RESEARCH ARTICLE

The gaming problem: A latent class analysis of DSM-5 criteria for Internet Gaming Disorder in a non-clinical sample [version 1; peer review: 1 approved with reservations, 1 not approved]

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Abstract

Background: In this study we aimed to test whether suggested DSM-5 criteria for Internet Gaming Disorder (IGD) share a similar latent structure to formally recognised addiction.
Methods: We used latent class analysis on a dichotomous measure of IGD. The data was collected from a convenient general population sample (500) and a targeted gaming forum sample (236).
Results: We found a four or six-class model to be most appropriate, ranging from '*casual/non-gamer*' to '*potentially disordered*' with increasing symptom severity. The majority of '*potentially disordered*' gamers (5+ criteria) were found to be 18-30 years old, and no '*potentially disordered*' gamers were over 42.
Conclusions: The results suggest that gaming may share a similar latent structure to established addictions, with adolescents and young adults being more at risk. Studies replicating these results would be beneficial, with further emphasis on a critical evaluation of the criteria and symptom cut-off point.

Keywords

Gaming, Internet Gaming Disorder, Pathological Gaming, Latent Class Analysis, Addiction, Behavioural Addiction

This article is included in the Addiction and Related Behaviors gateway.

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Open Peer Review

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Abbreviations

AIC: Akaike Information Criteria
BIC: Bayesian-Information Criteria
DSM: Diagnostic and Statistical Manual
GD: Gaming Disorder
ICD: International Classification of Diseases
IGD: Internet Gaming Disorder
LR: Likelihood Ratio

Introduction

Gaming Disorder (GD) was recently recognised by the World Health Organization (2020) as a behavioural addiction in the eleventh edition of the International Classification of Diseases (ICD-11), while the apparently synonymous Internet Gaming Disorder (IGD) is not recognised diagnostically, but was included in the Diagnostic and Statistical Manual (DSM-5) to foster research in the area (American Psychiatric Association, 2013).

A comparison of both systems in Mexico found that prevalence estimates of the DSM were almost twice as high as the ICD (Borges *et al.*, 2021). Similarly, Jo *et al.* (2019) found that while all ICD-11 cases were found by the DSM-5, not all DSM-5 cases were found by the ICD-11. This could suggest that the current DSM-5 criteria are too inclusive, or that the ICD-11 criteria are not sensitive enough. We have focused this study on the DSM-5 criteria, since evidence has shown the measure to have robust psychometric properties (Lemmens *et al.*, 2015). In addition, Aarseth *et al.* (2017) highlighted a number of concerns with the inclusion of GD in the ICD-11.

Previous studies on gaming have been inconsistent in classification, and results on prevalence, course, treatment, and biomarkers have been inconclusive (Petry *et al.*, 2014). Many researchers believe that gaming can become problematic (Charlton & Danforth, 2007; Gentile, 2009), while some are cautious (James & Tunney, 2017) and do not regard IGD as a genuine behavioural addiction. Some of the concerns highlighted by Aarseth *et al.* (2017) around gaming in the ICD-11 are relevant to the IGD, and these suggest that the introduction of gaming in any diagnostic manual is premature. In fact, Przybylski and Weinstein (2019) suggested that disordered gaming may actually be a symptom of a different underlying issue.

Latent class analyses help researchers to determine the number and type of classes a potential disorder may be split into, however the results are generally a function of the sample characteristics, and so may not be representative of 'definite' classes. Despite this, we can examine the classes found across several studies and see that research on problem gambling typically reports a three- (Chamberlain *et al.*, 2017; James *et al.*, 2016; McBride *et al.*, 2010) or four-class pattern (Kong *et al.*, 2014; Xian *et al.*, 2008), with increasing severity between classes. Similarly, substance use has been found to fit a three-class (Cohn *et al.*, 2017; Evans *et al.*, 2020; Henry & Muthen, 2010; Safiri *et al.*, 2016), or four-class model (Morean *et al.*, 2016; Yu *et al.*, 2018), categorised by severity. Interestingly, Deleuze *et al.* (2015) investigated both behavioural and substance addiction and found three theoretical subgroups. These included addiction-prone individuals, at-risk users, and not-prone individuals. They noted that although only a small sample of participants reported gaming, it was associated with loss of control and negative outcomes over half of the time.

Previous research into IGD has found a similar three-class model (Lemmens *et al.*, 2015; Peeters *et al.*, 2019), with Peeters *et al.* (2019) suggesting that the DSM-5 criteria could be helpful in identifying what they called 'problematic' gamers. However, they note that a strict cut-off point could lead to false positives. In contrast, Myrseth and Notelaers (2018) found a five-class model using the Gaming Addiction Scale-Adolescents. Despite this, Deleuze *et al.* (2017) determined in their study that a two-class system was more able to distinguish between 'problematic' and 'regular' gamers. This dichotomous outcome hints at gaming being different to established addiction disorders and suggests a need for more research into how gaming compares to formally recognised addictions.

The listed studies either used a small sample, did not include adults, or used non-DSM criteria. Although Clement (2021) reported that most gamers in the UK during 2019 were young adults (16-24), a significant number were older. In fact, 52% aged 25-34 were identified as gamers, 36% aged 35-44, and 40% aged 45-54. This would suggest that including a range of ages in gaming analysis could be beneficial.

Methods

Design

Using data collected from a cross-sectional online survey we conducted latent class analysis of DSM-5 criteria for IGD. Data was collected from a sample of adults (18+) to provide evidence towards whether IGD has a similar class structure to established addictions.

Participants
Five-hundred participants from the general population were recruited using convenience sampling through prolific.com in return for £7.50 (US$10.02). There were 244 females, 250 males, and six selected the option 'other'. The average age was 29.67 years (*sd* = 10.04). A further 236 participants were recruited from online gaming forums (Discord and Reddit). Eighty-two were female, 139 were male, seven selected 'other', and five did not answer. The average sample age was 25.41 years (*sd* = 6.52).

Procedure
Potentially problematic symptoms associated with gaming were measured using nine dichotomous (Yes/No) items from the IGD scale (Lemmens *et al.*, 2015), based on the diagnostic criteria of IGD described in the DSM-5 appendix. The survey was hosted at Qualtrics.com as part of a preregistered study (Raybould & Tunney, 2020) that gained ethical approval from the Aston University ethics committee. The targeted gamer sample also completed the IGD questions at Qualtrics.com in a study approved by Aston University.

Statistical analysis
We conducted latent class analysis on the samples separately using poLCA in RStudio (Linzer & Lewis, 2011), and then combined samples to examine IGD distribution across non-gamers, casual gamers, and dedicated gamers as a whole. Following this, we analysed the relationship between age and gaming using regression and descriptive statistics.

Ethical approval
Ethical approval [Ref: 1598] was granted by the Aston University ethics committee. All methods were carried out in accordance with relevant guidelines and regulations. Written informed consent was obtained from all participants.

Pre-printing
An earlier version of this article can be found on Research Square (doi: 10.21203/rs.3.rs-1003239/v1).

Results
Latent class analysis of the separate samples (Tables 1 & 2) suggested a two-, four-, or five-class model in the general population, and a two-, four- or six-class model in the gaming sample. The lowest Bayesian-Information Criteria (BIC),

Table 1. Model fit for latent class analysis of gaming data in a general population sample.

	2 Classes	3 Classes	4 Classes	5 Classes	6 Classes
AIC	3221.108	3147.275	3140.409	3146.423	3154.588
BIC	3301.185	3269.498	3304.778	3352.938	3403.250
G^2	340.4032	246.5705	219.7043	205.7183	193.8838
X^2	977.2995	480.3543	523.5736	576.3231	401.1686
Df	481	471	461	451	441
p	.000	.373	.023	.000	.913

Notes: Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), G^2 Likelihood-Ratio (G^2), Pearson X^2 (X^2), Degrees of Freedom (Df), and significance (*p*) are presented to analyse model fit for two to six latent classes. Analysis was conducted on Internet Gaming Disorder (DSM-5) data in a general population.

Table 2. Model fit for latent class analysis of gaming data in a gaming forum sample.

	2 Classes	3 Classes	4 Classes	5 Classes	6 Classes
AIC	1969.802	1963.023	1960.944	1966.664	1971.174
BIC	2035.615	2063.474	2096.033	2136.391	2175.54
G^2	213.4089	186.6297	164.5502	150.2703	134.7806
X^2	478.2925	493.4909	467.759	436.2665	369.5004
Df	217	207	197	187	177
p	.000	.000	.000	.000	.000

Notes: Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), G^2 Likelihood-Ratio (G^2), Pearson X^2 (X^2), Degrees of Freedom (Df), and significance (*p*) presented to analyse model fit for two to six classes. Analysis was conducted on Internet Gaming Disorder (DSM-5) data in a targeted gaming forum population.

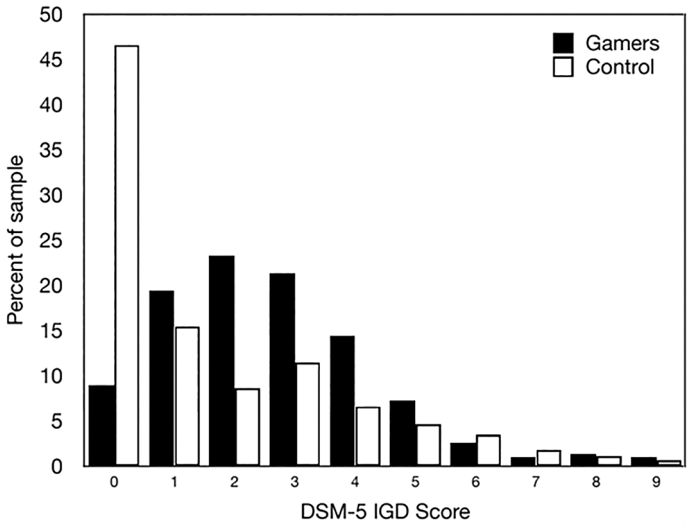

Figure 1. Distribution of IGD criteria in a General Population and Gaming forum sample.

Akaike Information Criteria (AIC), and Likelihood ratio (LR) indicated different models, suggesting high model uncertainty.

We then compared the distribution of participant responses (Figure 1) and found left-skewed results for both samples, with a more normal distribution in the gamers. This suggests that a large number of the general population were casual/non-gamers, while most of the gaming sample scored 2-3 checklist items. Interestingly, participants scoring 5+ were similar in both samples, suggesting an equal share of potential candidates for diagnosis (Raybould *et al.*, 2022).

We repeated class analysis in the combined sample, testing model fit up to six classes since the BIC was consistently larger (Table 3). The three- and five-class models failed to reach significance, whereas the two-, four-, and six-class models were significant. The lowest BIC indicated a four-class model, however the lowest AIC and LR suggested six-classes. We therefore analysed both in more detail (Table 4).

A '*casual/non-gamer*' class (1) with low likelihood of symptoms, and '*potentially disordered*' class with high likelihood of all symptoms (4/6) was present in both models. In the four-class model we found a group who are more likely than not to be preoccupied with gaming and use games to escape (2: '*mild gamer*'), and a group who are additionally likely to be unable to stop and have lost interest in other hobbies (3: '*at-risk*'). Similarly, the six-class model included class 2 '*mild gamers*', and '*at-risk*' gamers as class 4. In addition, we found class 3 '*moderate gamers*' who are likely to be preoccupied, gaming to escape, and have withdrawal, and class 5 '*borderline*' gamers who are likely to be preoccupied, increasing play, playing despite life impact, lying and gaming to escape. Averaged probability scores suggest a potential path of increasing severity in the four-class (1 – 0.036; 2 – 0.290; 3 – 0.434; 4 – 0.755), and six-class model (1 – 0.033; 2 – 0.268; 3 – 0.399; 4 – 0.476; 5 – 0.604; 6 – 0.850). To check the validity of this we asked R to predict participant class (Tables 5 and 6), and cross-tabulated predictions against IGD scores (Table 7).

Table 3. Model fit for latent class analysis of gaming data in a combined sample.

	2 Classes	3 Classes	4 Classes	5 Classes	6 Classes
AIC	5441.266	5310.379	5290.404	5287.812	5289.223
BIC	5528.689	5443.815	5469.852	5513.273	5560.695
G^2	472.8254	321.9388	281.9641	259.3721	240.7824
X^2	1730.994	478.5486	679.2437	469.0852	632.6213
Df	492	482	472	462	452
p	.000	.536	.000	.400	.000

Notes: Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), G^2 Likelihood-Ratio (G^2), Pearson X^2 (X^2), Degrees of Freedom (Df), and significance (*p*) presented to analyse model fit for two to six classes. Analysis was conducted on Internet Gaming Disorder (DSM-5) data in a combined general and targeted gaming forum population.

Table 4. Probability of positive response to IGD Questions based on a four- and six-class latent analysis model.

Item	1	2	3	4	1	2	3	4	5	6
Preoccupation	0.051	**0.595**	**0.626**	**1.000**	0.052	**0.536**	**1.000**	**0.628**	**0.826**	**1.000**
Withdrawal Symptoms	0.000	0.117	0.163	**0.825**	0.000	0.026	**1.000**	0.156	0.495	**1.000**
Increased Gaming	0.005	0.278	0.184	**0.817**	0.004	0.252	0.312	0.164	**1.000**	**0.748**
Unable to Stop	0.005	0.054	**0.651**	**0.659**	0.005	0.054	0.000	**0.631**	0.216	**0.919**
Lost Interest in Hobbies	0.119	0.299	**0.526**	**0.528**	0.116	0.308	0.129	**0.543**	0.149	**0.724**
Play despite Life Impact	0.029	0.431	0.428	**0.784**	0.026	0.423	0.396	**0.825**	**0.816**	**1.000**
Lying	0.019	0.057	0.428	**0.784**	0.021	0.022	0.066	0.427	**1.000**	**0.694**
Escape	0.092	**0.781**	**0.707**	**1.000**	0.073	**0.787**	**0.687**	**0.712**	**0.930**	**1.000**
Relationship Issues	0.000	0.000	0.193	0.401	0.000	0.000	0.000	0.202	0.000	**0.567**

Notes: Probability values above 0.5 are highlighted in bold for reference.

Table 5. Participant class predictions for a four-class latent structure.

	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9 0
[1]	1 1 1 2 1 4 2 2 2 4	1 1 1 1 1 4 2 3 1 1	3 2 2 1 2 2 1 2 1 1	2 1 1 1 3 1 1 2 3 2	1 1 1 1 2 2 1 1 1 1
[51]	1 2 1 1 1 1 4 3 2 1	1 1 1 3 2 1 4 1 3 2	1 2 4 1 2 1 1 1 1 4	1 1 2 1 2 1 1 1 1 2	1 1 1 1 1 1 2 1 1 1
[101]	1 2 1 1 1 1 1 1 2 2 1	2 1 2 2 3 2 1 2 1 3	1 1 1 1 1 2 3 2 1 2	1 1 2 1 2 1 3 3 2 1	1 1 1 3 1 1 1 1 1 1
[151]	1 1 2 4 1 1 1 1 2 1	2 1 1 1 1 2 1 2 2 2	1 2 1 1 1 4 1 2 1 1	1 2 1 3 2 2 1 1 2 1	1 1 1 3 1 2 2 2 1 1
[201]	1 1 1 1 1 2 1 1 2 2	1 2 1 1 1 1 2 4 3 1 1	3 2 3 1 2 1 2 4 1 1	3 1 3 1 1 1 1 1 1 1	2 1 1 3 1 2 1 1 2 1
[251]	1 1 1 1 1 1 1 1 4 1 2	1 1 3 1 1 1 2 2 3 1	1 4 3 1 1 2 2 1 1 1	1 1 2 2 2 1 2 2 1 1	1 1 1 1 1 1 1 1 1 1
[301]	2 1 2 1 1 1 2 1 1 3	1 1 1 1 1 1 1 1 1 1 1	1 1 1 1 3 1 1 2 2 1	3 1 2 1 2 4 2 4 1 3	2 1 1 1 2 1 1 2 1 1
[351]	4 1 1 1 4 3 1 2 2 2	1 1 1 1 1 2 2 1 3 1	1 1 1 1 1 1 1 1 1 2 4	2 2 1 2 1 2 1 1 1 2	2 1 1 2 1 2 1 2 2 1
[401]	2 1 2 2 2 1 1 1 1 1	1 4 1 1 1 2 1 1 4 4	2 1 1 1 1 1 4 1 2 2	4 2 1 1 3 1 1 1 1 2	1 2 1 1 1 3 2 2 1 1
[451]	1 1 3 2 1 1 1 1 2 1	1 1 1 1 2 3 1 1 1 1	4 2 2 2 1 1 1 2 1 1	1 1 1 1 1 3 1 1 4 3	3 1 2 2 1 1 1 2 4 3
[501]	4 4 4 4 4 4 4 3 3 3	4 4 3 3 3 3 3 3 3 3	3 3 3 3 3 3 3 3 2 3	2 3 3 2 2 3 2 2 2 2	2 3 2 2 3 3 2 3 2 2
[551]	3 3 3 2 3 2 3 3 2 2	2 2 2 2 2 2 2 2 2 2	2 2 2 2 2 2 2 2 2 2	2 2 2 2 2 2 2 2 2 3	3 2 2 2 2 2 3 2 2 2
[601]	2 2 2 2 2 2 2 2 2 2	2 2 2 2 2 2 2 2 2 2	2 2 2 2 2 2 2 2 2 2	2 2 2 2 2 2 2 2 2 2	2 2 2 2 2 2 2 2 2 2
[651]	2 2 2 2 2 3 2 2 2 2	2 2 2 2 2 2 2 2 2 1	1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1
[701]	1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1 1 1 1 1	1 1 1 1 1 1	

Note: Analysis of participant classification in a four-class latent structure model using $M4$predclass in R.

Age related to IGD Score ($F_{1,735} = 68.373$, $R^2 = .085$, $p = .000$), and accounted for 9% of symptom variation. We found that 15.65% of participants aged 18-20 selected 5+ criteria, compared to 13.75% aged 21-30, 8.28% aged 31-40, 4.44% aged 41-50, and 0% over 50. Further analysis on average results by age found that participants 18-20 were more likely to have mild symptoms and a higher mean IGD score (Table 8).

Despite this, 71.43% (four-class) and 63.64% (six-class) of '*potentially disordered*' gamers were over 21, while only 17.14% (four-class) and 14.63% (six-class) were over 30. There were none over the age of 42. This suggests that while some older adults display potentially disordered gaming, young adults appear more at risk.

Discussion

The criteria for IGD appears to have a four- or six-class structure ranging from '*casual/non-gamers*' to '*potentially disordered*' with increasing severity, suggesting that IGD may be presenting in a similar manner to established

Table 6. Participant class predictions for a six-class latent structure.

	1234567890	1234567890	1234567890	1234567890	1234567890
[1]	1122162226	1111142411	4221521211	5111411544	1121221111
[51]	1212115421	1114216142	1261211116	1121211122	1111112121
[101]	1511211221	2122421214	1111124212	1121214421	1114211111
[151]	1155111221	2111121252	1211261312	1314222121	1114122211
[201]	1111221153	1411126411	4241213611	4141111111	5114121121
[251]	1111111512	1141112242	1541122111	1122212221	1111111111
[301]	2121112114	1111111111	1111411221	4122255614	2211211211
[351]	6111641234	1112122141	1111111126	3212122112	2212121221
[401]	2152311111	1511131256	2111115122	5211411212	1211142311
[451]	1142111121	1111241111	6222122211	1111142154	4122111244
[501]	6666666444	5644444444	4444444424	2443242232	2422443432
[551]	4442434432	3533222222	2232324222	3422222224	4223224222
[601]	2222223222	2223222223	2222222222	2222222222	2222222222
[651]	2232242222	2222222222	2121111212	2222212122	1111112111
[701]	1121112122	2211111111	1111111111	111111	

Note: Analysis of participant classification in a four-class latent structure model using $M4$predclass in R.

Table 7. Number of identified criteria and most common igd score for each latent class.

Model	Class	Number of criteria	Most common IGD score(s)
4	1 - *Casual/Non-Gamer*	0-2	0
	2 - *Mild*	1-5	2-3
	3 - *At-Risk*	2-7	4-5
	4 - *Potentially Disordered*	5-9	6-9
6	1 - *Casual/Non-Gamer*	0-2	0
	2 - *Mild*	1-5	2-3
	3 - *Moderate*	2-5	4
	4 - *At-Risk*	2-7	4-5
	5 - *Borderline*	3-7	5-6
	6 - *Potentially Disordered*	6-9	7-8

Note: Where a range of IGD scores are provided the frequency of participants was the same for each value.

addictions. A four-class model was identified in both the combined and separate sample analysis; however, a six-class model may offer more nuance.

We additionally found that most potentially disordered gamers were under 30 years old, and none were over 42. Additionally, mean IGD scores continued to decrease with age, reaching as low as 0.26 in those over 51. Lemmens *et al.* (2015) also found that 31-40 year olds scored significantly lower than young adults and adolescents, which may suggest that adolescents and young adults are more at risk. Despite this, gaming is a new activity, with the first home consoles introduced in the 1970s. Contemporary gaming is very different from these simple arcade-style games, and Olson *et al.* (2011) reported that younger adults were more likely to use new technology, specifically computer/video games than older adults. Since the apparent addictive nature of gaming has only emerged recently it is therefore possible that future studies will find more potentially disordered gamers among older participants who have had more exposure to 'modern' videogaming from a young age.

Table 8. Average IGD score and predicted class for each age group.

Age	Mean score	Standard deviation	Most common predicted class		
18-20	2.73	2.03	*Mild Gamers*	Four-Class	46.96%
				Six-Class	43.48%
21-30	2.14	2.08	*Casual/Non-Gamer*	Four-Class	46.75%
				Six-Class	41.00%
31-40	1.40	1.84	*Casual/Non-Gamer*	Four-Class	63.45%
				Six-Class	56.55%
41-50	1.13	1.56	*Casual/Non-Gamer*	Four-Class	71.11%
				Six-Class	60.00%
51+	0.26	0.68	*Casual/Non-Gamer*	Four-Class	93.55%
				Six-Class	87.10%

In exploring the current DSM-5 symptom criteria, relationship issues were less than 50% likely in all classes except model-six '*potentially disordered*' gamers (57%), suggesting it may not be an appropriate criterion. However, without additional information on relationships we cannot test this result. Similarly, lying, and increased involvement were both less than 50% likely for low-moderate classes, but at least 70% likely in '*borderline*' or '*potentially disordered*' gamers. These may therefore be signs of maladaptive gaming. In contrast, preoccupation and gaming to escape were over 50% likely in all but the '*casual/non-gamer*' class and therefore may be facets of gaming generally rather than an indication of potentially disordered use.

Withdrawal symptoms were found to be 100% likely in the '*moderate gamer*' and '*potentially disordered*' class (six-class), suggesting a group of non-clinical gamers who experience withdrawal. Despite this, Kaptsis *et al.* (2016) found the evidence on withdrawal in behavioural addiction was underdeveloped, and symptoms were reported in less than 50 participants across five studies. They noted that withdrawal in IGD can be mistaken for reactions to imposed deprivation, and many studies did not specify the expected withdrawal symptoms proposed by the DSM-5. Further to this, Orford *et al.* (1996) reported that emotional withdrawal in gambling did not significantly contribute to maintaining the addiction, while Rosenthal and Lesieur (1992) found that some abstaining gamblers experienced symptoms which did not correlate with substance abuse withdrawal. Studies relying on a participant's understanding of withdrawal therefore may not accurately reflect potential symptoms.

In our sample we found a suggested prevalence of 2.98 – 4.74% of '*potentially disordered*' gamers. There appears to be a lot of variation in estimated prevalence rates for IGD, (0.7-27.5% - Mihara and Higuchi (2017); 0.7%-15.6% - Feng *et al.* (2017); 1.6% - Müller *et al.* (2015); 3.1% - Ferguson *et al.* (2011); 3.7% - Kuss *et al.* (2013)) however our results were in the expected range. Despite this, the prevalence rates of participants endorsing 5+ criteria were 11.82%, suggesting that the current cut-off may be too low. In fact, when amending this to 7+ symptoms we found a prevalence of 3.26%.

Future research into IGD should continue to build evidence on whether gaming is addictive, with an emphasis on critically evaluating the suggested criteria. Additionally, research comparing online and offline play, and various game types, may help to explain the different findings between studies. Subtle differences may arise as the social benefits of online multiplayer are likely to be significantly different from local multiplayer. Similarly, while most online games involve multiplayer competitive elements, offline gaming is often single-player storylines.

Data availability

Underlying data

Open Science Framework: Impulsivity, Scarcity and Maladaptive Choice Behaviours Project, https://doi.org/10.17605/OSF.IO/WXJUM (Raybould *et al.*, 2022).

This project contains the following underlying data:

- LCA Dataset.xlsx
- Full Survey Dataset.xlsx

Extended data

Open Science Framework: What are the Relationships between Impulsivity, Scarcity and Addiction?, https://doi.org/10.17605/OSF.IO/WXJUM (Raybould *et al.*, 2022).

This project contains the following extended data:

- Grisk_SocialStatus_Questions.pdf
- 9. AUDIT.pdf
- 6,8. MacArthur Scale of Subjective Social Status.pdf
- 5,7. NSSEC.pdf
- 16. GMQ-F.pdf
- 15. Debt Questions.pdf
- 14. TFEQ-18.pdf
- 13. DSM-V Criteria for Gaming Disorder.pdf
- 12. PGSI.pdf
- 10. CDS5.pdf
- 11. DUDIT.pdf

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Open Peer Review

Current Peer Review Status: ? ✗

Version 1

Reviewer Report 20 December 2022

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✗ **Veli-Matti Karhulahti**
University of Jyväskylä, Jyväskylä, Finland
Matúš Adamkovič
University of Jyväskylä, Jyväskylä, Finland

Dear Authors and Editors,

Thank you for inviting me to review this manuscript. Due to my limited expertise on LCA, I asked my colleague Matúš Adamkovič to separately comment on the R code. However, while reading the manuscript, I was surprised to notice that no code has been shared after all, despite the great choice to work with open software. Because I review under the PRO initiative (https://www.opennessinitiative.org), I should note that a justification for non-sharing should be provided or, preferably, the code should be shared for review.

The first part of the feedback was initially drafted by me (VMK) and later comments on methodology by MA. We both agree and sign all points made in this review.

1. The rationale of the study remains somewhat unclear. In addition to the fact that there are already numerous classification studies in the I/GD literature, there are also large-scale LCA studies[1]. Although I am warmly welcoming to replications and all other information about the validity of older findings, it is not clear how the present results update the prior understanding. E.g., the sentence about lacking research on age ("including a range of ages in gaming analysis could be beneficial") is relevant but the MS has little actual analysis or discussion on age beyond Table 8.

2. Sample justification is missing. See[2].

3. What language/nationality were the respondents, what were the inclusion/exclusion criteria? This is important especially because IGDS was used for measurement, and a Dutch validation study is cited. If the participants were native English speakers and an English version of the scale was used, please cite an English validation or other scale test, or discuss

in the limitations.

4. Regarding the design and results, a critical limitation is the lacking inclusion of any health and wellbeing variables in the model. For instance, when the study concludes that "IGD appears to have a four- or six-class structure ranging from 'casual/non-gamers' to 'potentially disordered' with increasing severity", there seems to be no evidence for *severity* beyond the total score. Including health or wellbeing measures in the design would've allowed assessing severity. In fact, threshold-based categorization and total scores can lead to inference errors because not all nine criteria are (equally) relevant, e.g[3,4]etc.

5. Following the above notes, the final contribution should be clarified to the reader and explained how it helps better understand I/GD. E.g., the discussion concludes that "IGD may be presenting in a similar manner to established addictions", but this deduction omits historical and psychometric context. Namely, IGD and IGDS were developed with a confirmatory approach from existing substance use criteria, and thus, logically, the nine DSM symptoms (taken from substance use and gambling) are likely to produce similar models as do their roots. If we study data from treatment-seekers and other clinical samples (especially qualitative ones), we see different symptoms, for which there has been a strong move away from confirmatory IGD models for a long time, see e.g. the more recent ICD-11 criteria[5] etc.

6. I would recommend carefully revising the discussion language, especially regarding the relevance of specific criteria. For instance, the prevalence of relationship issues ("relationship issues were less than 50% likely in all classes except model-six 'potentially disordered' gamers (57%), suggesting it may not be an appropriate criterion") can hardly be considered as evidence for its lack of actual problem-relevance. When analyzing a convenience sample, more severe outcomes are naturally less prevalent, yet these may well be the most valuable signs for identifying actual treatment-seeking or support-needing people. Please carefully reconsider such conclusions and related language in the discussion.

Additional notes on method from Matúš Adamkovič:

1. Although running LCA in the poLCA package is rather straightforward, I'd still welcome mentioning additional technical details in the text (or, alternatively, in the R code).

2. How was the data handled? Did you check for patterns of careless responding, improbable values, etc.? Were there any missing values in the data?

3. Please consider extending the paragraph in which you describe the specifics of each latent class – as I read it, this is the most important part of the paper and would benefit from a detailed description of the differences in symptoms composition across the different classes.

4. Related to the previous point, a visualization of the LCAs (maybe instead of Table 4) would be helpful to easier grasp the between-classes differences.

5. Could you please add (would work fine in supplementary material) information about the accuracy of the classifications? For example, by calculating the posterior probabilities that cases belong to each class (available in poLCA).

6. This point has already been raised by Matti (point no. 4) but since I, too, find it extremely important, I'd like to emphasize it once more. Since the data used for this study comes from a bigger dataset, it'd be valuable to, for instance, compare subgroups across some of these variables. This will provide further insights into the validity of the classification/s.

7. I suggest removing/moving to supplementary materials tables 5 and 6 since they have little information value.

8. Please add a paragraph that will reflect upon the limitations of the study.

We hope these comments will be helpful in revising the MS. If our feedback feels unclear or unfair, we can be contacted directly.

Matti & Matus

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Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Gaming disorder.

We confirm that we have read this submission and believe that we have an appropriate level of expertise to state that we do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Reviewer Report 08 August 2022

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Alexander Bradley
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The article explores the underlying class structure of the DSM criteria scale in samples of prolific and gaming forum users (discord and reddit). They find both 4 and 6 models provide good model fit in terms of BIC, AIC, Chi-square etc. Young adults had the highest gaming scores.

Introduction/Literature Review
Introduction could do with more clearly stating it's aims and hypotheses that it wishes to test. For example, in the design there is a suggestion that ICG has similar class structure to established addiction yet in the literature review addictions seemed to vary from 3-4 classes.

With the statistical analysis section I am guessing one sample was the prolific sample (N = 294) and Gaming forum sample (N = 236). Is this correct? Please do make this clearer.

Results
Clearer statement of what each of the classes is classed as in the text between tables 4 and table 5 for each type of model.

It would also be useful to know what percentage of your two different samples fell into each class. This would relate back to Introduction where prevalence of classes and differences between DSM and IGD were discussed. This could be added in as two extra columns in Table 7.

Are there any benefits of having 6 or 4 class model in terms of numbers classed as at risk gamers and potentially disordered gamers. i.e. comparison of percentages.

Do you have any items that might be able to link DSM scores to more behavioural measures like the amount of time spent playing games per week? Or amount spent on gaming?

Discussion
What extra nuance does a six model hold? You state this and only later suggest what this might

be.

Good points made around withdrawal and the value or not in pre-occupation and escapism as potential facets of gaming or any enjoyable hobby for that matter.

Data Availability
Even better if the Rscript with the LCA analysis was also deposited in the OSF so other could check the code.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
No

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Gambling research and statistical methods

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.