et al., 2019). It corresponds to the diagnostic criteria for Internet Gaming Disorder as defined by the DSM-5. A total score was calculated by summing up the number of criteria met, and a cut-off of 5 or more symptoms was used to represent meeting the cut-off for Internet Gaming Disorder.

Gaming intensity was measured by the frequency of playing for 3+ hours in a single session (Response scale: Never/Less than monthly/Monthly/2–3 times per week/4 or more times a week/Daily/More than once a day). Physical symptoms included self-reports of eye fatigue, hand pain, wrist pain and back or neck pain (Yes/No). Excessive in-game purchasing was measured based on self-reports of having spent more money than they should on making in-game purchases (Yes/No).

Analysis

Scale development. First, four separate confirmatory factor analyses (CFA) were conducted to check the unidimensionality of items for each diagnostic criterion (impaired control, increasing priority, continued gaming despite harm and functional impairment) using the development dataset. All items were specified as ordinal variables for items measured using Likert scale or binary variables for items with binary responses. The analyses were conducted in Mplus 7.3. Weighted least square mean and variance adjusted (WLSMV) estimator was used.

Second, item response theory (IRT) analysis was conducted to estimate the sensitivity of individual items for detecting severe cases in each diagnostic criterion using the development dataset. The generalized partial credit model was used because the items were either ordinal (impaired control, increasing priority and continued gaming despite harms) or binary (functional impairment). For the functional impairment IRT model, item difficulty was the location parameter. Items with higher levels of "difficulty" require individuals to have a higher level of impairment to have a positive response. For impaired control, increasing priority and continued gaming despite harms, item difficulty was calculated as the mean of the four threshold parameters because items for these three diagnostic criteria were measured with a 5-point scale. Items with higher level of "difficulty" require individuals to have a higher level of the underlying diagnostic criterion to have a higher response. The analyses were conducted using the *mirt* package in R (Chalmers, 2012).

Scale validation. Third, the research team selected two items from each diagnostic criterion based on item difficulty and semantics. A CFA was conducted with the 8 selected items using the validation dataset from the online panel and the university sample. Responses from items of impaired control, increasing priority, and continued gaming despite harm were dichotomised: "Every day" and "most days" were coded as "1: positive", "Some days", "Rarely" or "Never" were coded as "0: Negative". Analyses were conducted using the original and dichotomised responses. Cronbach's alphas were also estimated.

Fourth, the IGDT-10 scale, gaming intensity, physical symptoms and excessive in-game purchasing were regressed on the sum of the eight dichotomised items. IGDT-10, gaming intensity and the sum of the eight GADIT items were standardised. For physical symptoms and excessive in-game purchasing, logistic regression analyses were used. We expected our scale to be strongly associated with IGDT-10. Based on existing research that demonstrated the weak to moderate association between gaming intensity and Gaming Disorder, we expected that our new scale would be moderately associated with gaming intensity. We also expected our new scale would be predictive of eye fatigue, hand pain, wrist pain and back or neck pain as these physical symptoms were associated with excessive gaming. Lastly, we expected that our new scale would be predictive of excessive in-game purchasing. In this analysis, we ran separate models on the development sample, the validation sample, and the university sample. Multiple imputation using chained equation was used to replace missing values. Analyses were based on 20 imputed datasets. We also examined different cut-off points for GADIT against the IGDT-10 using a cut-off of 5. Kappa was calculated to assess agreement between GADIT using different cut-offs and the IGDT-10.

Ethics

Approval for the study was granted by The University of Queensland Human Research Ethics Committee (2022/HE000778).

RESULTS

Check for unidimensionality

Model fit statistics from confirmatory factor analysis models of impaired control, increasing priority and functional impairment indicated good model fit (Table 2; all RMSEA<0.08, CFI and TLI >0.99). Model fit from the confirmatory factor analysis model of continued gaming despite harm was satisfactory (RMSEA = 0.095, CFI and TLI >0.99). Factor loadings of all items on their respective factors were strongly significant (all $p < 0.001$). R^2 indicated that a single latent factor explained the majority of variance

Table 2. Confirmatory factor analysis of individual diagnostic criterion

	Impaired control	Increasing priority	Continued gaming despite harms	Functional impairment
RMSEA 90% CI	0.058 (0.052, 0.063)	0.058 (0.047, 0.069)	0.095 (0.071, 0.121)	0.038 (0.031, 0.044)
CFI	0.995	0.997	0.998	0.991
TLI	0.994	0.997	0.996	0.990
Chi-sq (df)	571.44 (209)	146.44 (54)	50.63 (9)	334.31 (189)

in items measuring impaired control (from 70% to 84%), increasing priority (74%–86%) and continued gaming despite harm (78%–88%). A single latent factor explained over 60% variance in 19 of the 21 items measuring functional impairment (from 62% to 92%), this factor explained less but still a substantial proportion of the variance in the remaining two items (46% and 56%). Based on these results, it is therefore reasonable to assume unidimensionality for all the four diagnostic criteria for subsequent item response theory analysis.

IRT analysis for individual diagnostic criterion

All four IRT models fit the data well (RMSEA from 0.028 to 0.072; CFI and TLI all >0.97). Tables 3–6 show the item difficulty for items in descending order. It should be noted that item difficulty can only be compared within each diagnostic criterion but not across. For each diagnostic criterion, we selected two items that were at the middle to high end of difficulty so that the item would have good sensitivity for detecting Gaming Disorder without pathologizing normal gaming. Items were selected through expert discussion

Table 3. IRT analysis for impaired control items

Impaired control items	Item difficulty	Item discrimination
1. How often have others unsuccessfully reduced your involvement with video games?	0.51	2.57
2. How often do you find it really hard not to think about video games when doing other things?	0.48	3.28
3. **How often has anyone else said you have difficulty controlling your gaming (regardless of whether you agreed with them or not)?	0.45	3.23
4. How often do you have difficulty getting the thought of video gaming out of your mind?	0.45	3.02
5. **How often have you been unable to reduce time spent playing video games, even when others repeatedly asked you to play less?	0.45	3.40
6. How often have you made unsuccessful attempts to control, cut down or cease playing video games?	0.44	3.45
7. How often have you spent more money than you intended or could afford on video games?	0.44	2.72
8. How often have you been unable to control the amount of time you spend playing video games?	0.43	3.25
9. How often have you started playing video games even when family or friends asked you to do something else with them?	0.42	2.82
10. How often have you tried to reduce the time spent playing video games but not succeeded?	0.41	2.81
11. How often have you wished to cut down on playing video games?	0.40	3.24
12. How often do you find it hard to stop playing video games even when friends or family call you away or you have to go somewhere?	0.40	3.06
13. How often have you put effort into reducing time playing video games but failed?	0.38	2.94
14. How often do you have strong urges to play video games that you cannot resist?	0.37	2.32
15. How often have you not been able to stop playing video games even when you 16. have spent a lot of time doing so already?	0.36	3.68
17. How often do you have an uncontrollably strong desire to play video games?	0.34	2.95
18. How often do you find it hard to stop playing video games even when there are other things you could or should be doing?	0.33	2.52
19. How often when playing video games do you find it difficult to stop?	0.32	2.76
20. How often have you continued to play video games, despite intending to stop?	0.32	2.64
21. How often have you felt you play video games too frequently?	0.29	2.46
22. How often have you played video games more frequently than you intended?	0.24	2.52
23. How often have you spent playing video games longer than you intended?	0.15	1.98

IRT model fit statistics: RMSEA = 0.028, 90% CI (0.019, 0.037), CFI = 0.994, TLI = 0.993. Selected items were marked with **. These two items were selected because both have high item difficulty and item discrimination. We have also considered other items with similar item difficulty and discrimination, but we considered the language of the two selected items are simpler. For example, we have considered item 4 in an initial stage, but the concept of "getting the thought of video gaming out of your mind" could be challenging to translate for other languages.

Table 4. IRT analysis for increasing priority items

Increasing priority items	Item difficulty	Item discrimination
1. **How often have you been at risk of losing an important relationship because of playing video games?	0.72	2.57
2. How often have you forgotten or neglected your family because you were playing video games?	0.64	3.26
3. How often have you forgotten or neglected important friendships in order to play video games?	0.64	3.08
4. How often have you forgotten or neglected your friends because you were playing video games?	0.59	3.71
5. **How often are you so immersed in video games that you forget to eat?	0.58	2.26
6. How often have you forgotten or neglected other hobbies in order to play video games?	0.54	2.53
7. How often has your enjoyment of other activities been less than previously because of your playing video games?	0.54	3.00
8. How often have you spent less time with friends, your partner or family in order to play video games?	0.52	3.27
9. How often have you experienced that playing video games is the first thing that comes to your mind when you wake up from sleep?	0.52	1.94
10. How often have you forgotten or neglected home tasks and responsibilities in order to play video games?	0.51	2.42
11. How often have you neglected your own health because of playing video games (for example not getting enough sleep, showering less, failing to brush teeth, drinking insufficient fluids)?	0.51	2.87
12. How often have you lost interest or reduced participation in hobbies or meeting up with friends because you were playing video games?	0.50	3.65

Model fit statistics: RMSEA = 0.032, 90% CI (0.000, 0.057), CFI = 0.985, TLI = 0.975. Selected items were marked with **. The two items were selected because they have high item difficulty and satisfactory item discrimination. Items 2, 3 and 4 were similar to item 1, and were not selected.

Table 5. IRT analysis for continued gaming despite harms items

Continued gaming despite harm items	Item difficulty	Item discrimination
1. **How often have you played video games even though you knew this was causing problems with your family or friends?	0.58	3.88
2. How often have you continued to play games even though you were having arguments with others about your gaming?	0.53	2.81
3. How often have you continued playing video games despite knowing it was causing problems between you and other people?	0.52	3.58
4. How often have you continued to play video games despite issues with your friendships, your family, study (at school or elsewhere), or work because of your gaming?	0.50	4.18
5. How often have you continued to play games even though you were aware of not getting enough sleep?	0.43	2.01
6. **How often have you continued to play video games despite it adversely affecting your health (for example, shoulder pain, poor vision)?	0.43	2.12

Model fit statistics: RMSEA = 0.072, 90% CI (0.045, 0.102), CFI = 0.99, TLI = 0.991. Selected items were marked with **. Item 1 was selected because of high item difficulty and item discrimination. Item 2, 3 and 4 were all about relationship, which were similar to item 1. Item 5 and 6 were both health-related. Item 6 was selected because we considered the scope of item 6 was broader and could potentially capture more harms.

and consensus (GC - biostatistician, DS - neuroscientist, JL - epidemiologist, JS – addiction medicine specialist, JC – clinical psychologist, AW – clinical psychologist, LH – clinical psychologist), which was based on item difficulty index, semantics of the items, meaning and applicability to the broad range of population. For example, for functional impairment, despite having a high difficulty level, the item "Has video gaming got you into trouble in school, college, study or work?" was not preferred because it might not be applicable to those who were not in education, training and employment. For continued gaming despite harms, we selected an item at the relatively lower end, which still had moderate difficulty and good discrimination, because several other items were measuring relationship problems with other people, which had already been captured by another selected item.

CFA for the eight selected items

CFA of the eight selected items using the validation sample and university sample, in both original and dichotomised

Table 6. IRT analysis for functional impairment items

Functional impairment items	Item difficulty	Item discrimination
1. I have no hobbies other than video gaming.	0.93	1.76
2. Has video gaming got you into trouble in school, college, study, or work?	0.92	4.33
3. Has video gaming caused serious problems with school, college, study, or work?	0.90	4.52
4. Has video gaming caused significant distress because of financial losses?	0.84	4.55
5. **Nothing else interests me apart from playing video games.	0.83	3.32
6. Have you risked or lost an important relationship or friendship because of playing video games?	0.82	4.72
7. I have nothing else to do besides playing video games.	0.81	2.36
8. **Has playing video games caused significant mental stress for someone close to you?	0.80	4.03
9. Have you experienced changes in your appetite or weight due to playing video games?	0.78	3.66
10. Has your mental health been negatively affected by playing video games (for example, feeling anxious, sad or irritable)?	0.76	3.31
11. Have you argued with parents, relatives or friends because you were spending a lot of time playing video games?	0.75	3.32
12. Have you experienced any decrease in your self-care, hygiene or appearance?	0.72	3.09
13. Has playing video games prevented you from eating regular meals?	0.72	2.82
14. Has playing video games caused significant distress (for example guilt, anxiety, annoyance, or depression) for you?	0.68	3.72
15. Has video gaming negatively affected your work or home duties?	0.67	3.42
16. Has your involvement in video games caused problems in your relationship with your partner, friends, or family?	0.67	4.30
17. Has your social life (real life or off-line life) suffered because you were playing video games?	0.65	3.19
18. Video gaming has become the most time-consuming activity in my life.	0.62	3.72
19. Has your sleep been negatively affected by playing video games (for example, having trouble getting to sleep or staying asleep)?	0.43	2.23
20. Have you experienced physical problems (for example, headache, neck stiffness, back pain, fatigue) because of playing video games?	0.41	2.07

Model fit statistics: RMSEA = 0.050, 90% CI (0.044, 0.057), CFI = 0.990, TLI = 0.988. Selected items were marked with **. Item 5 and 8 were selected because of high item difficulty and item discrimination. We have considered item 1, 2, 3, 4, 6 and 7. Item 1 and 7 have relatively low item discrimination; item 2 and 3 would miss people who were Not in Education, Employment and Training (NEET), and this group was very likely to be at high risk of gaming disorder. Item 4 was about financial loss and might not be applicable to younger people. Item 6 was similar to an item selected to measure continued gaming despite harms.

responses, show satisfactory to excellent model fit (Table 7; RMSEA from 0.000 to 0.108, CFI and TLI >0.97). All items loaded strongly onto a single latent factor (Supplementary Table 1). The internal consistency of the eight items, in both original and dichotomised scale, were high. Since the dichotomised version is likely to be easier to administer and score, we will focus on using the dichotomised items for the subsequent validation analyses.

Validation analyses

The findings from the validation regression analyses were largely consistent with our expectation (Table 8). Our scale was strongly associated with IGDT-10 in all three datasets (standardised b = 0.68 to 0.78, all $p < 0.001$). The association between our scale and gaming intensity was highly statistically significant, but the association was, as anticipated, weaker (standardised b = 0.25 – 0.28, all $p < 0.001$). In general, our scale was associated with all physical symptoms and excessive in-game purchases.

For IGDT-10, it was recommended that a cut-off of 5 was used to detect Internet Gaming Disorder. Table 9 shows the crosstabulation between GADIT with various cut-off and IGDT-10 with a cut-off of 5. When both IGDT-10 and GADIT, capturing DSM-5 and ICD-11 diagnoses respectively, were dichotomised, the agreement between the

Table 7. Confirmatory factor analysis using the validation set and a separate sample recruited from university

Confirmatory Factor Analysis	Validation set		University sample	
	In original measurement scale	All binary	In original measurement scale	All binary
RMSEA 90% CI	0.108 (0.081, 0.137)	0.062 (0.027, 0.094)	0.072 (0.052, 0.093)	0.000 (0.000, 0.038)
CFI	0.991	0.990	0.980	1.00
TLI	0.988	0.986	0.972	1.00
Chi-sq(df)	69.20 (20)	36.21 (20)	62.16 (20)	18.00 (20)
Cronbach's alpha	0.92	0.88	0.81	0.77

Table 8. Regression analyses

	Predictor: Gaming Disorder 8 items					
	Development sample		Validation sample		University sample	
Outcome	b	95% CI	b	95% CI	b	95% CI
IGDT 10	0.78	(0.73, 0.84)	0.77	(0.68, 0.86)	0.68	(0.61, 0.75)
Gaming intensity	0.26	(0.18, 0.34)	0.28	(0.14, 0.41)	0.25	(0.15, 0.34)
	OR	95% CI	OR	95% CI	OR	95% CI
Eye fatigue	1.32	(1.08, 1.60)	1.32	(0.97, 1.79)	1.31	(1.01, 1.69)
Hand pain	1.62	(1.33, 1.98)	1.42	(1.03, 1.95)	1.37	(1.11, 1.70)
Wrist pain	1.81	(1.48, 2.22)	1.43	(1.03, 1.98)	1.42	(1.14, 1.76)
Back or neck pain	1.38	(1.14, 1.69)	1.46	(1.06, 2.00)	1.18	(0.92, 1.51)
Excessive in-game purchase	2.47	(1.95, 3.13)	2.49	(1.68, 3.69)	1.47	(1.19, 1.83)

All estimates were adjusted for gender and age. In the development and validation sample, we also adjusted for location.

two scales, as measured by absolute percentage, was satisfactory. For example, of those with a GADIT score 5 or above, 79%, 90% and 75% also met the cut-off of the IGDT-10 in the development set, validation set and the university sample respectively. The kappa statistics, although all statistically significant, were between 0.4 and 0.7 across datasets and various GADIT cut-off, indicating moderate to substantial agreement. The weaker agreement as measured by kappa is likely due to the difference in the definition of Internet Gaming Disorder in the DSM-5 and Gaming Disorder in ICD11.

DISCUSSION

In this study, we developed and assessed the psychometrics of the GADIT, an 8-item screening tool of Gaming Disorder under the ICD-11 definition. We did this by evaluating the suitability of 297 assessment items from 48 existing scales for Gaming Disorder or gaming addiction. Using participants recruited from Australia, United States, United Kingdom and Canada, we identified eight items that mapped on to the four diagnostic criteria for Gaming Disorder, and validated them using samples from an online panel and a university-recruited sample. These items displayed very strong psychometric properties. IRT analyses demonstrated that each item was sensitive in detecting the respective diagnostic criterion at a moderate to high level of severity, thus reducing the likelihood of pathologizing healthy gaming behavior. CFA analyses demonstrated that they were strongly and consistently loaded on to a latent factor and that such a factor structure was not affected by response scale (5-point or dichotomised). In addition, as expected, regression analyses demonstrated that our scale was strongly associated with the ten-item Internet Gaming Disorder Test (IGDT-10), moderately with a range of physical symptoms that were associated with excessive gaming, moderately with excessive in-game purchasing, and weakly but statistically significantly with gaming intensity, all of which supported the validity of the GADIT scale. Further, we demonstrated that it could be generalised beyond the initial sample (online panel) that was used for item selection.

For the purpose of screening for Gaming Disorder, our scale could be used with dichotomised responses to maximise ease of administration. While the diagnosis of Gaming Disorder requires all four criteria to be met, we recommend a cut-off of 5 for our scale for screening purposes. It is then straightforward for diagnostic purposes to check on whether all four criteria have been met. In addition, although we have identified two items with strong psychometric properties for each diagnostic criterion, it is possible that some aspects of each diagnostic criterion were not captured. For example, with the rise of streamlined in-game purchasing or "microtransactions" (for virtual goods or to facilitate game progression), individuals addicted to gaming may suffer substantial financial loss (King & Delfabbro, 2019). The impact of gaming on personal finance is becoming more severe, as leading game publishers now have deployed patented, monetisation schemes that incentivise in-game spending (King & Delfabbro, 2019).

One of our initial assessment items for functional impairment measured the impact of financial loss due to gaming. We decided not to include this item in our final selection because financial loss may be less applicable to a younger population who are not yet in full time employment. We acknowledge that this is an important aspect of Gaming Disorder that is not captured in our scale. Since our scale is a screening tool, we recommend prioritising the reducing false negatives over false positives. Given that IRT analyses showed that the selected items were in general more sensitive in detecting the moderate to severe end of each diagnostic criterion, we considered that 5 positive responses to our 8 items should be considered as a positive case for further clinical assessment. Future research on GADIT will need to focus on benchmarking against clinician diagnosis to confirm the optimal cut-off point in different populations. Table 10 shows the full GADIT with explanatory note.

Strengths

The key strengths of our study include (1) its focus on the ICD-11 diagnosis of Gaming Disorder, as issued by WHO, (2) multi-country data collection, (3) use of multi-disciplinary expertise (clinical psychology, addiction medicine,

Table 9. Comparison against IGDT-10 using different cutoff

		Development set						Validation set						University sample					
		IGDT-10						IGDT-10						IGDT-10					
		Below 5		5+		Overall		Below 5		5+		Overall		Below 5		5+		Overall	
		N	%[#]	N	%[#]	N	%[^]	N	%[#]	N	%[#]	N	%[^]	N	%[#]	N	%[#]	N	%[^]
GADIT	Below 4	282	93.69	19	6.31	301	74.68	102	87.93	14	12.07	116	80.00	264	93.62	18	6.38	282	91.56
	4 or above	29	28.16	74	71.84	103	25.32	6	20.69	23	79.31	29	20.00	10	38.46	16	61.54	26	8.44
	Kappa	0.67						0.60						0.48					
	Below 5	296	89.43	35	10.57	331	81.93	106	84.80	19	15.20	125	86.21	270	92.47	22	7.55	292	94.81
	5 or above	15	20.55	58	79.45	73	18.07	2	10.00	18	90.00	20	13.79	4	25.00	12	75.00	16	5.19
	Kappa	0.62						0.55						0.44					
	Below 6	302	86.53	47	13.47	349	86.39	107	82.95	22	17.05	129	88.97	274	91.33	26	8.67	300	97.40
	6 or above	9	16.36	46	83.64	55	13.61	1	6.25	15	93.75	16	11.03	0	0.00	8	100.00	8	2.60
	Kappa	0.54						0.48						0.35					
	Overall	311	76.98	93	23.02			108	74.48	37	25.52			274	88.96	34	11.04		

[#]Row percentages sum to 100%; [^]Column percentages sum to 100%.

Table 10. The Gaming Disorder Identification Test (GADIT). Please select the appropriate answer for each question in relation to your gaming behaviour over the last 12 months

No.	Question items	Answer				
		Every day	Most day	Some days	Rarely	Never
1	Has anyone else said you have difficulty controlling your gaming – whether you agreed with them or not?					
2	Have you been unable to reduce time spent playing video games – even when others have asked you to play less?					
3	Have you been at risk of losing an important relationship because of playing video games?					
4	Have you been so immersed in video games that you forget to eat?					
5	Have you continued playing video games even though you knew this was causing problems with your family or friends?					
6	Have you continued to play video games despite it adversely affecting your health - for example, shoulder pain, poor vision?					
		Yes			No	
7	Has playing video games caused significant mental stress for someone close to you?					
8	Nothing else interests me apart from playing video games.					

A total score of 5 or more suggests the presence of the ICD-11 gaming disorder. For item 1 to 6, "Everyday" and "Most day" are scored 1; all other responses are scored 0. For item 7 and 8, "Yes" is scored 1 and "No" is scored 0.

ICD-11 Gaming Disorder

Gaming disorder, predominantly online, is characterised by a pattern of persistent or recurrent gaming behaviour ('digital gaming' or 'video-gaming') typically evident over at least 12 months, that is manifested by:

1. impaired control over gaming;
2. increasing priority given to gaming over other life interests and daily activities;
3. continuation of gaming despite negative consequences; and
4. The behaviour pattern is of sufficient severity to result in significant impairment in personal, family, social, educational, occupational or other important areas of functioning.

neuroscience, epidemiology and biostatistics) in initial item appraisal and selection, (4) rigorous psychometric analysis methods for final item selection, and (5) the use of two separate samples to demonstrate generalisability. A key strength of GADIT compared to two existing instruments, the Gaming Disorder Test (Pontes et al., 2021) and the GAMES (Higuchi et al., 2021), was that we have (i) selected a candidate set of items from a large number of items from existing scales on gaming addiction and unhealthy gaming, (ii) applied a range of statistical methods to select the best set of items that were sensitive in detecting moderate to severe level of each ICD-11 diagnostic criterion, and (iii) validated them using two independent samples collected using different methodologies.

Limitations

This study has certain limitations. First, similar to many other questionnaires for unhealthy gaming, our sample is not a random population one. We sought enriched samples by imposing a threshold of three hours gaming per week on both the panel and the university-recruited sample. We have also addressed this by having two validation samples. Samples from the two populations were obtained using different recruitment methods and from different demographics. The GADIT's excellent psychometric properties in both samples demonstrates its potential to be generalised to a broader population. Second, our study was based on cross-sectional data collection, and we were not able to conduct test-retest reliability analysis. Third, our scale captures two important aspects of each diagnostic criterion; other aspects, including financial losses were not captured. This is unlikely to undermine GADIT as a screening tool because the two items we selected were sensitive at detecting each diagnostic criterion at a moderate to severe level. As justified above, we concluded that using a cut-off of 5 served the purpose of a screening tool without inflating the false positive rate excessively. However, future research with a clinical sample and diagnosis will be needed to further verify and potentially recalibrate the cut-off. Finally, it was not possible for us to recruit and perform gold standard validation of our tool in a clinical sample. Future work that recruits a sample of individuals that do and do not meet the diagnostic criteria set out in the ICD-11 will be necessary to address this limitation.

CONCLUSION

From an initial pool of 297 items, we have selected two items for each of the four diagnostic criteria for Gaming Disorder defined by the ICD-11 to form the 8-item Gaming Disorder Identification Test (GADIT, English version). Our scale has

strong psychometric properties and has been validated against existing scales and variables that are associated with Gaming Disorder. Our scale has been evaluated in two independent samples from four countries, providing evidence that it could be generalised to populations beyond those used for its development. This now sets the scene for independent validation studies against diagnoses of gaming disorder, examining the cross-cultural applicability of the questions and cut-off scores for different countries and cultural and socio-demographic groups.

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Conflicts of interest: Daniel King is an Associate Editor of the Journal of Behavioral Addiction. The other authors declare no conflict of interest.

SUPPLEMENTARY MATERIALS

Supplementary data to this article can be found online at https://doi.org/10.1556/2006.2024.00038.

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