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Disordered gaming in esports: Comparing professional and non-professional gamers

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ABSTRACT

Introduction: The American Psychiatric Association (APA) proposed 'Internet Gaming Disorder' (IGD) as a tentative disorder (APA framework) in 2013 and in 2019 the World Health Organization (WHO) has fully recognized 'Gaming Disorder' (GD) as a mental health disorder (WHO framework). These two frameworks have not yet been jointly investigated in the context of esports. The present study aims to investigate the feasibility of the APA and WHO frameworks for disordered gaming among professional and non-professional gamers and to ascertain the suitability of existing psychometric tools for use in esports. *Methods*: A sample of 5,734 gamers (M_{age} = 21.47 years, SD = 6.69 years; 6.94% female) recruited through an online survey prior to the COVID-19 pandemic that included an age and gender matched group of professional (n = 2,867) and non-professional gamers (n = 2,867) was investigated. Pairwise comparisons, measurement invariance (MI), and latent mean difference tests were conducted to distinguish the two groups of gamers. *Results*: Overall, professional gamers showed greater time spent gaming and prevalence of disordered gaming than non-professional gamers. Additionally, MI was supported and both disordered gaming levels and latent means were significantly higher among professional gamers when compared to non-professional gamers across both APA and WHO frameworks. *Conclusions*: Esports is cross-sectionally associated with greater disordered gaming vulnerability through increased time spent gaming and disordered gaming prevalence rates. Furthermore, the APA and WHO frameworks are viable in the context of esports gaming with existing assessment tools being effective in the assessment of disordered gaming in esports. The results and implications are further discussed in light of the extant literature.

1. Introduction

Gaming is a prevalent pastime activity worldwide, with electronic sports (or esports) gaining substantial popularity more recently. In 2021, a total of 2.8 billion individuals reported playing video games (Newzoo, 2021b). Of these, about 215.4 million were classified as "esports enthusiasts" (Newzoo, 2021a). Esports refers to competitive gaming activities that follow the characteristics of traditional sports where fans can watch professional gamers compete at live gaming events (Robertson, 2021). Specifically, esports is defined as professional and highly competitive team-based gaming involving organized events (e.g., tournaments or competitive leagues) with a specific goal (i.e., winning a championship title and/or a large prize money), and a clear distinction between players and teams that are competing against one another (Newzoo, 2021a). In this sense, esports involves organized multiplayer video game competitions, typically between professional gamers that can be staged in front of an audience (Chung et al., 2019).

Previously, it has been argued that the definition of esports was too narrow in scope as it was seen as a way of playing video games competitively in a professional setting (Jenny et al., 2017). For this reason, the definition for esports has been expanded and refers to "an area of sport activities in which people develop and train mental or physical abilities in the use of information and communication" (Wagner, 2006, p. 2). Note though that it is accepted that one characteristic

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which distinguishes gaming from a sport is the use of physical skills (Coakley, 2008; Suits, 2007). However, the use of physical skills in the context of esports is often questioned (Jenny et al., 2017).

Esports became a new area within the gaming culture, being one of the most essential and popular components of gaming communities in this day and age (Bányai, Griffiths, Király, et al., 2019). Esports culture has been championed by organizations such as the Electronic Sports League (ESL), which is the largest esports company, leading the industry across the most popular video games with numerous gaming competitions being organized at any given time (ESL, 2021).

As a popular activity, esports allows individuals to become professional gamers and to develop a career in competitive gaming as an occupation, adding to the usual gaming hobby such individuals may have (Bányai et al., 2020). In the present study, the operationalization of professional gaming refers to individuals who play video games for a living (Adamus, 2012). As such, professional gamers can be investigated and compared against other professional sports individuals such as professional football players who may also transform their "hobbies" into a competitive profession. By contrast, non-professional gamers (or casual gamers) are defined in the present study as those who only play for fun and recreation (Ma, Wu & Wu, 2013). Previous research in esports has reported significant differences between professional gamers and non-professional gamers in terms of their motivation and competition factors experienced in gaming (Bányai, Zsila & Griffiths, 2020). Therefore, it is likely that such individual differences may also permeate other gaming-related experiences, including how symptoms of disordered gaming may be experienced.

Professional gaming through esports is one of the many examples of the numerous benefits video games offer (Griffiths, 2019). However, dysregulated gaming may lead to harmful addictive-like experiences translating to functional impairments for a minority of individuals who engage with the activity excessively (Pontes & Griffiths, 2020; Pontes, 2017). To this end, the American Psychiatric Association (APA) proposed the tentative inclusion of Internet Gaming Disorder (IGD) through nine criteria in the 5th revision of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; APA, 2013) in 2013, while the World Health Organization (WHO) has formally recognized Gaming Disorder (GD) as a mental health disorder within the 11th revision of the *International Classification of Diseases* (ICD-11; WHO, 2021).

A recent Delphi study (Castro-Calvo et al., 2021) including a total of 29 international experts on disordered gaming reported that in general, the diagnostic criteria for disordered gaming within the APA framework present with high diagnostic validity, clinical utility, and prognostic value while some criteria such as tolerance and deception present with low diagnostic validity, clinical utility, and prognostic value. For the diagnostic criteria within the WHO framework, the same study concluded that with the exception of the criterion related to reduced non-gaming interests, all other criteria showed high diagnostic validity, clinical utility, and prognostic value. Given the findings of this study, it is paramount to further understand the feasibility of the APA and WHO frameworks within specific populations, particularly when it comes to professional gamers as it is key to distinguish high (professional) gaming engagement from disordered gaming (Billieux et al., 2019), eliciting functional impairments (see Männikkö, Ruotsalainen, Miettunen, Pontes, & Kääriäinen, 2020; Moore, Satel, & Pontes, 2022; Pontes, Király, Demetrovics, & Griffiths, 2014).

Accordingly, in the context of the APA framework, IGD has been defined as excessive and harmful use of video games, both online and offline, leading to significant functional impairment and/or clinical distress (APA, 2013). Similarly, in the context of the WHO framework, GD was conceptualized as an excessive pattern of gaming behavior (online and/or offline) reflecting lack of control, greater priority given to gaming over other life interests and activities, and continuation of the behavior despite negative outcomes (WHO, 2021). As esports gamers invest significant amounts of time playing video games professionally, they may be at greater risk for developing disordered gaming symptoms (Bányai, Griffiths, Demetrovics, et al., 2019). The Media Literacy Council in 2017 (as cited in Chung et al., 2019) argued that esports players are more disciplined and adopt measures that may render them more prone to disordered gaming, which is plausible given that professional video gamers experience high levels of stress due to the competitive nature of their occupation (Bányai et al., 2019). Nevertheless, to the best of the authors' knowledge, there is currently no research elucidating the role of esports in disordered gaming or scrutinizing existing disordered gaming psychometric tools within the professional-gaming population, particularly taking also into account both the APA and WHO frameworks.

This constitutes a key gap in the extant literature as there is a need to ascertain the implication of esports and the psychometric properties of such tools among professional gamers since they mostly focus on non-professional gamer samples, and so little is known whether disordered gaming can be validly and reliably measured within this niche population in the context of the most current psychometric tools available for disordered gaming.

Consequently, the present study will investigate the role of esports in disordered gaming and the psychometric feasibility of two widely utilized disordered gaming tools according to the APA (i.e., Internet Gaming Disorder Scale–Short-Form [IGDS9-SF], Pontes & Griffiths, 2015) and WHO frameworks (i.e., Gaming Disorder Test [GDT], Pontes et al., 2021). The present investigation is timely as emerging differences have been reported across both APA and WHO frameworks (see Montag et al., 2019).

This study will generate unique contributions to the literature in several ways. Firstly, it will provide novel data informing whether professional esports gamers may be at greater risk for disordered gaming compared to non-professional gamers. Secondly, it will shed light on whether existing psychometric assessment tools for disordered gaming are suitable to non-normative gaming populations (i.e., professional gamers) in esports. Thirdly, the findings obtained will inform the emerging literature investigating the diagnostic features, the similarities, and discrepancies across the APA and WHO frameworks for disordered gaming. Taken together, these contributions will likely help advance the field in relation to the psychometric assessment of disordered gaming in professional esports and non-professional gaming.

2. Methods

2.1. Participants and procedures

This study is part of an international Corporate Social Responsibility campaign promoted by ESL in order to raise awareness about disordered gaming and foster healthy gaming behaviors in the esports community. This research was conducted independently (e.g., study design, analysis), without direct or indirect rewards (e.g., financial) being given to the researchers. Participants received feedback on some of the data they provided as an incentive (see below). The sole role of ESL was to disseminate the online survey among their global esports community, which was achieved by promoting the project's website on ESL's page and via the media as the platform was heavily publicized online and offline through several means such as university press releases, specialized gaming forums and websites, online magazines, international news platforms, and radio interviews. Participants visiting the survey platform (www.do-i-play-too-much.com), which was disseminated by ESL opted to partake in the study if they wished to do so. The study has received ethical approval by the research team's University Ethics Committee (PONTES 2018/95, Nottingham Trent University). All participants were assured the data used for the analysis would be anonymous and confidential and while participants aged between 12 and 15 years were required to provide an electronic parental consent, those aged 16 provided an electronic informed consent to partake in the study.

Data were collected using an online survey through an online

platform developed by the researchers. The aggregated data needed to replicate the present findings alongside the survey items are available on Open Science Framework (OSF) via the following link: https://osf.io/ntyhr/. No financial rewards were given to participants as they have received detailed anonymized normative feedback containing graphical and text-based data-driven insights into their own gaming behaviors in comparison to those who had completed the survey at that point in time.

To mitigate potential confounding effects associated with the SARS-CoV-2 (COVID-19) pandemic, we opted to only analyze the data collected prior to the pandemic (May-December 2019). This decision was informed by recent reports suggesting that the current pandemic has fueled mental health disorders, especially in relation to gaming and other digital technologies (see Islam et al., 2021; Rozgonjuk, Pontes, Schivinski, & Montag, 2022; Teng, Pontes, Nie, Griffiths, & Guo, 2021).

As such, a total of 136,920 gamers were initially recruited, however 881 cases were removed for several reasons. More specifically, 178 were excluded for providing implausible responses, such as reporting that they were both professional gamers and that they intended to become one in the future. Two cases were further excluded due to incomplete answers to one of the disordered gaming scales (as per the reviewer's request), 488 individuals were removed for reporting playing more than 168 h per week (weekdays and weekend), in addition to 10 professional gamers who reported not playing any hours at all during the week. Finally, we excluded 58 participants for reporting being older than 80 years. After employing these cleaning steps, a final sample of 136,184 individuals was achieved, with 2,867 being professional gamers (2.11%). For the present study, to obtain an equivalent sample to the professional gamers, we employed a random pairing method to sub-sample age and gender-matched non-professional gamers from the total sample, which led to an effective sample of 5,734 participants including both professional (n = 2,867, 50%) and non-professional gamers. The overall features of the effective sample used in the study are presented in Table 1.

Table 1
Descriptive statistics, disordered gaming levels, and gaming-related behaviors within the sample.

	Professional gamers (n = 2,867, 50%)	**Non-professional gamers** (n = 2,867, 50%)	**Overall sample** (N = 5,734, 100%)	**Mean comparisons**
Age (mean, (SD))*	21.47 (6.69)	21.47 (6.69)	21.47 (6.69)	
Gender (female, *n* (%))	199 (6.94)	199 (6.94)	398 (6.94)	
Weekly time spent gaming (*hours*)				
Mean	33.33	22.88	28.11	t(5067.9) = 18.614, d = 0.491, p <.001
Standard deviation	24.81	16.98	21.89	
Minimum	1	0	0	
Maximum	168	144	168	
Intention to become a professional gamer (yes, *n* (%))	0 (0%)	396 (13.81%)	396 (6.91%)	
Potential disordered gaming status (disordered, *n* (%))				
APA framework (IGDS9-SF)	297 (10.36%)	141 (4.92%)	438 (7.64%)	t(5506.4) = 12.692, d = 0.335, p <.001
WHO framework (GDT)	111 (3.87%)	58 (2.02%)	169 (2.95%)	t(5620.5) = 11.007, d = 0.291, p <.001

Note: *Age range was 12 to 77 years. Although we excluded those aged > 80 years, 77 years was the maximum age observed in the present sample. Mean comparisons were investigated with t-tests to test potential mean differences between professional and non-professional gamers (who do not want to become a professional gamer).

2.2. Instruments

2.2.1. Sociodemographic information

Participants provided information regarding their gender, age, time spent gaming, whether they were professional gamers (*Are you a professional gamer* [i.e., *making a living playing video games*]*? [yes/no]*), and if not, whether they intended to become one in the future.

2.2.2. Internet Gaming Disorder Scale-Short Form (IGDS9-SF)

The IGDS9-SF (Pontes & Griffiths, 2015) was designed to assess disordered gaming as per the APA framework (APA, 2013). The scale includes nine items rated on a 5-point Likert scale (1 = *never* to 5 = *very often*) where higher scores indicate greater disordered gaming symptomatology. The IGDS9-SF has been translated and validated to several cultures and was shown to be a sound tool (de Palo et al., 2019; Gomez, Stavropoulos, Beard, & Pontes, 2019; Pontes & Griffiths, 2015; Poon et al., 2021) (see Table 2 for further information).

2.2.3. Gaming Disorder Test (GDT)

The GDT (Pontes et al., 2021) is a 4-item scale that assesses disordered gaming symptoms according to the WHO framework (WHO, 2021). All four items are rated using a 5-point Likert scale (1 = *never* to 5 = *very often*), where higher scores suggest increased levels of disordered gaming symptoms. In addition to English, the GDT has also been validated across different countries and languages such as German, Chinese, and Turkish (see Evren et al., 2020; Montag et al., 2019; Pontes et al., 2021) and has been shown to have robust psychometric properties within a unidimensional factor structure (see Table 2 for further information).

2.3. Statistical analyses

A unidimensional model was fitted for both the IGDS9-SF and the GDT using Confirmatory Factor Analysis (CFA) for the overall sample and separately for professional and non-professional gamers. Due to the ordinal nature of the responses to the items of both scales, Weighted Least Squares Mean and Variance adjusted estimator (WLSMV) was used following the suggestions of Brown (2015).

Model fit was assessed using the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), and interpreted according to the recommended guidelines proposed by Hu and Bentler (1999) (i.e., adequate fit = CFI $\geq$ 0.95, TLI $\geq$ 0.95, RMSEA $\leq$ 0.06, and SRMR $\leq$ 0.08). The reliability of the scales' scores was assessed using the Cronbach's alpha (α) and McDonald's Omega (ω).

Measurement Invariance (MI) across professional and non-professional gamers was investigated through Multigroup Confirmatory Factor Analysis (MGCFA). MI is utilized to test whether psychometric tests reveal differences among individuals with membership to different groups in relation to the latent trait being measured (i.e., in this case disordered gaming), when they actually differ on the latent trait (Millsap, 2011). Thus, before comparing levels of disordered gaming among gamers measured within the APA (IGDS9-SF) and WHO (GDT) frameworks, researchers must ensure that the latent variable being assessed is measured similarly among professional and non-professional gamers. The evaluation of MI followed the recommended guidelines

Table 2
Disordered gaming descriptive statistics and reliability of the Internet Gaming Disorder Scale-Short Form (IGDS9-SF) and of the Gaming Disorder Test (GDT) psychometric assessment tools.

	IGDS9-SF				GDT			
	Minimum-Maximum	Mean (SD)	α	ω	Minimum-Maximum	Mean (SD)	α	ω
Professionals	9–45	20.07 (7.52)	0.85	0.85	4–20	9.81 (3.59)	0.75	0.75
Non-professionals	9–45	17.77 (6.12)	0.82	0.82	4–20	8.83 (3.11)	0.73	0.73
All	9–45	18.92 (6.95)	0.84	0.84	4–20	9.32 (3.39)	0.74	0.74

Abbreviations: IGDS9-SF: Internet Gaming Disorder Scale-Short Form; GDT: Gaming Disorder Test; α = Cronbach's alpha; ω = McDonalds' Omega. SD = Standard Deviation.

from the literature whereby a new model constraint was added with each step (Brown, 2015). Configural invariance was first examined to test if factor structure is equivalent across the groups being tested (i.e., if the disordered gaming construct has an equivalent model form in professional and non-professional gamers). This solution serves as the baseline model for subsequent tests of MI. Second, metric or weak invariance was assessed by placing constraints on factor loadings forcing them to be the same across groups (i.e., it evaluates if the items of the scale contribute to the disordered gaming latent factor similarly for professional and non-professional gamers). Third, scalar or strong invariance was conducted by constraining item intercepts to be equal across groups and indicates if groups have the same baseline item average. Fourth, residual or strict invariance was explored by constraining item variances to be equal across groups (i.e., it tests if the sum of specific variance and error variance of the scale items are similar across both groups) and would indicate if the spread of the scores for individual items is the same in the two groups. It is worth noting that most MI studies omit investigating residual invariance as it is inconsequential to interpretation of latent mean differences (Putnick & Bornstein, 2016).

To examine MI between these steps, we adopted Chen's criteria (Chen, 2007) which suggests ΔCFI ≥ -0.010, ΔRMSEA ≥ 0.015, and ΔSRMR ≥ 0.030 for metric or weak invariance, and ΔCFI ≥ -0.010, ΔRMSEA ≥ 0.015, and ΔSRMR ≥ 0.010 for scalar or strong and strict invariance. Values greater than the recommended cut-offs indicate measurement non-invariance at the step in which the model shows a significant degradation in fit, indicating the need to examine partial invariance in that specific step. Partial invariance implies detecting the parameter that is non-invariant and freely estimating it to test if the model is invariant without this parameter. This procedure was conducted by inspecting the score statistic (χ^2) of the parameters and freeing the ones presenting with highest values, one-by-one until partial invariance is observed.

In addition to the MI analysis, population heterogeneity was also investigated by examining the equality of latent means across professional and non-professional gamers, which indicates the equivalence of the average levels of disordered gaming between the two groups. This approach allows the comparison of disordered gaming levels between professional and non-professional gamers in the context of a measurement model that is adjusted for measurement error. Group comparisons of latent means may be conducted only if the factor loadings and indicator intercepts have been found to be invariant (i.e., when configural, metric, and scalar invariance have been supported). However, this comparison can also be performed if some (but not all) of the factors or intercepts are invariant (i.e., when partial scalar invariance is achieved) (Brown, 2015).

This was done by estimating latent means for each participant by multiplying the standardized item loading by the participant item raw score and averaging these weighted scores. Latent means were then compared between professional and non-professional gamers by computing Cohen's *d* and *t*-statistics. The comparison between both factor latent means enables ascertaining whether the scale is structurally invariant (Beaujean, 2014).

All the statistical analyses were conducted with R version 4.1.0 (R Core Team, 2021) using the packages *lavaan* (Rosseel, 2012), *semTools* (Jorgensen et al., 2020), and *semPlot* (Epskamp, Stuber, Nak, Veenman, & Jorgensen, 2022).

3. Results

3.1. Descriptive statistics and gaming-related features

Overall professional gamers showed greater average weekly time spent gaming and higher prevalence of disordered gaming on both APA (i.e., 10.36%) and WHO (i.e., 3.87%) frameworks when compared to non-professional gamers, with these differences being statistically significant (see Table 1). Note that prevalence rates were estimated according previous similar research and guidelines (Pontes et al., 2022). In the case of the APA framework, disordered status was determined when at least five items of the IGDS9-SF were answered with 4 = '*Often*' or 5 = '*Very Often*'. Similarly, prevalence for the WHO framework was estimated based on answers of 4 = '*Often*' or 5 = '*Very Often*' to all four items.

3.2. Measurement Invariance: APA framework

The MGCA results for the APA framework using the IGDS9-SF comparing professional and non-professional gamers are shown in Fig. 1. The results of this analysis yielded adequate fit indices for both professional ($\chi^2 = 198.824$, df = 27, $p < .001$, CFI = 0.960, TLI = 0.947, RMSEA = 0.047, SRMR = 0.028) and non-professional gamers ($\chi^2 = 200.536$, df = 27, $p < .001$, CFI = 0.947, TLI = 0.930, RMSEA = 0.047, SRMR = 0.030), with all standardized factor loadings being relatively high and statistically significant.

Table 3 shows the fit indices for the different models for the APA framework (IGDS9-SF) analysis. A ΔCFI of -0.02 and a ΔSRMR of 0.016 were obtained when assessing invariance under the strict model (i.e., fixed factor loadings, intercepts, and residuals). Thus, partial MI was investigated, as the item variance constraint was not warranted for all the items (Beaujean, 2014). After observing the constrained item parameters, item 9 presented with the largest chi-square score ($\chi^2 = 74.224$, df = 1, $p < .001$) in the professional gamers sample. Consequently, partial strict invariance was achieved by allowing the residual of item 9 to be freely estimated (see Table 3). Note that latent means can still be assessed since full strict invariance is not a condition for this analysis because the residuals are not part of the latent factor (Vandenberg & Lance, 2000).

3.3. Measurement invariance: WHO framework

The results of this analysis produced an adequate fit for both professional ($\chi^2 = 22.525$, df = 2, $p < .001$, CFI = 0.988, TLI = 0.965, RMSEA = 0.060, SRMR = 0.015) and non-professional gamers ($\chi^2 = 17.433$, df = 2, $p < .001$, CFI = 0.988, TLI = 0.963, RMSEA = 0.051, SRMR = 0.014). As can be seen in Fig. 2, the standardized factor loadings were all relatively high and statistically significant.

The fit indices and fit changes of the WHO framework (GDT) analysis are shown within Table 3. The results suggested that full scalar or strong

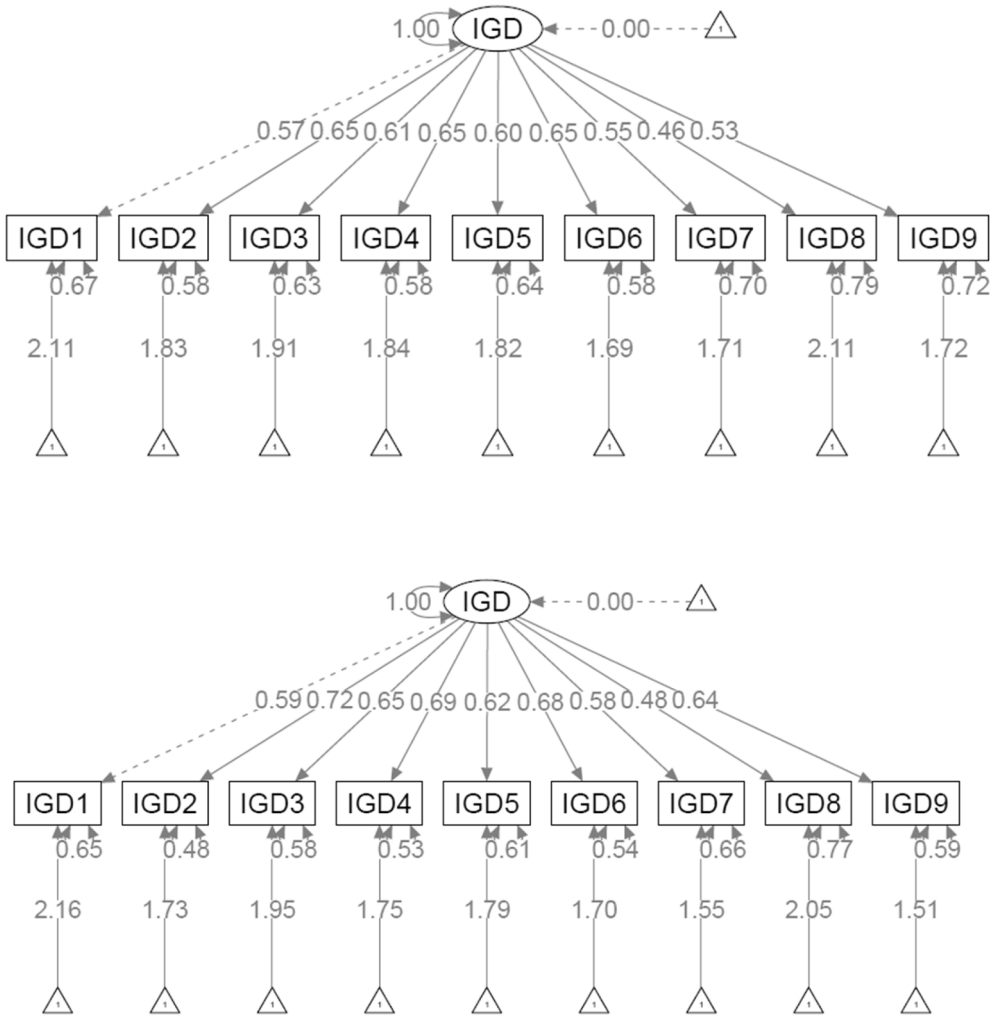

Fig. 1. Internet Gaming Disorder Scale–Short-Form (IGDS9-SF) path diagrams for professionals (above) and non-professionals (down) gamers.

Table 3
Fit indices and chi-square of the Internet Gaming Disorder Scale-Short Form (IGDS9-SF) and of the Gaming Disorder Test (GDT).

Model invariance	χ^2	df	CFI	RMSEA	SRMR	ΔCFI	ΔRMSEA	ΔSRMR
IGDS9-SF								
Configural	399.336	54	0.955	0.047	0.029	–	–	–
Metric or weak	420.165	62	0.953	0.045	0.035	-0.002	-0.002	0.006
Scalar or strong	498.141	70	0.944	0.046	0.037	-0.009	0.001	0.002
Strict or residual	657.213	79	0.924	0.051	0.053	-0.020	0.005	0.016
Partial strict or residual*	578.963	78	0.935	0.047	0.045	-0.009	0.001	-0.008
GDT								
Configural	39.733	4	0.988	0.056	0.015	–	–	–
Metric or weak	33.970	7	0.991	0.037	0.015	0.003	-0.019	0
Scalar or strong	87.731	10	0.974	0.052	0.023	-0.017	0.015	0.008
Partial scalar or strong**	35.056	9	0.991	0.032	0.016	0	-0.005	0.001

Note: Configural: Baseline model; Scalar: equal loadings; Metric: equal loadings and intercepts; Strict: equal loadings, intercepts, and residual variances. * Item 9 unconstrained. ** Item 1 unconstrained.

invariance was not achieved (ΔCFI = -0.017), and item 1 among professional gamers had the largest intercept, suggesting that partial strong invariance of item 1 was achieved by freely estimating its intercept. Despite the lack of support for full scalar invariance, comparison of latent means was performed because most of the item intercepts (i.e., three out of four) were invariant (Brown, 2015).

3.4. Latent means comparisons

The next step was to conduct latent mean comparisons among professional and non-professional gamers to determine how these two groups differ in terms of disordered gaming symptoms at the latent-trait level. This step was warranted since the MI analyses of the APA and WHO frameworks supported partial strict invariance and partial strong invariance respectively.

Predicted latent means were then computed by multiplying total scores by the standard deviation and adding the mean. Thus, within the APA framework, non-professional gamers had a disordered gaming latent mean of 17.768 while professional gamers had a disordered gaming latent mean of 20.066. In terms of the WHO framework, non-

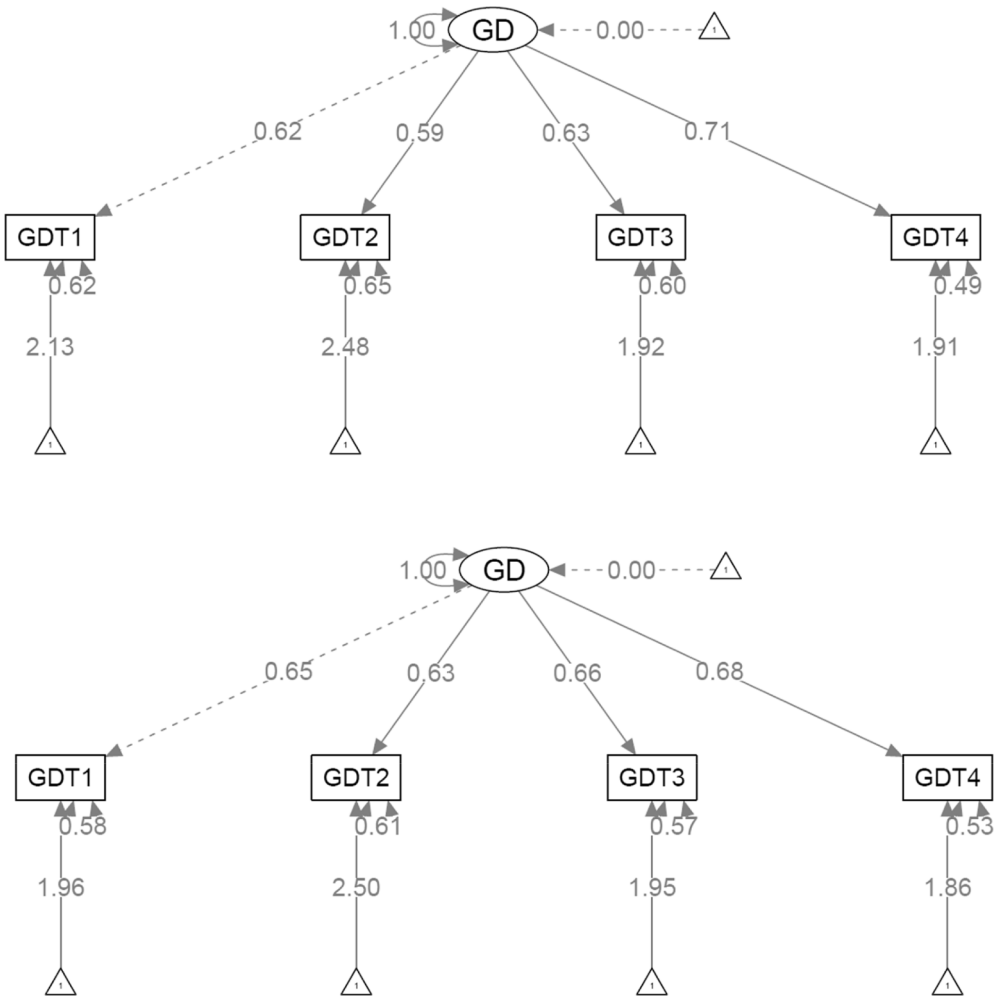

Fig. 2. Gaming Disorder Test (GDT) path diagrams.

Table 4
Latent mean difference between professionals and non-professionals gamers.

Framework	Mean Difference	*t*-statistic	*p*	Cohen's *d*
APA framework (IGDS9-SF)	2.298	−14.92	< 0.001	−0.39
WHO framework (GDT)	0.986	−14.85	< 0.001	−0.39

***Note*:** Mean differences between professional and non-professional gamers are shown.
Abbreviations: APA: American Psychiatric Association; WHO: World Health Organization. IGDS9-SF: Internet Gaming Disorder Scale-Short Form; GDT: Gaming Disorder Test.

professional gamers had a disordered gaming latent mean of 8.829 and professional gamers had a disordered gaming latent mean of 9.815. Furthermore, comparison tests of the obtained latent means indicated they were significantly different among professional and non-professional gamers across both the APA and WHO frameworks, implying that professional gamers exhibited higher latent levels of disordered gaming symptoms than non-professional gamers (see Table 4).

4. Discussion

This study sought to investigate disordered gaming among professional and non-professional gamers in the context of esports. To the best of the authors' knowledge, no previous research has paid attention to the psychometric assessment of disordered gaming among professional gamers using widely recognized psychometric tools for these two diagnostic frameworks. Moreover, we also provided prevalence rates for professional and non-professional gamers in order to ascertain whether greater vulnerability might be experienced among gamers engaged in esports.

To achieve the study goals, pairwise comparisons were performed alongside MI analysis in light of the APA and WHO frameworks using the IGDS9-SF and GDT respectively. When comparing professional and non-professional gamers, we found that the former presented higher vulnerability through increased time spent gaming and prevalence rates of disordered gaming.

Furthermore, the MI analysis indicated that the IGDS9-SF was invariant at the scalar level and partially invariant at the residual level. Moreover, the GDT was invariant at the metric level and partially invariant at the scalar level. At the item-level, the IGDS9-SF achieved partial residual invariance by freeing item 9 (i.e., *Have you jeopardized or lost an important relationship, job or an educational or career opportunity because of your gaming activity?*) while the GDT reached partial scalar invariance not constraining item 1 (i.e., *I have had difficulties controlling my gaming activity*). For the IGDS9-SF, strict invariance means that the factor structure, the patterns of the loadings, the intercepts, and most of the error variances are equal between professionals and non-professional gamers. Regarding the GDT, an invariant factor structure and patterns of loadings was found, but equality of intercepts and error variances was not achieved since the intercept of item 1 was not

invariant.

There are several potential explanations for the non-invariance of these two items. For example, item 9 of the IGDS9-SF might be problematic for professional gamers as the symptoms being measured may not be inherently problematic since gaming excessively constitutes an integral part of being a professional gamer (i.e., playing represents a professional activity that is part of a gamer's career) (Griffiths, 2017). A similar rationale may be true for the non-invariance of item 1 of the GDT as professional gamers need to consistently show increased gaming activity in terms of time investment in order to excel professionally and perform at high levels. Therefore, controlling or reducing the gaming activity might not be of interest nor a central feature of professional gaming, and therefore, potentially irrelevant in the assessment of disordered gaming in the context of esports.

Despite the non-invariance of item 9 from IGDS9-SF and item 1 from GDT, both instruments presented the minimum level of invariance required to adequately compare disordered gaming levels between professional and non-professional gamers (Putnick & Bornstein, 2016). This allows researchers and clinicians to accurately compare mean scores of professional and non-professional esports gamers relying on the fact that the disordered gaming constructs, as measured by the IGDS9-SF and the GDT, have the same meaning to those groups. Also, the non-invariance of the items can tell us differences between the groups to interpret the same construct (Putnick & Bornstein, 2016). This can be explained in our study as the control to time spent gaming and the possibility to jeopardize or lose important relationships, career or educational opportunities, are not robust predictors of disordered gaming in professional gamers.

Furthermore, latent mean comparisons of disordered gaming levels between professional and non-professional gamers indicated significant differences across these two groups in both frameworks as professional gamers showed the highest disordered gaming latent means compared to non-professional gamers. This finding mirrors those of previous studies showing that professional and non-professional gamers differ in terms of their gaming motives, and importantly, how intense they play video games and spend their time gaming (Bányai, Griffiths, Demetrovics, et al., 2019).

It is also important to note that the prevalence rates of disordered gaming were found to be more elevated among professional gamers than non-professional gamers. This finding may be partly driven by the fact that professional gamers need to exhibit high performance levels in their jobs, and so excessive gaming may be rendering these gamers more prone to experiencing disordered gaming - thus justifying greater prevalence rates. However, an important caveat is that disordered gaming in the context of esports could be reflecting 'workaholism' or 'work addiction' tendencies rather than disordered gaming (Bányai, Griffiths, Király, et al., 2019; Griffiths, 2017). Future research is needed to investigate whether professional gamers may be at greater risk for 'work addiction', disordered gaming, or both as this can lead to decreased engagement and satisfaction with the activity (Karnika--Murray, Duncan, Pontes, & Griffiths, 2015).

Taken together, the results obtained in this study indicate a high level of consistency in the assessment of disordered gaming symptoms across both frameworks. However, it is possible that certain criteria and symptoms might be experienced differently among professional gamers since engaging in the activity excessively is likely to constitute a requirement of high-performance, and may not directly reflect greater levels of disordered gaming symptoms. The findings of the present study support the idea that both disordered gaming frameworks do not differ systematically in the assessment of professional and non-professional gamers, and that they can be both employed to assess disordered gaming in esports.

5. Limitations and future research

Despite the novel insights provided by this study, our findings should be interpreted with caution due to several potential limitations in this study. Firstly, the present sample was a convenience sample, and therefore our findings cannot be generalized to all gamers. Secondly, professional gamers were identified based on the gamers' own perceptions, and so it is likely that individual variations and own understanding of what constitutes professional gaming may have interfered with this classification. Thirdly, it is possible that additional gamers potentially experiencing disordered gaming were not fully included in this study due to the adopted inclusion and exclusion criteria pertaining to the age threshold. Notwithstanding this, the overwhelming majority of gamers (i.e., 93%) (at least in the United States of America) have been reported to be younger than 65 years old (Entertainment Software Association, 2021). For this reason, another possible limitation is the fact that we did not report participants' country, which could be interesting to advancing the cross-cultural research in the field.

Nevertheless, this study paves the way to future research examining disordered gaming and its assessment in the context of esports, an area in which little research has been conducted to date. This study also offers insights about the implications related to the assessment of risk factors and disordered gaming symptoms through the use of widely adopted psychometric tests for disordered gaming (i.e., the GDT and IGDS9-SF) among professional gamers. Overall, the findings obtained support the usefulness of these two psychometric tests for the purposes of clinical evaluation of possible gaming-related problems due to excessive play within highly competitive environments. Another implication emerging from the findings of this study is that esports organizers can monitor and assess the potential long-term risks and harms associated with disordered gaming among professional gamers, further engaging in socially responsible preventative practices aimed at minimizing harms, all within an evidence-based corporate social responsibility framework aligned with industry-led player protection policies (Griffiths & Pontes, 2020).

Finally, an interesting theoretical ramification of this study is that future research is needed to clarify the relationships between 'work addiction' and disordered gaming among professional gamers where gaming is part of one's professional activity and not so much a pastime or leisure activity. Furthermore, additional research is needed to investigate the role of specific risk factors for disordered gaming among professional gamers so that prevention campaigns can be informed by robust evidence. Last but not least, the present study can be expanded by future research into esports examining how intention to become a professional gamer may influence likelihood and risk for disordered gaming compared to non-professional and professional gamers as this strand of research may elucidate the potential early risks being associated with esports and competitive gaming.

5.1. Conclusions

The results obtained suggest that professional gamers may be at greater risk for disordered gaming compared to non-professional gamers. Further, the APA and WHO frameworks are suitable for the assessment of disordered gaming in esports. However, further investigation is needed to understand whether higher levels of disordered gaming might reflect greater work engagement or greater disordered gaming distress. To this end, research aiming at unravelling the links between professional gaming, 'work addiction' and disordered gaming is paramount.

CRediT authorship contribution statement

Laura Maldonado-Murciano: Writing – original draft, Writing – review & editing, Data curation, Formal analysis. **Georgina Guilera:** Writing – original draft, Writing – review & editing, Visualization, Supervision, Data curation, Formal analysis. **Christian Montag:** Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Supervision, Project administration, Funding acquisition. **Halley M. Pontes:** Conceptualization, Methodology,

Investigation, Writing – original draft, Writing – review & editing, Supervision, Project administration.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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