

RUNNING HEAD: TESTING THE PIE-9: INTERNET GAMING DISORDER

Psychometric testing of the PIE-9: A new measure designed to assess Internet Gaming Disorder

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Acknowledgments

The study was completed as part of Benjamin Percy's PhD studies and is unfunded. The authors do not believe there are any conflicts of interest.

Abstract

Internet Gaming Disorder is in the early stages of recognition as a disorder, following its inclusion in the Diagnostic and Statistical Manual for Mental Disorders (DSM-5, American Psychiatric Association, 2013) as a condition for further study. Existing measures of Internet gaming pathology are limited in their ability to measure Internet Gaming Disorder as defined in the DSM-5. We present the initial development and validation of a new measure derived from the proposed DSM-5 criteria for Internet Gaming Disorder, the Personal Internet Gaming Disorder Evaluation (PIE-9). A student sample (n=119) and a community sample (n=285), sourced through a variety of online gaming forums, completed an online survey comprising the new measure, existing measures of Internet Gaming Disorder, and a range of health and demographic questions. Exploratory and confirmatory factor analysis supported a single factor structure for the 9-item PIE-9. Internal consistency ($\alpha=.89$) and test re-test reliability (ICC=.77) were high. Convergent validity was demonstrated with similar gaming addiction measures. Predictive validity was established through significant differences in distress and disability between those who met the criteria for Internet Gaming Disorder and those who did not. The distress and disability associated with meeting IGD criteria fell within the range of other common DSM-5 disorders. Preliminary testing of the PIE-9 has demonstrated that it is an efficient and straightforward measure for use in further research of Internet Gaming Disorder, and as a potential screening measure in clinical practice.

Introduction

Internet Gaming Disorder (IGD) is in the early stages of recognition as a disorder. The Substance Use Disorder Work-group were tasked by the American Psychiatric Association to define IGD for inclusion in the Diagnostic and Statistical Manual for Mental Disorders (DSM-5)¹ as a condition for further study². The Substance Use Disorder Workgroup noted that within extant research in the area the diagnostic criteria were inconsistent and varied across authors². These inconsistencies in diagnostic criteria have made it difficult to establish reliable and valid measures for the purpose of diagnosis. By proposing diagnostic criteria, the DSM-5 has provided a foundation for future research into Internet Gaming Disorder³. The key feature of IGD is the persistent and recurrent use of the Internet to engage in games, often with other players, leading to clinically significant impairment or distress over a 12-month period (see Table 1 for full diagnostic criteria). A standardised definition followed by a unified approach to assessment of IGD has been called for by members of the DSM-5 Substance Use Disorder Work-group and leading researchers in the area^{2,4,5}. Further research will then be required to refine the definition of IGD proposed in the DSM-5¹, and to establish the reliability and validity of the proposed diagnostic criteria. In this article we first review existing measures of Internet gaming pathology before presenting the development and initial validation of a new brief measure designed to assess IGD, as defined by the DSM-5¹.

<insert Table 1 about here>

Existing Measures of Internet gaming pathology

King and colleagues⁵ conducted a systematic review of measures designed to assess Internet gaming addiction. They found that existing measures excelled in terms of brevity, ease of scoring, and psychometric properties. However, there are a number of shortcomings to existing measures, resulting in King and colleagues concluding that existing measures were limited in their ability to appropriately assess the newly proposed Internet Gaming Disorder. First, the reliability and validity of existing measures was questionable due to weak or inconsistent internal consistencies and underlying structures between studies. Second, previous measures were produced prior to the release of the DSM-5¹ and therefore most do not cover all of the suggested criteria. New measures of IGD are needed to ensure these shortfalls are addressed.

King and colleagues⁵ identified two existing measures of IGD that appeared to demonstrate adequate psychometric properties: the Problematic Video-game Playing scale (PVP) and the Gaming Addiction Scale (GAS). The PVP is a nine item scale designed to measure problems associated with addictive use of videogames⁶ and appears to cover all of the criteria for IGD proposed in DSM-5^{1,6}. However, the PVP suffers from some limitations that may impact its clinical utility. First, the PVP uses a dichotomous response format, which does not provide any information on the frequency of symptoms over the past 12 months, as per the IGD criteria. Second, the PVP has demonstrated variable internal consistency across studies (range $\alpha = .69 - .91$ ⁶⁻⁹; Table 2). The Gaming Addiction Scale (GAS) was developed to measure video game addiction¹⁰. The GAS demonstrated acceptable psychometric properties (Table 2), however it is limited as a measure of IGD as it only covers seven of the nine IGD criteria, excluding 'continued use despite knowledge of harm' and 'deception'.

In the period since King and colleagues review⁵, a new measure, The Internet Gaming Disorder 20 scale¹¹ (IGD-20) has been published. The reliability and validity of the scale appear acceptable based on the original study¹¹ (Table 2). However, the IGD-20's items are mapped to six underlying factors of salience, mood modification, tolerance, withdrawal, conflict and relapse¹², rather than the nine IGD criteria directly, thereby limiting its utility as a

screening tool for IGD. In summary, the existing measures of Internet gaming pathology are limited in their ability to measure Internet Gaming Disorder as defined in the DSM-5¹.

<insert Table 2 about here>

The current study

This study reports on the initial development and validation of a new measure derived from the proposed DSM-5 criteria for Internet Gaming Disorder, the Personal Internet Gaming Disorder Evaluation (PIE-9). The PIE-9 has been developed with the aim of producing a brief, reliable and valid measure for research purposes and to assist clinicians in identifying individuals who may present with IGD as defined by the DSM-5¹. Brief measures are more useful in practice than measures with 20 or more items that may take more than 10 minutes to administer⁵, provided they are reliable and valid.

The first hypothesis was that a single factor would be extracted from the PIE-9 items using exploratory factor analysis, and that the unitary factor structure would yield a good fit using confirmatory factor analysis in an independent sample. The second hypothesis was that the PIE-9 would demonstrate good internal consistency, with a Cronbach's alpha above .80¹³. The third hypothesis was that the PIE-9 would demonstrate good test-retest reliability over a 2-week period. The fourth hypothesis was that the PIE-9 would demonstrate convergent validity by correlating moderately with the PVP⁶, GAS¹⁰, and IGD-20¹¹. The fifth hypothesis was that participants who meet the cut off for IGD as defined by the DSM-5¹ would have significantly higher rates of disability and distress than participants who do not meet the cut off.

Method

Participants

Two samples were used in this study: a university student sample (N=119, 57.1% males, 42.9% females), and a community sample (N=285, 75.4% males, 24.6% females), sourced through online gaming forums across the Internet. To participate in the study, participants needed to be over 16 years of age and participate in at least one hour of

Internet gaming per week. Demographic information collected for the two samples is provided in Table 3.

<insert Table 3 about here>

Measures

The PIE-9

The PIE-9 is a new 9-item measure developed to assist in the diagnosis of the DSM-5's¹ Internet Gaming Disorder. A single item is used to assess each of the 9 IGD criteria. Items were developed by restructuring the DSM-5 IGD criteria into a first-person perspective, ensuring the creation of a brief and targeted measure for IGD in the general adult population (see Table 1). Participants respond using a 5 point Likert scale ranging from never (1) to very often (5) to measure the frequency of the symptoms over the past 12 months, in line with the DSM-5's¹ proposed criteria. If participants scored often (4) to very often (5) on five or more of the nine items, they were considered to have met the criteria for IGD.

The Problematic Videogame Playing scale

The PVP is a 9 item measure designed to assess gaming addiction⁶. The PVP has a unitary factor structure and borderline-acceptable internal consistency⁵⁻⁸ (Table 2)

The Gaming Addiction Scale

The GAS is a 7 item measure of gaming addiction¹⁰. The GAS has a unitary factor structure and has demonstrated acceptable reliability and internal consistency in previous studies (Table 2).

The Internet Gaming Disorder scale

The IGD-20 is a 20 item measure designed to assess Internet Gaming Disorder¹¹ (Table 2). The items load on six factors, with the internal consistency of each of the six factors ranging from $\alpha = .63$ to $.80$ ¹¹.

The Kessler 10 scale

The Kessler 10 (K10) is a 10-item scale designed as a brief measure of non-specific psychological distress¹⁴. The five point response format ranges from none of the time (1) to all of the time (5), with a possible score range of 10 to 50. A sample question is 'In the past

30 days...how often did you feel nervous?'. The K10 has demonstrated good internal consistency ($\alpha = .93^{14,15}$) and validity¹⁵.

The World Health Organisation Disability Assessment Schedule 2.0

The World Health Organisation Disability Assessment Schedule 2.0 (WHODAS) is a reliable and valid 12-item measure of disability, designed to provide a standardized method for measuring health and disability across cultures¹⁶. The WHODAS has a response scale from none (0) to extreme or cannot do (5) in response to questions including 'standing for long periods, such as 30 minutes?'. The WHODAS is a widely accepted measure and has demonstrated good internal consistency ($\alpha = .94 - .98^{16}$) and validity^{16,17}.

Validity Items

King and colleagues⁵ proposed that future measures should consider adding items that assess whether the individual and significant others believe that his/her video-gaming behaviour is problematic as a validity check. The following two items were therefore included as validity checks: "I personally believe that my Internet game playing behaviour is problematic" and "Significant others in my life would consider my Internet game playing as problematic". Participants were provided with a 4-point Likert scale from strongly disagree (1) to strongly agree (4) to avoid neutral or misleading responses.

Procedure

After obtaining approval from the institution's Human Research Ethics Committee (Approval No. RDHS-09-15), two online surveys (one for students and one for the general public) were hosted on Qualtrics.com. Students were recruited through a university student participation pool and internal marketing. Community participants were recruited through snowballing on social media and through posting on online gaming or social interest forums. Upon providing informed consent participants completed the online survey. The order of the Internet gaming pathology measures was randomised. The survey took approximately 20 minutes to complete. Consenting participants were e-mailed a link to the re-test survey (comprising the PIE-9) 14 days later. Data was downloaded from Qualtrics.com into SPSS. Only completed surveys were used for analysis.

Results

Factor analyses and reliability

Principal axis factoring was used to explore the factor structure of the PIE-9 items using a randomly selected portion of the community sample (n=80). The remaining sample (n=205) was saved for a confirmatory factor analysis. Sampling adequacy (KMO = .88) and sphericity ($\chi^2(36)=595.36, p<.001$) indicated the data was appropriate for factor analysis. Minor violations of normality and linearity were not considered problematic due to the robust nature of factor analysis. The PIE-9 items loaded on a single factor (eigenvalue greater than one) explaining 62.6% of the variance (range of loadings = .43 to .84, Table 4). A confirmatory factor analysis on the second dataset was then conducted using EQS v6.1 (see Figure 1). The model provided acceptable model fit^{18,19} across multiple fit indices, (see Table 5).

<insert Table 4 about here>

<insert Table 5 about here>.

<insert Figure 1 about here>

Internal consistency and Test re-test reliability

Internal consistency of the PIE-9 in the community ($\alpha = .89$) and student samples ($\alpha = .86$) was high and comparable to the IGD-20 and GAS (Table 6). The PVP yielded poor internal consistency. The PIE-9 demonstrated acceptable test-retest reliability (community; ICC=.77, n=78; students ICC=.84, n=71) over a two week period.

<insert Table 6 about here>

Criterion related and concurrent validity

Table 6 presents Spearman rho correlations of the PVP, GAS and IGD-20 with the PIE-9. The strong positive correlations between the PIE-9 and other measures of problematic internet gaming provide support for the PIE-9's concurrent validity.

Participants were classified as meeting the criteria for IGD if they answered 'sometimes' to 'very often' for 5 or more of the 9 questions in the PIE-9. Table 7 summarises responses to the validity questions between those who were or were not identified as

meeting the criteria for IGD. Compared to participants who did not meet IGD criteria, a significantly higher proportion of participants who met criteria endorsed the personal validity question in both the community, $\chi^2(1, N = 263) = 54.15, p < .001$, and student samples, $\chi^2(1, N = 107) = 6.57, p = .01$, and endorsed the significant others validity question in the community sample, $\chi^2(1, N = 263) = 26.76, p < .001$. There was no significant difference in the student sample for the significant others validity question, $\chi^2(1, N = 107) = 1.29, p = .25$.

<insert Table 7 about here>

Distress and disability

Independent samples t-tests were used to compare mean scores of those who did and did not meet the criteria for IGD on measures of distress (K10) and disability (WHODAS) (Table 8). Participants who met the cut off for the IGD criteria scored significantly higher on both distress and disability compared to participants who did not meet criteria. The effect sizes were large²⁰ across both samples.

<insert Table 8 about here>

Discussion

The overall aim of this study was to conduct preliminary psychometric testing of a new measure of IGD, the PIE-9. It was hypothesised that the PIE-9 would have a unitary structure, high internal consistency and test-retest reliability, and that it would demonstrate criterion-related and concurrent validity. These hypotheses were supported. The PIE-9 items loaded on a single factor and met criteria for good model fit. The PIE-9 demonstrated good internal consistency and test-retest reliability. Moderate to strong positive correlations between the IGD and existing measures of Internet gaming pathology supported the PIE-9's convergent validity. Furthermore, participants who met the cut-off for IGD as defined by the DSM-5¹ had significantly higher levels of distress and disability compared to those who did not.

Factor structure

The unidimensionality of the PIE-9 scale supports the notion that IGD symptoms reflect a single underlying factor. King and colleagues⁵ systematic review reported that five of the 11 pathological gaming measures with factor structure information available were also unidimensional. This is in alignment with a recent study by Lemmens, Valkenburg and Gentile²¹ who confirmed a single factor structure for their IGD measure during preliminary testing. Lemmens and colleagues²¹ measure is yet to be compared to existing IGD measures for convergent validity and may be a useful comparative measure for future research.

Distress and disability

One of the most critical considerations before IGD is included in future editions of the DSM is whether those who present with symptoms of IGD experience similar levels of distress and disability compared to existing mental disorders. Comparisons in the current study found that those who met IGD criteria showed significantly higher levels of distress and disability compared to those who did not meet the IGD criteria. Andrews and Slade¹⁵ conducted a normative study for the Kessler 10 scale in Australia and identified scores for individuals likely to be well (<20), and scores for individuals likely to have mild (20-24), moderate (25-29), and severe (30+) mental disorders. The mean Kessler 10 score for community sample participants who met criteria for IGD in the current study was in the severe range, whereas the mean of the non-IGD group fell in the mild range. The student sample yielded similar results, with the mean of the IGD group falling in the moderate range and the mean of the non-IGD group falling in the well range. These findings provide evidence that individuals identified by the PIE-9 as meeting the criteria for IGD experience similar levels of distress as individuals with other DSM mental disorders.

Participants who met the IGD criteria in both the community and student samples also reported significantly higher levels of disability than the non-IGD groups. Comparisons between participants in this study who met criteria for IGD and Australian total population norms for the WHODAS¹⁷ suggest that the mean of the IGD group in the student sample was equivalent to the 95th percentile, and the mean for the IGD group in the community

sample was above the 95th percentile. The means for the non-IGD groups for both samples were equivalent to the 85th percentile of the total population norm scores. These comparisons provide evidence that IGD is a significant mental health concern associated with high levels of distress and disability.

Limitations

The dropout rate was 38% for the community sample online survey. Administration of a number of similar measures may have appeared repetitive, which may have deterred participants from completing the full questionnaire battery. The majority of participants completed the Internet gaming measures (n=352 in the community sample) and appeared to drop out once they had completed this section. We acknowledge that the disparity between sample sizes has the potential to increase Type I error. As an additional check, the data was reanalysed using Mann-Whitney U tests, resulting in similar findings. This strengthens our confidence in the results.

Future research direction

We recommend further research focusing on two areas. First, a lack of clinical testing is a known weakness of existing Internet gaming pathology measures⁵. Administering the PIE-9 as part of a structured interview would provide an assessment of the clinical utility of the measure and help further our understanding of the underlying constructs and clinical impacts of the condition. Second, exploring the relationship between IGD and other mental disorders seems warranted as a result of the distress and disability scores examined in the current study. It will also be important to identify pathways to comorbidity, whereby IGD may be a consequence of other mental disorders (e.g., functional avoidance secondary to social anxiety or depression), other mental disorders may be a consequence of IGD (e.g., depression may ensue due to IGD), IGD and other disorders may be manifestations of common underlying vulnerabilities to psychopathology, or IGD may develop independently of other disorders. Third, we recommend discriminant validity testing of the PIE-9 in future studies, to further the conceptualisation of IGD by comparing the PIE-9 with existing measures of Internet addiction.

Conclusions

Preliminary testing of the PIE-9 has demonstrated that it is an efficient and straightforward measure for use in further research of IGD, and as a potential screening measure in clinical practice. Internal consistency and test-retest reliability were high and evidence for convergent and concurrent validity was found. The study has provided advances in our knowledge of the association between IGD and distress and disability.

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Table 1. IGD criteria and PIE-9 items.

IGD Criteria	PIE-9 item
1. Preoccupation with Internet games.	1. I have been preoccupied with Internet games.
2. Withdrawal symptoms when Internet gaming is taken away.	2. I have experienced withdrawal symptoms when Internet gaming is taken away (such as anger, frustration or sadness).
3. Tolerance – the need to spend increasing amounts of time engaged in Internet games.	3. I find an increasing need to spend increasing amounts of time engaged in Internet games.
4. Unsuccessful attempts to control the participation in Internet games.	4. I have had unsuccessful attempts to control the participation in Internet games.
5. Loss of interests in previous hobbies and entertainment as a result of, and with the exception of, Internet games.	5. I have lost of interest in previous hobbies and entertainment other than Internet games.
6. Continued excessive use of Internet games despite knowledge of psychosocial problems.	6. I continue excessive use of Internet games despite knowledge of knowing it causes me problems.
7. Has deceived family members, therapists, or others regarding the amount of Internet gaming.	7. I have deceived family members, therapists, or others regarding the amount of time I spend Internet gaming.
8. Use of Internet games to escape or relieve a negative mood.	8. I use Internet games to escape or relieve a negative mood.
9. Has jeopardized or lost a significant relationship, job, or educational or career opportunity because of participation in Internet games.	9. I have jeopardized or lost significant relationships, jobs, or educational opportunities because of participation in Internet games

Note. IGD = Internet Gaming Disorder, PIE-9 = Personal Internet Gaming Disorder Evaluation-9.

Table 2. Existing measures of Internet gaming addiction symptoms.

Measure name	Purpose	Number of items	Response format	Sample item	Factor structure	Reliability (α)
GAS	Gaming addiction	7	Never(1) – Very often(5)	Have you neglected other activities (e.g. school, work, sports) to play games?	1	.81 - .86*
IGD-20	Internet Gaming Disorder	20	Strongly disagree(1) – Strongly agree(5)	I often lose sleep because of long gaming sessions	6	.88**
PVP	Gaming addition	9	Yes or No	When I can't use the video games I get restless or irritable	1	.69 -.91***

Note. GAS = Gaming Addiction Scale (Lemmens, Valkenburg, & Peter¹⁰), IGD-20 = Internet Gaming Disorder-20 (Pontes, Kiraly, Demetrovics, & Griffiths¹¹), PVP = Problematic Video-game Playing scale (Salguero & Moran⁶).

* Lemmens, Valkenburg, & Peter¹⁰

** Pontes, Kiraly, Demetrovics, & Griffiths¹¹

*** King, Haagsma, Delfabbro, Gradisar, & Griffiths⁵; Salguero, & Moran⁶; Sun, Ma, Bao, Chen, & Zhang⁷; Hart et al.⁸; Collins, Freeman, & Chamarro-Premuzic⁹

Table 3. Demographic characteristics of the two samples.

	Community Sample (n=285)		Student sample (n=123)	
	Mean	SD	Mean	SD
Age (years)	25.08	7.87	20.72	3.82
Time spent playing games per week (hours)	19.82	15.99	10.34	9.72
	n	%	n	%
Gender				
Male	215	75%,	68	57%,
Female	70	25%	51	43%
Country				
Australia	101	35%	113	95%
United States	90	32%		
United Kingdom	30	11%		
Canada	7	2%		
Denmark	5	2%		
Malaysia			3	3%
Singapore			2	2%
Other	51	18%		
Employment status				
Full-time Employment	102	36%	3	3%
Full-time Education	94	33%	57	48%
Part-time Employment	14	5%	12	10%
Part-time Education	7	2%	4	4%
Full-time Training	1	0%		
Part-time Training	1	0%	1	
Combination of Education, Employment or Training	30	10%	41	35%
Not in Education, Employment or Training	36	13%	1	

Table 4. Principal Axis Factoring loadings of the nine item PIE-9.

Item	Factor loadings
6. I continue excessive use of Internet games despite knowledge of knowing it causes me problems.	.84
9. I have jeopardized or lost significant relationships, jobs, or educational opportunities because of participation in Internet games	.69
2. I have experienced withdrawal symptoms when Internet gaming is taken away (such as anger, frustration or sadness).	.65
3. I find an increasing need to spend increasing amounts of time engaged in Internet games.	.63
5. I have lost of interest in previous hobbies and entertainment other than Internet games.	.63
4. I have had unsuccessful attempts to control the participation in Internet games.	.62
1. I have been preoccupied with Internet games.	.59
7. I have deceived family members, therapists, or others regarding the amount of time I spend Internet gaming.	.54
8. I use Internet games to escape or relieve a negative mood.	.43
Percentage of Variance:	62.60%

Note. PIE-9 = Personal Internet Gaming Disorder Evaluation-9

Table 5. Goodness of fit indices for the confirmatory factor analysis of the PIE-9

Goodness of fit indices	Fit indices score	Desired cut-off score for acceptable fit.
NFI	.94	$\geq .95$
TLI	.94	$\geq .95$
CFI	.96	$\geq .95$
SRMR	.04	$\leq .08$
RMSEA	.08	$\leq .06$

Note: desired cut-off scores were derived from Hu and Bentler's (1998¹⁹, 1999¹⁸) recommendations. PIE-9 = Personal Internet Gaming Disorder Evaluation-9, NFI = Normed Fit Index, TLI = Tucker-Lewis Index, CFI = Comparative Fit Index, SRMR = Square Root Mean Residual, RMSEA = Root Mean Square Error of Approximation.

Table 6. Internal consistency (α) and Spearman's Rho correlations (r_s) between gaming measures.

	Community sample (n=285)		Student sample (n=119)	
	<i>Correlation with PIE-9</i>	<i>Internal consistency</i>	<i>Correlation with PIE-9</i>	<i>Internal consistency</i>
PIE-9		.89		.86
IGD-20	.64*	.89	.49*	.89
GAS	.57*	.84	.69*	.82
PVP	.43*	.66	.45*	.68

Note. GAS = Gaming Addiction Scale (Lemmens, Valkenburg, & Peter¹⁰), IGD-20 = Internet Gaming Disorder-20 (Pontes, Kiraly, Demetrovics, & Griffiths¹¹), PVP = Problematic Video-game Playing scale (Salguero & Moran⁶).

* $p < .001$, two tailed.

Table 7. Concordance of the PIE-9 with validity questions.

	Community sample				Student sample			
	<i>IGD group</i>		<i>Non-IGD group</i>		<i>IGD group</i>		<i>Non-IGD group</i>	
	n	%	n	%	n	%	n	%
PIE-9 IGD criteria met	22		263		12		107	
Personal Validity question*	15	68%	27	10%	5	42%	14	13%
Significant others validity question**	18	82%	74	28%	5	42%	28	26%

Note. PIE=9 = Personal Internet Gaming Disorder Evaluation (PIE-9), IGD = Internet Gaming Disorder.

* "I personally believe that my Internet game playing behaviour is problematic."

** "Significant others in my life would consider my Internet game playing as problematic."

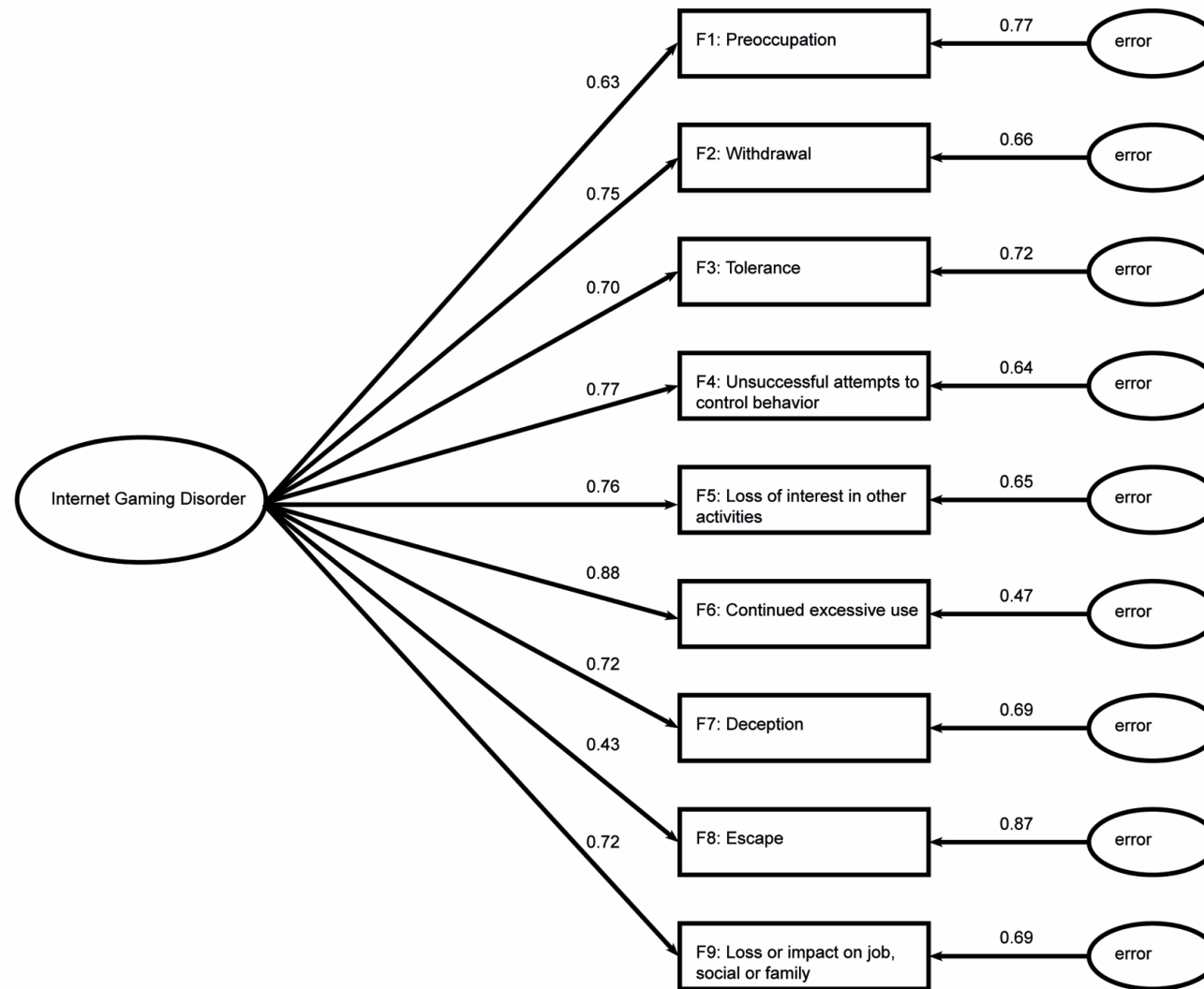
Table 8. Independent samples t-tests between the PIE-9 and distress and disability measures

Community sample		n	Mean	SD	t	df	p	Effect Size (<i>d</i>)
Kessler-10	IGD	22	30.14	10.35	4.96	283	<.001	1.10
	Non-IGD	263	20.47	8.64				
WHODAS 2.0	IGD	22	18.23	15.35	6.62*	21.72	.002	1.47
	Non-IGD	263	6.66	6.93				
Student sample		n	Mean	SD	t	df	p	Effect Size (<i>d</i>)
Kessler-10	IGD	12	27.5	7.73	3.56	117	<.001	2.96
	Non-IGD	107	19.42	7.42				
WHODAS 2.0	IGD	12	13.42	7.18	2.99	117	.003	2.42
	Non-IGD	107	6.96	7.07				

Note. Kessler-10 = Kessler 10 scale (Kessler et al.¹⁴), WHODAS 2.0 = World Health Organization Disability Assessment Schedule 2.0 12 item version (Üstün et al.¹⁶)

*Equal variances not assumed

Figure 1. Standardized model of the confirmatory factor analysis of the PIE-9



Note. All items significantly loaded on the latent factor.