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Internet Gaming Disorder: Investigating the Clinical Relevance of a New Phenomenon

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Abstract

The American Psychiatric Association identified Internet Gaming Disorder as a new potential psychiatric disorder and has recognized that little is known about the prevalence, validity, or cross-cultural robustness of proposed Internet Gaming Disorder criteria. In response to this gap in our understanding, this project estimated the period prevalence of this new potential psychiatric disorder using APA guidance, examined the validity of its proposed indicators, evaluated reliability cross-culturally and across genders, compared it to gold-standard research on gambling addiction and problem gaming, and estimated its impact on physical, social, and mental health. To do so, in a first for this research topic, four survey studies (n = 18,932) with large international cohorts employed an open-science methodology wherein the analysis plans for confirmatory hypotheses were registered prior to data collection.

Results showed that of those who play games, more than 2 in 3, did not report any symptoms of Internet Gaming Disorder, and findings showed a very small proportion of the general population – between 0.3% and 1.0% – might qualify for a potential acute diagnosis of Internet Gaming Disorder. Comparison to Gambling Disorder revealed that Internet-based games may be significantly less addictive than gambling and similarly dysregulating as electronic games more generally. The evidence linking Internet Gaming Disorder to game engagement was strong, but links to physical, social, and mental health outcomes were decidedly mixed.

Keywords: Internet Gaming Disorder, Internet Games, DSM, addiction

Introduction

The American Psychiatric Association (APA) has identified Internet Gaming Disorder as a potential psychiatric disorder that might merit inclusion in a future revision of the Diagnostic and Statistical Manual of Mental Disorders.[1] In line with this possibility, the APA Substance-Related Disorders Work Group[2] has called for basic research exploring Internet Gaming Disorder prevalence, validity of Internet Gaming Disorder diagnostic criteria, and cross-cultural reliability and criteria (Table 1).

Work responding to this call is at an early stage, and extant studies rely on constructs not informed by APA's guidance. For example, a number of these early studies do not distinguish between offline and online games[3] and the flexible criteria used to date have meant estimates of addiction range from as low as 0.2%[4] to as high as 46%.[5] A comprehensive review of this literature estimated a prevalence rate of 3.1%, though these experts caution that the accuracy of this figure is not reliable because relevant studies do not distinguish between passionate engagement and pathology.[6]

The APA call for new research and unified criteria might help address concerns raised in regard to the existing body of research. First, in addition to defining key features of Internet Gaming Disorder, this guidance acknowledges that dysregulated gaming is characterized by significant distress, a nuance that may discriminate passion from pathology. Many players may experience a feature of Internet Gaming Disorder, for example a preoccupation with a new game that distracts from other responsibilities. Much in the same way a sports fan might feel distracted at work if their team reaches the finals, feeling this way may be typical among those for whom gaming is a favored hobby. Such experiences are not necessarily pathological if unaccompanied

by significant distress. The presence of distress for diagnosis may be key to accurately distinguishing pathological from non-pathological individuals.[6]

Second, DSM-5 guidance underlines the need for improving the methodologies used to study the potential disorder. With few exceptions,[4,7] most of what is known about dysregulated gaming comes from studying samples of convenience.[6] Polling online support communities may exaggerate the clinical relevance of problem gaming as it samples those who have pre-existing difficulties regulating their behavior and are therefore seeking out community help. Similarly, data from Internet-based gaming forums might oversample highly invested and engaged players, and may therefore not reflect the experience of most players, given between half and three quarters of people play such games.[8,9]

The present research employed large scale national cohort samples and used an open-science methodology to evaluate four research questions key to the APA call:

Research Question 1: What is the acute prevalence rate of the Internet Gaming Disorder criteria proposed in the DSM-5, and of Internet Gaming Disorder diagnoses?

Research Question 2: How does the prevalence of clinically relevant Internet Gaming Disorder compare with known rates from gold-standard research on gambling addiction[10] and problem gaming?[4]

Research Question 3: To what extend do the assumptions behind an indicator-based method for evaluating Internet Gaming Disorder hold up psychometrically? In the DSM-5 guidance, all nine symptoms are thought to equally contribute toward a diagnosis of Internet Gaming Disorder providing significant distress is present. Is this the case across demographic and national groups?

Research Question 4: To what extent might those with Internet Gaming Disorder vary in terms of their everyday behaviors and clinical outcomes, as compared to those who do not meet criteria?

Method

We present data from four studies: A cohort of young adults aged 18 to 24 years from the United States (Study 1; 527 females, 720 males), a sample of adults aged 18 years and older from the United Kingdom (Study 2; 941 females, 958 males), four young adult cohorts aged 18 to 24 years from the United States, United Kingdom, Canada, and Germany (Study 3; 4,995 females, 5,014 males), and a sample of adults aged 18 years and older from the United States (Study 4: 3,328 females, 2,449 males). Participants were recruited through Google survey using joint distributions of age, gender, and geographic location for Studies 1-3, and Study 4 used YouGov omnibus panel platform. Demographic information inferred from web tracking data identified participants and inform demographic quotas in Studies 1-3, and YouGov participants were selected based on self-reported panel data for Study 4. Ages for the first three studies were bucketed for samples of young adults aged 18-24 years (Studies 1 and 3), into six age cohorts 18-24 years (21.9%), 25-43 (20.3%), 35-44 years (15.4%), 45-54 years (18.2%), and 65 years and older (10.0%) for Study 2, and were continuous for Study 4, $M = 46.59$, $SD = 17.80$. Because the surveys presented low participant burden the weighted completion rate was 92.23%. Google surveys has been shown particularly effective in reaching dispersed populations[11,12] while YouGov samples are used to study issues in depth,[13] both have been used to study health behaviors[14–16] and technology[17,18] use in the general population.[13,19]

In Studies 1-3 participants completed a brief indicators checklist drafted in consultation with clinical and research psychologists active in the area, and Study 4 added measures of health

and behavior focused on the previous six months.[20] The research presented minimal risk, and was granted clearance by the University of Oxford (CUREC/C1A15-006). Study 1 was treated as an exploratory study, whereas Studies 2-4 had confirmatory aspects registered prior to data collection,[21–23] and all data and materials are available on the Open Science Framework.[24]

Results

More than half of participants had recently played Internet-based games (Table 2). Preliminary reliability analyses indicated Internet-Gaming Disorder indicators loaded well together (αs ranged from .68 to .76), and exploratory chi-square tests indicated no statistically significant differences in Internet-gaming as a function of gender in Studies 1 and 2, *ps* > .11; In Study 3, the proportion of Internet-gaming was higher for males (83%) than females (78%), χ^2 (1) = 32.3, $p < .01$, $p < .01$. In Study 4, the proportion of Internet-gaming was higher for females (68%) than males (62%), $z = 4.19$, $p < .01$ (log-linear model with weights considered), reflecting a general trend towards egalitarianism among those who play games.[25,26]

Internet Gaming Disorder Indicator and Diagnosis Prevalence (Research Question 1)

Figure 1 presents the proportion of participants reporting indicators of Internet Gaming Disorder. More than half of players reported no indicators (68.1%, 69.8%, 58.5%, 68.4 respectively), and the proportion monotonically decreased as the number of indicators increased. The proportion of participants who endorsed five or more indicators was 2.8% in Study 1 (95% CI = [2.0%,3.9%]), 2.7% (95% CI = [2.0%,3.5%]) in Study 2, 2.6% (95% CI = [2.3%,2.9%]) in Study 3, and 1.2% (95% CI = [0.8%,2.0%]) in Study 4, indicating nearly 2.4% demonstrated potentially dysregulated gaming, a level close to the 3.1% estimated in a comprehensive recent meta-analysis.[6]

To assess the period prevalence of Internet Gaming Disorder, we estimated the proportions of participants who reported they suffered significant distress due to gaming and endorsed five or more of the indicators. Diagnosis prevalences were 1.0% in Study 1 (95% CI = [0.6%,1.8%]), 0.5% (95% CI = [0.2%,0.9%]) in Study 2, 0.7% (95% CI = [0.5%,0.9%]) in Study 3, and 0.3% (95% CI = [0.2%,1.0%]) in Study 4. The number of indicators endorsed was positively correlated with the distress criterion across all four studies (*rs* = .24 to .33), and those who endorsed five or more of the indicators were more likely to report distress compared to those who did not (17%-37% vs. 1.3%-3.0%). For online game players only the observed prevalences for Internet Gaming Disorder were 1.0% in Study 1 (95% CI = [0.5%,1.9%]), 0.6% (95% CI = [0.3%,1.1%]) in Study 2, 0.8% (95% CI = [0.7%,1.1%]) in Study 3, and 0.5% (95% CI = [0.3%,1.0%]) in Study 4.

Comparison to Disordered Gambling and Problem Gaming (Research Question 2)

Three samples were drawn to compare Internet Gaming Disorder rates to gold-standard research on Gambling Disorder, the only non-substance addiction recognized as a psychiatric condition, and to general gaming. Two subsamples were drawn from the British Gambling Prevalence Survey,[10] one of 7,536 adults aged 18 years and older, and a second of 757 adults ranging in age from 18 to 24 years. Results indicated that 5,574 participants (74%) 18 years and over, and 557 participants (73%) aged 18 to 24 years had engaged in some form of gambling in the past year. This included, but was not limited to, participation in online gambling, lottery, pool betting, sports betting, bingo, or casino games. A total of 73 participants aged 18 years and older (1.0%), and 20 participants aged 18 to 24 years (2.6%), met established criteria for Gambling Disorder.[27,28] To evaluate differences in prevalences between Gambling Disorder and Internet Gaming Disorder – those who endorsed five of nine indicators and identified gaming as a

significant source of distress, we compared our data in Studies 2 and 3 with samples of problem gamblers. Results indicated that rate of gambling addiction among the general UK population in Studies 2 (z = -2.08, p = .038) and 3 (z = -3.53, p < .001) were higher than what was observed for Internet Gaming Disorder. Results showed the prevalence of Internet Gaming Disorder was lower among those who had played Internet-based games in the past year, compared to Gambling Disorder among those who had engaged in any form of gambling in the past year in Study 2 (z = -2.71, p = .006) and Study 3 (z = -3.93, p < .001).

A third sample composed of 656 Germans aged 18 to 24 years was drawn from Festl's study of video game addiction[4] to compare to our estimate of Internet Gaming Disorder. Results indicated that only a single participant (0.2%) qualified as addicted to games[3] and our data collected from German participants (n = 2,477) in Study 3 identified that five participants (0.2%) met DSM-5 criteria for Internet Gaming Disorder. These proportions were not different in our German cohort (z = 0.12, p = .904).

Exploring the Validity of Self-Report to Assess Internet Gaming Disorder (Research Question 3)

A key feature of the DSM-5 guidance on Internet Gaming Disorder is that diagnosis can be made, in part, on the endorsement indicators of problem gaming. The implicit idea behind this approach is that these criteria equally contribute toward the diagnosis of Internet Gaming Disorder. Statistically, this is the assumption of a Rasch model in item response theory,[29] and can be tested by examining the fit of the model to the data using structural equation modeling. In all studies, our analysis showed a very good fit of the Rasch model to the data across gender, Comparative Fit Index = 0.97-0.99, Tucker Lewis index = 0.97-0.99, Root Mean Square Error of Approximation = 0.017-0.029 and across the four countries (US, UK, Canada, and Germany) in

Study 3, χ^2 (140) = 408.3, Comparative Fit Index = 0.97, Tucker Lewis index = 0.97, Root Mean Square Error of Approximation = 0.028. These results suggest that items assessed Internet Gaming Disorder with the same sensitivity and difficulty across gender and these countries.

Behavioral and Clinical Impact of Internet Gaming Disorder (Research Question 4)

Behavioral impact. Given that Internet Gaming Disorder is thought to have a practically significant influence on functioning, akin to psychiatric disorders, we tested a preregistered hypothesis that those meeting the diagnostic threshold would show more frequent gaming, and less frequent physical exercise (physical activity) and quality social time with others (social activity), as compared to those who did not. A series of one-way Bayesian t-tests using a default Cauchy prior of 0.707 for the effect size of the alternative hypothesis tested confirmatory relations between Internet Gaming Disorder and behavioral engagement with games and physical and social activity.[30,31] Bayesian t-test was selected for our registered analysis plan in place of null hypothesis testing because it quantifies the relative evidence for the alternate hypothesis with moderately sized effects compared to the null.[32] In line with best practices, if observed Bayes factors were 3 or above we considered our hypotheses to be supported, if Bayes factors were 1/3 or below we considered the null hypothesis to be supported, and if Bayes factors observed were between 1/3 and 3 we considered the results inconclusive.[33] Full results are available in the supplemental online materials. Internet Gaming Disorder was significantly linked to higher levels of regular gaming (Bayes Factor = 11.29), showing that engagement levels were higher for those meeting the Internet Gaming Disorder threshold (M = 4.00, SD = 1.04) than not (M = 2.80, SD = 1.67). Those meeting the Internet Gaming Disorder threshold reported overall lower levels of physical activity (M = 2.92, SD = 1.49, vs. M = 3.26, SD = 1.39) yet higher social

activity (M = 3.92, SD = 1.00, vs. M = 3.61, SD = 1.14) but evidence from Bayes Factors indicated these differences were not significant. .

Clinical impact. Those meeting the Internet Gaming Disorder threshold reported marginally lower levels of mental health (M = 2.77, SD = 1.01 vs. M = 2.78, SD = 1.01), and marginally higher levels of physical (M = 2.33, SD = 1.23 vs. M = 2.31, SD = 0.94), and social health (M = 2.64, SD = 1.03 vs. M = 2.23, SD = 0.96), but evidence derived from Bayes Factors indicated these differences were not significant.

Discussion

The present research represents the first large-scale studies of Internet Gaming Disorder guided by an open-science approach, and grounded in American Psychiatric Association criteria. The studies addressed fundamental questions about this potential psychiatric condition and provided evidence regarding the acute symptom patterns, potential diagnoses, and the clinical and behavioral impact of this condition.

Results indicated that Internet-based games are widely popular among adults in the United States, United Kingdom, Germany, and Canada. At the same time, the great majority of players, nearly three in four, reported no indications of behavioral dysregulation. Specific indicators, such as increasing play time to maintain excitement, were reported roughly three times more frequently than other indicators, such as risking social relationships. Importantly, all criteria were relevant to a potential diagnosis, with the least common still reported consistently across studies and all appearing to be psychometrically sound. These findings are promising because they suggest the proposed criteria tap into less frequent or more extreme symptoms, and are appropriate for characterizing the phenomenon.

Second, findings suggested the rates of potential Internet Gaming Disorder diagnosis estimates based on DSM-5 criteria are quite low. Our results indicated the acute period prevalence rate might realistically be as high as 1.0% among young adults (Studies 1 and 3) and 0.5% among all adults (Studies 2 and 4) in the nations we studied. Indeed, acute prevalence rates of gambling, the only behavioral addiction in the DSM-5, were notably higher. This provides tentative evidence that despite being a new and popular activity, Internet-based games might be less dysregulating than gambling. Finally, our findings indicated that Internet Gaming Disorder classifications did predict gaming engagement, but there was little evidence for other behavioral or clinical effects .

This study informs ongoing debate about Internet Gaming Disorder between those who argue for[35] and against[36] an international consensus regarding gaming addiction. It may be that Internet Gaming Disorder can be detected in line with DSM-5 guidance but such classifications might reflect self-regulatory challenges epiphenomenal to electronic game play. Our analyses suggest that there might be cross-cultural variability in Internet Gaming Disorder; Prevalence estimates in Study 3 varied significantly across the nations studied, χ^2 (3) = 12.00, $p < .01$, with Germans showing the lowest levels. Work comparing Internet Gaming Disorder prevalence and stability across a wider range cultures such as Asian nations where gaming is widespread and played in different social settings will be useful.[2] These studies relied on self-reported data, and evidence derived from convergent sources including peers, caregivers, and health specialists is needed.

The present work carries three important takeaways for developing reliable and robust research into Internet Gaming Disorder. First, unlike most research on technology addiction, the present work collected data generalizable to adult populations in a number of countries.

Maintaining this standard will allow for direct comparisons between datasets and studies in this new and developing area.[4] Second, these data are publically available.[24] This affordance increases the robustness of research[30] and minimizes wasted resources in an area rife with duplicate efforts.[37] Finally, this research identified its exploratory and confirmatory features, given some predictions were registered before the start of data collection.[21–23] Because clinics in a number of countries are already claiming to treat gaming addiction[38] practitioners should be made aware that exploratory findings, which are especially susceptible to false positive results,[39] should be weighted differently than confirmatory ones.

Closing Remarks

Internet-based games are currently one of the most popular forms of leisure and researchers studying their potential darker sides must take care. If one extrapolates from our data, upwards of 160 million American adults play Internet-based games and as many as one million of these people might meet the proposed DSM-5 criteria for addiction to online games.[40] This represents a large cohort of people struggling with what could be clinically dysregulated behavior. However, because we did not find evidence supporting a clear link to clinical outcomes, more evidence for clinical and behavioral effects is needed before concluding this is a legitimate candidate for inclusion in future revisions of the DSM. If adopted, Internet Gaming Disorder would vie for limited therapeutic resources with a range of serious psychiatric disorders.

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Table 1. Proposed DSM-5 Criteria for Internet Gaming Disorder

	Label	Description
1.	Preoccupation with Internet Gaming	Preoccupation with Internet Games (The individual thinks about previous gaming activity or anticipates playing the next game; Internet gaming because the dominant activity in daily life).
2.	Experienced Withdrawal	Withdrawal symptoms when Internet gaming is taken away (These symptoms are typically described as irritability, anxiety, or sadness, but there are no physical signs of pharmacological withdrawal).
3.	Developed Tolerance	Tolerance—the need to spend increasing amounts of time engaged in Internet games.
4.	Loss of Control	Unsuccessful attempts to control the participation in Internet games.
5.	Continued Use	Continued excessive use of Internet games despite knowledge of psychosocial problems.
6.	Mislead Others	Has deceived family members, therapists, or others regarding the amount of Internet gaming.
7.	Use as Escape	Use of Internet games to escape or relieve a negative mood (e.g., feelings of helplessness, guilt, anxiety).
8.	Reduced Interests	Loss of interest in previous hobbies and entertainment as a result of, and with the exception of, Internet games.
9.	Risked Opportunities	Has jeopardized or lost a significant relationship, job or educational or career opportunity because of participation in Internet games.

Note: Only nongambling Internet games are included in this disorder. Use of the Internet for required activities in a business or profession is not included; nor is the disorder intended to include other recreational or social Internet use. Similarly, sexual Internet sites are excluded.

Note. Content taken from Section III (Emerging Measures and Models) of the DSM-5, pp. 795-796.

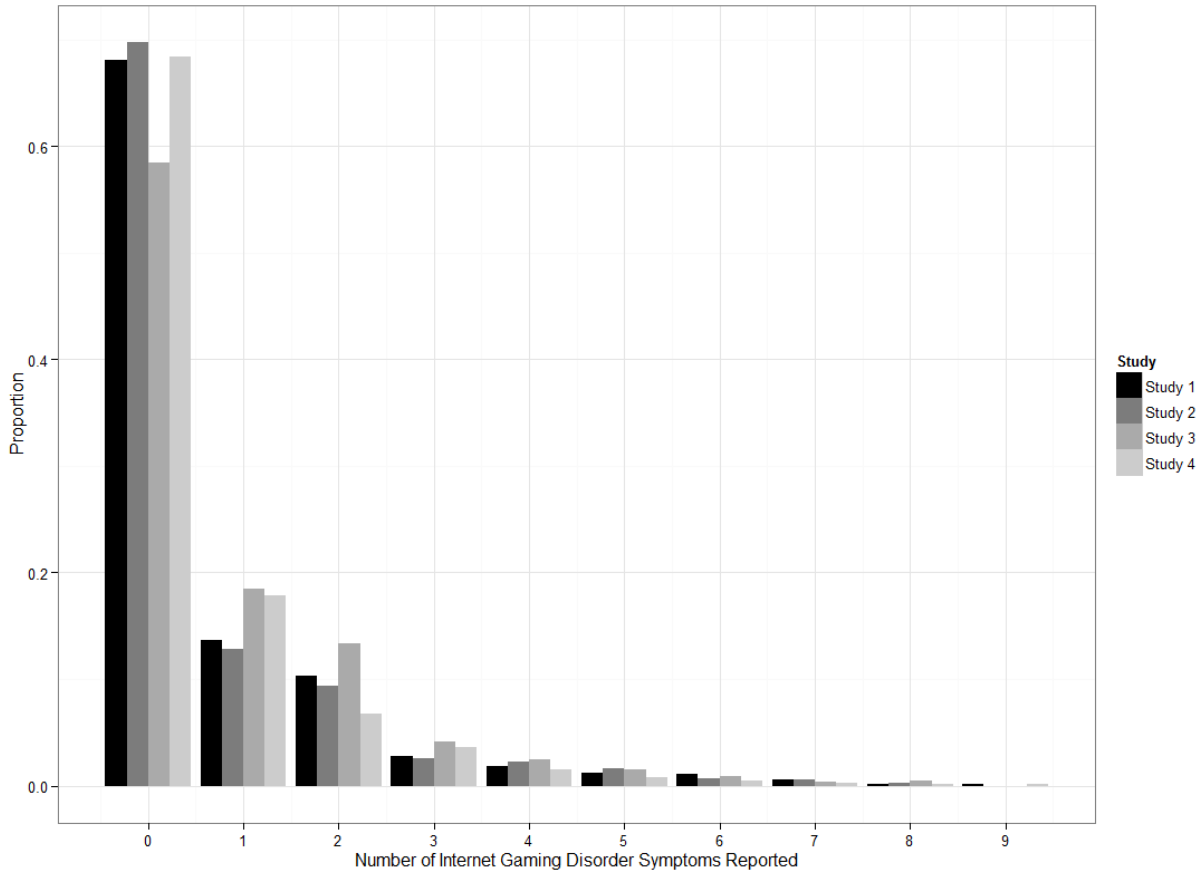
Table 2. Observations of Internet Gaming, Internet Gaming Disorder, Indicators, and the Significant Distress Criterion

		Study 1 (*n* = 1,247)		Study 2 (*n* = 1,899)		Study 3 (*n* = 10,009)		Study 4 (*n* = 5,777)	
		%	95% CI	%	95% CI	%	95% CI	%	95% CI
Recent Internet Gaming	Total	86.3	84.2-88.1	85.2	83.5-86.7	80.6	79.8-81.4	64.9	63.4-66.3
	Females	85.6	82.2-88.4	86.5	84.1-88.6	78.4	77.2-79.5	68.0	66.1-69.7
	Males	86.8	84.1-89.1	83.8	81.3-86.1	82.9	81.8-83.9	61.7	59.4-64.0
Internet Gaming Disorder Prevalence	Total	1.04	0.58-1.83	0.47	0.23-0.93	0.68	0.53-0.87	0.32	0.18-0.56
	Females	1.14	0.46-2.59	0.74	0.32-1.60	0.56	0.38-0.82	0.25	0.12-0.53
	Males	0.97	0.43-2.09	0.21	0.03-0.84	0.80	0.58-1.10	0.38	0.17-0.85
Preoccupied with Internet Gaming	Total	6.90	5.58-8.48	6.74	5.67-7.99	8.71	8.17-9.29	3.88	3.25-4.63
	Females	4.17	2.70-6.35	7.33	5.79-9.24	7.01	6.32-7.76	3.40	2.80-4.11
	Males	8.89	6.96-11.27	6.16	4.76-7.92	10.41	9.59-11.30	4.36	3.30-5.75
Experienced Withdrawal	Total	5.05	3.93-6.46	4.69	3.80-5.76	5.20	4.77-5.65	3.08	2.58-3.68
	Females	4.93	3.31-7.24	4.68	3.46-6.28	4.84	4.27-5.49	3.53	2.92-4.27
	Males	5.14	3.69-7.08	4.70	3.48-6.29	5.54	4.93-6.22	2.62	1.88-3.66
Developed Tolerance	Total	8.90	7.41-10.65	7.06	5.96-8.33	9.29	8.73-9.88	4.57	3.92-5.33
	Females	5.12	3.47-7.46	7.23	5.69-9.12	8.07	7.34-8.87	4.38	3.69-5.21
	Males	11.67	9.46-14.29	6.89	5.41-8.73	10.51	9.68-11.40	4.76	3.70-6.10
Loss of Control	Total	8.02	6.60-9.70	11.21	9.85-12.74	11.95	11.32-12.60	4.47	3.89-5.13
	Females	6.26	4.41-8.77	14.34	12.20-16.79	12.01	11.13-12.95	4.93	4.24-5.75
	Males	9.31	7.33-11.72	8.14	6.53-10.10	11.89	11.01-12.82	3.99	3.12-5.09
Continued Use	Total	5.77	4.57-7.25	5.00	4.09-6.11	6.33	5.87-6.83	2.76	2.22-3.42
	Females	4.36	2.85-6.58	4.99	3.73-6.64	6.07	5.43-6.77	2.53	2.01-3.18
	Males	6.81	5.13-8.96	5.01	3.75-6.64	6.60	5.94-7.33	2.99	2.11-4.23
Mislead Others	Total	6.74	5.44-8.31	6.37	5.33-7.59	8.11	7.59-8.67	3.35	2.80-4.01
	Females	5.31	3.62-7.68	6.38	4.94-8.18	7.61	6.89-8.39	3.10	2.53-3.80
	Males	7.78	5.98-10.04	6.37	4.94-8.15	8.62	7.86-9.43	3.61	2.72-4.79

Use as	Total	8.10	6.67-9.79	8.32	7.14-9.68	10.31	9.73-10.93	9.79	8.85-10.81
an Escape	Females	5.12	3.47-7.46	9.35	7.60-11.44	9.77	8.97-10.63	10.39	9.30-11.60
	Males	10.28	8.20-12.79	7.31	5.77-9.19	10.85	10.01-11.75	9.18	7.71-10.89
Reduced	Total	7.62	6.24-9.27	7.58	6.45-8.89	9.55	8.99-10.15	5.01	4.37-5.74
Interests	Females	5.69	3.94-8.12	7.55	5.98-9.47	8.89	8.12-9.72	5.47	4.70-6.36
	Males	9.03	7.08-11.42	7.62	6.06-9.53	10.21	9.39-11.09	4.54	3.57-5.76
Risked	Total	3.21	2.33-4.38	3.16	2.44-4.08	3.90	3.53-4.30	1.81	1.38-2.39
Opportunities	Females	2.28	1.24-4.06	3.19	2.20-4.58	3.02	2.57-3.55	1.53	1.13-2.09
	Males	3.89	2.65-5.64	3.13	2.16-4.50	4.77	4.20-5.40	2.09	1.37-3.18
Experienced Significant	Total	3.21	2.33-4.38	1.74	1.22-2.46	3.57	3.22-3.95	1.37	1.03-1.81
Distress Due-Gaming	Females	2.47	1.38-4.29	1.81	1.09-2.94	3.00	2.56-3.52	1.17	0.82-1.65
	Males	3.75	2.53-5.48	1.67	0.99-2.76	4.13	3.60-4.73	1.57	1.03-2.38

Note. Observed percentages for Internet Gaming Disorder prevalence and indicators show values for online game players.

Figure 1. Frequency Distribution of Sums of Internet Gaming Disorder Indicator Counts.



Supplementary Research Question 3 and 4 Analyses Exploring the Validity of Self-Report to Assess Internet Gaming Disorder

A key feature of the DSM-5 guidance on Internet Gaming Disorder is that diagnosis can be made, in part, on the endorsement indicators of problem gaming. The implicit idea behind this approach is that these criteria equally contribute toward the diagnosis of Internet Gaming Disorder. Statistically, this is the assumption of a Rasch model in item response theory,[29] and can be tested by examining the model fit of a factor model with equal factor loadings. As an exploratory analysis, we applied a factor model with equal factor loadings and dichotomous outcome variables to the data. Results used a maximum likelihood estimation with robust standard errors. The Rasch model showed very good fit to the data, with significant factor loadings across all the studies (0.75, 0.77, 0.70, and 0.70, respectively). Findings supported the validity of these nine items to assess Internet Gaming Disorder (see Supplementary Table 1). Further, multi-group analyses examined the equivalence of factor loadings across gender and countries. Across all studies, the Rasch model with equal factor loadings and intercepts (item difficulty) across gender showed good fit to the data, Comparative Fit Index = 0.97-0.99, Tucker Lewis index = 0.97-0.99, Root Mean Square Error of Approximation = 0.017-0.029.

The same model showed equivalent factor structures across the four countries (US, UK, Canada, and Germany) in Study 3, χ^2 (140) = 408.3, Comparative Fit Index = 0.97, Tucker Lewis index = 0.97, Root Mean Square Error of Approximation = 0.028, suggesting that items assessed Internet Gaming Disorder with the same sensitivity and difficulty across these countries. We also examined whether distributions of item endorsements were equivalent comparing those with and without distress among those who endorsed five or more than five indicators. Results did not show differences in the profile of endorsement at this level with and without distress, χ^2

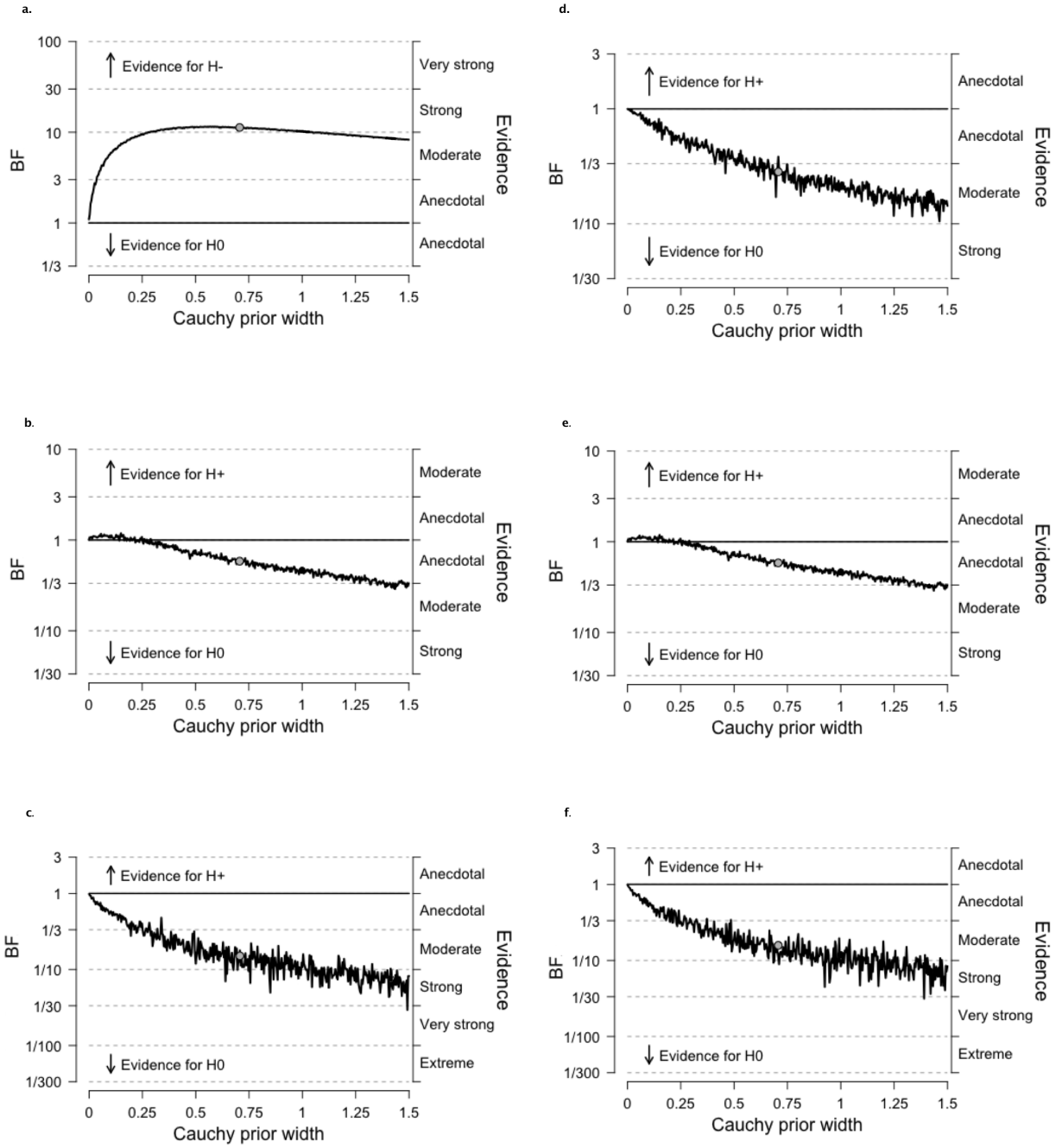
(8) = 2.23, 0.67, 14.7, and 4.94 (Studies 1-4), suggesting that items assessed Internet Gaming Disorder with the same sensitivity and difficulty across the distress criterion.

Sensitivity analysis. We conducted exploratory analyses to test the robustness of relations between Internet Gaming Disorder and observed outcomes. To do so, we tested the significance of a range of effect sizes smaller and larger than what was predicted relating Internet Gaming Disorder to outcomes (Supplemental Figure 1).For gaming behavior evidence strongly supported our hypothesis, for all other outcomes the null hypothesis was supported. In the most favorable conditions for the alternative hypothesis, where the prior effect size specified approached zero, Bayes factors approached a value of 1. These sensitivity analyses provided further evidence for relations between Internet Gaming Disorder and behavioral and clinical outcomes at levels different than those hypothesized were not significant.

Supplementary Table 1. Rasch Equal Factor Loading Models for Internet Gaming Disorder Indicators by Study

Study	χ^2	*df*	Comparative Fit Index	Tucker-Lewis Index	Root Mean Square Error for Approximation
1	64.6	35	0.98	0.98	0.026
2	70.9	35	0.99	0.99	0.020
3	286.4	35	0.98	0.98	0.027
4	80.6	35	0.98	0.98	0.019

Supplemental Figure 1. Assessing the Robustness of the Bayes Factors Relating Internet Gaming Disorder to Behavioral and Clinical Outcomes.



Note. a. Gaming activity. b. Physical activity. c. Social activity. d. Mental health. e. Physical health. f. Social health