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# Assessing the symptoms of Internet Gaming Disorder among college/university students: An international validation study of a self-report*

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The present study evaluated the psychometric properties of a self-report scale for assessing Internet Gaming Disorder (IGD) symptoms according to the DSM–5 and ICD–11 among 3270 college/university students (2095 [64.1%] females; age mean 21.6 [3.1] years) from different countries worldwide. Croatian, English, Polish, Portuguese, Serbian, Turkish, and Vietnamese versions of the scale were tested. The study showed that symptoms of IGD could be measured as a single underlying factor among college/university students. A nine item-symptom scale following DSM–5, and a short four-item scale representing the main ICD–11 symptoms, had sound internal consistency and construct validity. Three symptom-items were found non-invariant across the language samples (i.e., preoccupation with on-line gaming, loss of interests in previous hobbies and entertainment, and the use of gaming to relieve negative moods). This study provides initial evidence for assessing IGD symptoms among college/university students and will hopefully foster further research into gaming addiction in this population worldwide especially with taking into account language/cultural differences.

**Key words:** Internet gaming, IGD, cross-cultural equivalence

## Highlights:

- Nine item-symptoms represent a single factor of the Internet Gaming Disorder (IGD).
- The ICMH-IGD scale is measuring invariantly the IGD in both genders.
- Three out of nine symptom-items are non-invariant across different languages.

Over the past two decades, significant mental health problems have been linked to excessive Internet use worldwide (Kuss & Lopez-Fernandez, 2016). Research indicates that the main negative consequence of excessive Internet use is the development of specific behavioral addictions characterized by excessive or poorly controlled preoccupations, urges, or behaviors regarding Internet use, accompanied by significant impairments in daily functioning (Kuss, Griffiths, Karila, & Billieux, 2014; Petry, Zajac, & Ginley, 2018; Weinstein & Lejoyeux, 2010). In relation to these behavioral aspects, neuropsychological changes such as attention difficulties, reductions in response inhibition or lowered mental flexibility, as well as neurobiological changes such as dysfunctions involving parts of the prefrontal cortex, cortical and sub-cortical regions, are evident among individuals engaged in excessive Internet use (Brand, Young, & Laier, 2014). At least three types of behavioral addictions have been proposed as possible mental disorders with specific manifestations related to excessive Internet use: Internet gambling disorder, Internet gaming disorder, and Internet addiction/Problematic Internet use (Petry, Zajac, & Ginley, 2018).

Following the conclusions of an ample number of studies on problematic video gaming and its associated emotional, cognitive, behavioral, and social consequences from 1980's to 2000's, it has become necessary to include a disorder originating from excessive gaming (including Internet games) in the current classifications of mental disorders (Männikkö et al., 2017; Pontes & Griffiths, 2014; Rumpf et al., 2018). The Diagnostic and Statistical Manual of Mental Disorders (DSM–5; American Psychiatric Association [APA], 2013) has recognized Internet Gaming Disorder (IGD) as a condition needing further study, while Gaming disorder (GD), either online or offline, has been introduced in the 11$^{th}$ revision of the International Classification of Diseases (ICD–11) developed by the World Health Organization (WHO, 2018). The ICD–11 proposed that GD is characterized by a lack of control over gaming habits, prioritizing gaming over other interests and activities, and continuing gaming despite its negative consequences (WHO, 2018). In the DSM–5, a broader set of symptoms was proposed: preoccupation with on-line gaming, withdrawal symptoms when gaming is taken away or not possible (e.g., sadness, anxiety, irritability), the need to spend more time gaming to satisfy the urge (i.e., tolerance), inability to reduce playing, unsuccessful attempts to quit gaming, giving up other activities, loss of interest in previously enjoyed activities due to gaming, continuing to game despite problems, deceiving family members or others about the amount of time spent on gaming, the use of gaming to relieve negative moods (guilt, hopelessness, and risk), and having jeopardized or lost a job or relationship due to gaming (APA, 2013). Both classifications require that the presenting symptoms are exhibited over a period of at least 12 months and that there is a clinically significant impairment or distress present.

Recent reviews showed that the prevalence of IGD varies from .7 to 27.5% worldwide (Feng, Ramo, Chan, & Bourgeois, 2017; Mihara & Higuchi, 2017), while the prevalence rates range from 3.5 to 17% in studies among Chinese populations (Long et al., 2018). Various demographic (e.g., male gender, younger age), personality and psychological (e.g., impulsivity, agreeableness), familial, scholastic, and social factors (e.g., poor parental educational background, dysfunctional parent–child relationships), or game-related factors (e.g., game genres, gaming experience) have been linked to IGD (Long et al., 2018; Mihara & Higuchi, 2017). Summarizing various neuropsychological and neurobiological data, individuals with IGD, compared to healthy controls, were found to have poorer response-inhibition and emotion regulation, lower cognitive control, poorer working memory and decision-making capabilities, decreased visual and auditory functioning, and a deficiency in the neuronal reward system. Hyperactivation in the anterior and posterior cingulate cortex, caudate, posterior inferior frontal gyrus (IFG) and hypoactivation in the anterior IFG, with reduced gray-matter volume in the anterior cingulate, orbitofrontal, dorsolateral prefrontal, and premotor cortices have been observed in adults with IGD (Fauth-Bühler & Mann, 2017; Kuss, Pontes, & Griffiths, 2018; Long et al., 2018; Yao et al., 2017). From a clinical point of view, besides the proposed symptoms, individuals with IGD may also have concentration and learning difficulties, proneness to impulsive acts and aggression, interpersonal insensitivity, and different psychiatric symptoms, such as anxiety, depression, obsessive-compulsive, somatization, paranoid ideation, insomnia, and suicide attempts (Kim et al., 2016; Laconi, Pirès, & Chabrol, 2017; Männikkö et al., 2017).

Different approaches to the conceptualization of gaming addiction have led to the development of several questionnaires for measuring aspects of gaming behavior including online/Internet gaming (King et al., 2013), while measures based on the DSM-5 criteria have appeared recently. In this light, several self-report measures were developed: the *Internet Gaming Disorder Test* (IGDT–20; Pontes, Király, Demetrovics, & Griffiths, 2014), the *Internet Gaming Disorder Scale* (IGD scale; Lemmens, Valkenburg, & Gentile, 2015), the *Internet Gaming Disorder Scale–short form* (IGDS9-SF; Pontes & Griffiths, 2015), and the *Chinese Internet Gaming Disorder Scale* (C–IGDS; Sigerson, Li, Cheung, Luk, & Cheng, 2017). Among the first to be developed was the IGDT–20 (Pontes et al., 2014) with 20 items assessing six underlying factors related to addictive behaviors (i.e., salience, mood changes, tolerance, withdrawal, conflict, and relapse), which has been recently shortened into a 10-item version (IGDT–10; Király et al., 2017). Both versions were developed to be used for assessing IGD severity and both have sound psychometric properties demonstrated in samples of participants with problematic Internet use and gamers. The IGD scale (Lemmens et al., 2015) has a 27-item and a 9-item version with polytomous and dichotomous response options for assessing IGD symptoms. Sound

psychometric properties were demonstrated among adolescents and adults aged 13–40 years in general population, while the dichotomous 9-item version showed solid psychometric properties for diagnostic purposes (Lemmens et al., 2015). The IGDS9–SF for assessing IGD severity in gamers (Pontes & Griffiths, 2015) and the C–IGDS for IGD screening in general population of adults (Sigerson et al., 2017) were developed with items representing the DSM–G criteria verbatim. The IGDS9–SF and C–IGDS have 9 items each, with the first having a polytomous response format and the later a dichotomous format. Both demonstrated sound internal consistency and construct validity. In addition to these self-reports, clinician rating scales were also developed based on the DSM–5 conceptualization, such as the Clinical Video Game Addiction Test (C–VAT 2.0; Van Rooij, Schoenmakers, & Van de Mheen, 2017) and a structured clinical interview (Koo, Han, Park, & Kwon, 2017).

Even though the research on IGD is proliferating rapidly and epidemiological, neurobiological, and clinical studies have provided useful data, differences in methodologies, studying predominantly individuals at risk (i.e., gamers) and a limited number of international studies using reliable and uniform methods (King et al., 2013; Mihara & Higuchi, 2017) render it difficult to generalize available findings. In order to increase reliability and validity across gaming addiction studies worldwide, Pontes and Griffiths (2014) called for a commonly agreed assessment criteria based on DSM–5, which has been achieved with scales recently developed especially the IGDS9–SF (Pontes & Griffiths, 2015) and C–IGDS (Sigerson et al., 2017). Nevertheless, the assessment methods of the IGD with sound cross-cultural measurement invariance (Dimitrov, 2010) and considering culture-related diagnostic issues (APA, 2013) should be further evaluated. There is conflicting evidence on whether expressions and measurement of IGD symptoms could vary markedly across countries (Király et al., 2019; Pontes et al., 2017). In addition to this, evaluating the three main ICD–11 criteria for IGD (WHO, 2018) is also important, since the greatest part of the world is using this classification system when diagnosing psychiatric disorders.

In 2018, the *International Child Mental Health Study Group* (ICMH–SG; Atilola, Balhara, Stevanovic, Avicenna, & Kandemir, 2013; Stevanovic et al., 2017) initiated a cross-cultural project to explore the patterns of Internet use among college/university students across different Asian and European countries with a focus on problematic Internet use and IGD. Therefore, the aims of the present study were: (a) to evaluate the dimensionality of a self-report for assessing the IGD symptoms according to the DSM–5 and ICD–11 criteria among college/university students worldwide, including additional validity aspects explored, (b) to evaluate the measurement invariance of this self-report scale across different language groups, (c) to evaluate its measurement invariance across genders, and (d) to explore how participants cluster based on the preferred responding on the scale in order to detect those who are at risk of having IGD.

# Method

## Participants and Procedure

An online survey using a cross-sectional design was considered for the present study. Online data collection methodology was chosen due to its benefits regarding ease of access to larger sample pools, opportunity to reach heterogeneous groups, cost-efficiency, and its usefulness and practical advantages for researching behavioral addictions (Griffiths, 2012; Pontes, Stavropoulos, & Griffiths, 2017). The online survey method containing four questionnaires (see below) was used. Since the English language is used completely or in part during educational courses in colleges and university or it is required for students to speak it besides the mother language in a non-English speaking country like Bangladesh, India, Italy, Nepal, Nigeria, Sweden, and United Arab Emirates, students participating from these countries used the English version of the questionnaires. The survey was available in additional nine languages, namely Bulgarian, Croatian, Lithuanian, Polish, Portuguese, Spanish, Serbian, Turkish, and Vietnamese.

The authors of the study were responsible to advertise the study and to send a link of the survey to students pursuing various graduation courses in colleges/universities. Students were solicited to participate in the study directly or via students' organizations. The study was approved by an institutional board/ethical committee relevant to the authors' institutions.

Complete data was available for 3270 college/university students from the following countries: Bangladesh, Brazil, Croatia, India, Italy, Nepal, Nigeria, Sweden, United Arab Emirates (UAE), Poland, Portugal, Serbia, and Turkey, but there were 34 participants from other countries as well. Table 1 summarizes the survey language and country of residence for the participants. There were not enough data collected in the Lithuanian and Spanish language to be presented in this article. Relevant demographic data are summarized in Table 2.

Table 1
*Survey language and country of residence for the participants* ($N$ = 3270)

| Survey language | Country of residence | *n* (% participants) |
|---|---|---|
| Croatian ($n$ = 464) | Croatia | 464 (100) |
| English ($n$ = 1208) | Bangladesh | 183 (15.1) |
| | India | 487 (40.3) |
| | Italy | 47 (3.9) |
| | Nepal | 165 (13.7) |
| | Nigeria | 53 (4.4) |
| | Sweden | 35 (2.9) |
| | United Arab Emirates | 210 (17.4) |
| | Others | 28 (3.2) |
| Polish ($n$ = 161) | Poland | 161 (100) |
| Portuguese ($n$ = 412) | Portugal | 279 (67.7) |
| | Brazil | 127 (30.8) |
| | Others | 6 (1.5) |
| Serbian ($n$ = 321) | Serbia | 321 (100) |
| Turkish ($n$ = 251) | Turkey | 251 (100) |
| Vietnamese ($n$ = 453) | Vietnam | 453 (100) |

Table 2
*Descriptive statistics of the participants* (*N* = 3270)

| Demographics | Total sample (*N* = 3270) | Croatian (*n* = 464) | English (*n* = 1208) | Polish (*n* = 161) | Portuguese (*n* = 412) | Serbian (*n* = 321) | Turkish (*n* = 251) | Vietnamese (*n* = 453) |
|---|---|---|---|---|---|---|---|---|
| Gender (female), *n* (%) | 2095 (64.1) | 354 (76.3) | 614 (50.8) | 118 (73.3) | 325 (78.9) | 229 (71.3) | 154 (61.4) | 301 (66.4) |
| Age range | 17–40 | 19–38 | 17–38 | 18–28 | 17–40 | 19–39 | 18–40 | 17–33 |
| Mean age in years (*SD*) | 21.6 (3.1) | 21.8 (2.5) | 21.3 (2.7) | 21.5 (2.1) | 22.8 (5) | 22.3 (2.5) | 21.5 (2.7) | 20.9 (2.1) |
| Not in a relationship, *n* (%) | 1963 (60) | 218 (47.5) | 870 (72.3) | 79 (49.1) | 200 (48.7) | 159 (49.7) | 150 (60.2) | 287 (64.2) |
| W/out mental disorder, *n* (%) | 2956 (90.4) | 437 (96.5) | 1074 (92.5) | 119 (75.8) | 368 (90.9) | 304 (95.9) | 212 (86.5) | 442 (98.4) |
| Internet use | | | | | | | | |
| Gaming mainly | 56 (1.7) | 13 (2.8) | 18 (1.5) | 0 (/) | 8 (1.9) | 11 ()3.4 | 4 (1.6) | 2 (0.4) |
| Diff. activities incl. gaming | 1275 (39) | 255 (55.8) | 382 (31.6) | 41 (25.5) | 129 (31.3) | 162 (50.5) | 71 (28.3) | 235 (51.9) |
| Diff. activities w/out gaming | 1939 (59.3) | 196 (42.2) | 808 (66.9) | 120 (74.5) | 275 (66.7) | 148 (46.1) | 176 (70.1) | 216 (47.7) |
| Hours of Internet browsing per day, n (%) | | | | | | | | |
| 1–3 hours | 1360 (41.6) | 199 (42.9) | 500 (41.4) | 79 (49.1) | 140 (34) | 167 (52) | 80 (31.9) | 195 (43.0) |
| 4–6 hours | 1273 (38.9) | 198 (42.7) | 437 (36.2) | 71 (44.1) | 159 (38.6) | 122 (38) | 109 (43.4) | 177 (39.1) |
| 7–9 hours | 302 (9.2) | 31 (6.7) | 127 (10.5) | 6 (3.7) | 50 (12.1) | 15 (4.7) | 27 (10.8) | 46 (10.2) |
| 10 and more hours | 335 (102) | 36 (7.8) | 144 (11.9) | 5 (3.1) | 63 (15.3) | 17 (5.3) | 35 (13.9) | 35 (7.7) |

## Questionnaires

**Internet Gaming Disorder Self-report for College/University Students by the ICMH-SG (ICMH – IGD scale; Appendix 1).** The principal investigators (DS, AD, YSB, and OA) initially developed a pool of items for the questionnaire, guided with the principle that the DSM–5 and ICD–11 symptoms be covered as much as possible. Afterwards, the comments from the other authors were sought and their implementation led to the development of the final version. Following the IGDS9–SF (Pontes & Griffiths, 2015) and the C–IGDS (Sigerson et al., 2017), in adapting the nine DSM–5 symptoms of IGD for our questionnaire, we also converted each DSM–5 symptom into self-report items, minimally altering the original wording of the proposed symptoms. There were two major modifications compared to the mentioned measures. The *preoccupation with gaming* symptom in the IGDS9–SF and C–IGDS is framed practically the same as proposed by the DSM–5, but the main concept put forward is the *feelings of preoccupation* "... feel preoccupied with your gaming behavior/Internet games? (Some examples: Do you think about previous gaming activity or anticipate the next gaming session? Do you think gaming has become the dominant activity in your daily life?)" (Pontes & Griffiths, 2015; Sigerson et al., 2017). However, in the IGD scale with 9 items (Lemmens et al., 2015), this item is conceptually focused on *thinking* "... have there been periods when all you could think of was the moment that you could play a game?" Therefore, we decomposed this symptom into three items in order to ease its interpretation and to cover the thinking/behavioral aspect of the preoccupation with gaming, i.e., "I constantly think about games I play on the Internet"; "I anticipate playing the next Internet game", and "Internet gaming becomes a dominant activity in my life". The second modification concerns the fourth DSM–5 symptom, *unsuccessful attempts to control the participation in Internet games,* which was worded simply as "I cannot control my Internet gaming" in order to convey the persistence of playing and lacking control over gaming habits as proposed by the ICD–11 (WHO, 2018). In this regard, the questionnaire consists of

11 items all to be answered on a 5-point Likert scale with values ranging from 1 (*never*) to 5 (*always*), where a higher score indicates a greater difficulty. Four items ("I cannot control my Internet gaming"; "I am not interested in hobbies, social activities, or entertainment because I have Internet games"; "I continue to play my Internet games, even when I no longer feel good about it", and "I jeopardized or lost a significant relationship, job or educational or career opportunity because of participation in Internet games") directly tapping the three main ICD–11 criteria for GD of predominantly the online type (WHO, 2018).

Thus, two composite scores were anticipated. The first score for a nine-item scale as a sum of all answered items considering that from the first three items only one score is used, namely the highest score answered on any of the first three items. The other score for a-four item scale related to the ICD–11 is also created as a sum of all answered items (Item 4, 5, 6, and 9, Appendix). Thus, the total score could range 9–45 and 4–20 respectively, with higher scores indicating a greater intensity of IGD symptoms present.

The ICMH–IGD scale was developed in English and it was translated and culturally adapted using the same approach for all language versions: two forward translations, a single form development, a single back-translation, and reconciliation. Firstly, all items were translated from English into each country's native language, namely Bulgarian, Croatian, Lithuanian, Polish, Portuguese, Spanish, Serbian, Turkish, and Vietnamese. After the first translation, the items were back-translated by independent translators into English. Finally, an open discussion among the authors followed specially to evaluate to which extent participants to whom English is not the first language would understand/interpret the items. It was concluded that all items were comprehensive, precise and relevant and no item was added, replaced or omitted in the translations, which has ensured item and conceptual equivalence among the language versions.

**Generalized Problematic Internet Use Scale-2.** The GPIUS-2 is a multidimensional scale for assessing problematic internet use (Caplan, 2010). The GPIUS-2 has 15 items scored as a Likert-type scale ranging from 1 (strongly disagree) to 7 (strongly agree), where the total score is the sum of all answered items. In this project, we used a version with nine items, which measures problematic internet use as a unidimensional construct (prefers online interaction, talks with others when feeling isolated, preoccupied with the thought of going online, difficulty controlling the amount of time spent online, internet use has made it difficult to manage life, online social interaction is more comfortable, used the internet to feel better, feels lost if unable to go online, and missed social engagements or activities). Total scores range from 0 to 63, where higher scores indicate greater symptom severity for both questionnaires. Cronbach's alpha of the GPIUS 9 item-scale in the present study was .88.

**Patient Health Questionnaire 9 (PHQ–9) and Generalized Anxiety Disorder 7 (GAD–7).** The PHQ–9 was designed to assess major depressive symptoms (Kroenke, Spitzer, & Williams, 2001). It comprises of nine items scored on a four-point Likert scale from of 0 (*not at all*) to 3 (*nearly every day*), with total scores ranging from 0 to 27. The GAD–7 questionnaire was designed to assess anxiety symptoms in general, but mostly related to the generalized anxiety disorder (Kroenke, Spitzer, Williams, Monahan, & Löwe, 2007). It consists of seven items also scored on a four-point Likert scale from of 0 (*not at all*) to 3 (*nearly every day*), with total scores ranging from 0 to 21. Higher scores indicate greater symptom severity for both questionnaires. Both PHQ–9 and GAD–7 have accumulated data supporting strong reliability and validity (https://www.phqscreeners.com/). Cronbach's alpha of the PHQ–9 and GAD–7 in the present study were .88 and .91, respectively.

## Data Analysis

The initial statistical analyses included the assessments of the factor structure (i.e., confirmatory factor analysis [CFA]), correlations with external validation measures, and internal consistency. All analyses were performed using SPSS version 24 and the R package lavaan (Rosseel, 2012). Robust maximum likelihood estimator (MLR; Yuan & Bentler, 2000) was used to test CFA models since it was suggested as an appropriate method when

the number of response options is five or more in order to account for non-normality in the distribution of the data (Rhemtulla, Brosseau-Liard, & Savalei, 2012). Pairwise deletion was used to handle missing data (as the amount was negligible, 0.1–0.2%). Absolute model fit to the data was evaluated using the comparative fit index (CFI), Tucker–Lewis index (TLI), and root mean square error of approximation (RMSEA) with the following cut-offs: TLI and CFI ≥ .90, RMSEA ≤ .08 as adequate; TLI and CFI ≥ .95, RMSEA ≤ .06 as good fit; RMSEA ≤ .10 as marginal fit; Hu & Bentler, 1999; Brown, 2006).

Afterwards, multigroup CFA (MG-CFA) approach was used to assess the measurement invariance of the proposed model across languages and across genders. Prior to specifying the configural equivalence model as the baseline model for the comparison with more restricted (i.e., nested) models, the proposed unidimensional structure of the questionnaire was fitted to each of the samples across languages group in order to ascertain whether the structure derived on the total sample is appropriate for the subsamples as well (Brown, 2006). We included correlated residuals, as suggested by modification indices and if theoretically justified, as the way to account for the local dependencies among items when needed to achieve adequate model fit. Since these correlated residuals may capture the idiosyncrasies of particular samples, if not substantial in a number, they are not taken as evidence against essential unidimensionality. Next, configural invariance is deemed satisfactory if the model held across groups and if the configural invariance model showed adequate overall fit to the data. Finally, metric (equal loadings) and scalar (equal intercepts) invariance models were tested respectively sequentially as this incremental strategy gives the way for examining sources of non-invariance (Brown, 2006). A change in the approximate fit indices was used to judge the difference in the fit between nested models and it was combined ΔCFI greater than .01 and ΔRMSEA greater than .015 as cut-off criteria (Chen 2007; Cheung & Rensvold, 2002; Sass, Schmitt, & Marsh, 2014).

## Results

### Factor Structure and Measurement Invariance

A CFA of the nine-item scale (i.e., a single IGD underlying factor represented by all nine DSM–5 symptom-items) showed an excellent model fit for the total sample (MLR$\chi^2$ (*df*) = 237.57 (27); TLI = .952, CFI = .964, and RMSEA [90% CI] = .049 [.046–.052]) with all standardized regression weights being statistically significant ($p < .001$; Table 3 and Table 4). In order to cross-validate the structure obtained in the total sample, the model was fitted in separate subsamples based on the language versions. Two samples (Turkish and Polish) required correlated residuals to be specified in order to achieve adequate fit to the data. It is possible that these correlated residuals captured the local dependencies between items and the appearance of which may have been facilitated by smaller sample sizes that allowed pronounced influences of idiosyncratic features of the samples in question. Thus, these modifications do not provide definitive evidence against essential unidimensionality in these samples. Hence, we took these results as evidence of model's cross-replication and proceed with testing the configural invariance model which had an adequate fit to the data. The full metric invariance model showed a substantial deterioration in model fit (as evidenced by a change in CFI).Therefore, omnibus score test for removing equality constraints of each of the parameters (while all others are constrained to be equal; anchors) across all groups guided the identification of non-invariant indicator loadings/intercepts. Largest $\chi^2$

values (omnibus score test) were associated with the removal of constraints of first ($\chi^2(6) = 124.46$; $p < .001$) and fifth ($\chi^2(6) = 121.58$; $p < .001$) indicator's loading followed by somewhat heightened value associated with item 8 ($\chi^2(6) = 96.92$; $p < .001$).Removing two constraints (loadings of items 1 and 5) led to a substantial improvement in model fit as evidenced by CFI and RMSEA difference compared to the configural model. Therefore, these two parameters were left unconstrained in all subsequent analyses (while further constraints were imposed) and the invariance testing was continued under a partial invariance framework. The scalar invariance model showed a substantial reduction in fit. Omnibus score tests for removing equality constraints of each of the intercepts indicated non-invariance of intercepts of items 1 ($\chi^2(6) = 144.33$; $p < .001$), item 5 ($\chi^2(6) = 130.02$; $p < .001$), and item 8 ($\chi^2(6) = 144.77$; $p < .001$). Removing constraints for these three intercepts across groups resulted in a partial scalar invariance model that did not differ substantially from the partial metric model in terms of model fit indices.

A CFA analysis of the four-item scale (i.e., a single IGD underlying factor represented by all four ICD–11 symptom-items) provided a close-to-perfect (excellent) model fit for the total sample and across all language groups. Fit indices of the metric invariance model were not have substantially reduced in comparison to the unconstrained model. Following the results of the nine-item version and the non-invariance of item 5, these constraints were also removed, resulting in a partial metric invariance model. Finally, scalar invariance was not supported, and the non-invariance of item 5 indicator's intercept was found resulting in the partial scalar invariance model fitting equally well as the baseline configural model.

Table 3
*Factor loadings of the nine items in the total sample (N = 3257)*

| Item | Nine-item scale | Four-item scale |
|---|---|---|
| Being preoccupied with my Internet gaming | .69 | |
| If I am not playing my Internet games, I feel irritable, anxious, distressed or sad | .82 | |
| I feel a continued need to play more and more Internet games | .87 | |
| I cannot control my Internet gaming | .86 | .85 |
| I am not interested in hobbies, social activities, or entertainment because I have Internet games | .76 | .77 |
| I continue to play my Internet games, even when I no longer feel good about it | .83 | .83 |
| I hide the fact that I play Internet games a lot from other people or tell them that I have decreased the amount of Internet gaming, even when I had not | .80 | |
| I play Internet games to escape or relive a negative mood I have like feelings of helplessness, guilt, sadness or anxiety | .69 | |
| I jeopardized or lost a significant relationship, job or educational or career opportunity because of participation in Internet games | .79 | .80 |

*Note*. Item Being preoccupied with my Internet gaming scored as the highest score from items I constantly think about games I play on the Internet; I anticipate playing the next Internet game, and Internet gaming becomes a dominant activity in my life. All factor loadings were statistically significant (i.e., $p < .01$), with the communalities of > .4.

Table 4
*CFA and measurement invariance results across language groups*

| Language | MLR$\chi^2$ (df)* | TLI | CFI | RMSEA [90% CI] | ΔCFI/ΔRMSEA |
|---|---|---|---|---|---|
| Nine-item scale | | | | | |
| Total sample (*n* = 3257) | 237.57 (27) | .952 | .964 | .049 [.046–.052] | / |
| Croatian (*n* = 463) | 46.06 (27) | .938 | .953 | .039 [.029–.049] | / |
| English (*n* = 1208) | 87.43 (27) | .973 | .980 | .043 [.037–.049] | / |
| Polish (*n* = 161) | 41.46 (24)[b] | .900 | .933 | .067 [.046–.088] | / |
| Portuguese (*n* = 412) | 79.78 (27) | .895 | .922 | .069 [.061–.077] | / |
| Serbian (*n* = 321) | 41.89 (27) | .939 | .954 | .041 [.031–0.52] | / |
| Turkish (*n* = 251) | 58.76 (25)[a] | .889 | .923 | .073 [.060–.087] | / |
| Vietnamese (*n* = 445) | 67.55 (27) | .938 | .953 | .058 [.046–.071] | / |
| Configural Invariance | 478.23 (189) | .925 | .944 | .057 [054–.061] | / |
| Metric Invariance | 597.88 (237) | .926 | .930 | .057 [.054–.060] | .014/0 |
| Partial Metric Invariance (item 1 and 5 loadings freed) | 524.00 (225) | .935 | .942 | .053 [.050–.057] | .002/.004 |
| Scalar Invariance | 755.76 (273) | .914 | .907 | .065 [.062–.067] | .035/-.012 |
| Partial Scalar Invariance (item 1, 5, and 8 intercepts freed) | 603.60 (255) | .933 | .933 | .054 [.051–.057] | .009/-.001 |
| Four-item scale | | | | | |
| Total sample (*N* = 3261) | .35 (2) | 1.004 | 1.000 | .000 [.000–.000] | |
| Croatian (*n* = 463) | .94(2) | 1.033 | 1.000 | .000 [.000–.037] | / |
| English (*n* = 1208) | 3.02 (2) | .996 | .999 | .021 [.000–.046] | / |
| Polish (*n* = 161) | .23(2) | 1.168 | 1.000 | .000 [.000–.000] | / |
| Portuguese (*n* = 412) | .45(2) | 1.032 | 1.000 | .000 [.000–.000] | / |
| Serbian (*n* = 321) | .38(2) | 1.09 | 1.000 | .000 [.000–.000] | / |
| Turkish (*n* = 251) | 2.18(2) | .993 | .998 | .019 [.000–.071] | / |
| Vietnamese (*n* = 445) | .08 (2) | 1.034 | 1.000 | .000 [.000–.000] | / |
| Configural Invariance | 6.52 (14) | 1.020 | 1.000 | .000 [.000–.000] | / |
| Metric Invariance | 38.13 (32) | .993 | .995 | .020 [.000– .031] | .005/-.02 |
| Partial Metric Invariance (item 5 loading freed) | 18.974 (26) | 1.009 | 1.000 | .000 [.000–.000] | -.007/.02 |
| Scalar Invariance | 57.432 (44) | .989 | .988 | .026 [.015–.035] | .012/-.026 |
| Partial Scalar Invariance (item 5 intercept freed) | 29.918 (38) | 1.008 | 1.000 | .000 [.000–.000] | -.012/-.026 |

*Note*. MLR = Robust maximum likelihood estimator; TLI = Tucker–Lewis index; CFI = comparative fit index; RMSEA = root mean square error of approximation.

[a]Error correlations between items 1 and 3 and between items 6 and 7; [b]Error correlations between items 7 and 9, items 1 and 5, and items 1 and 3.

Full scalar invariance for the two genders was found for both versions (Table 5).

Table 5
*CFA and measurement invariance results across gender*

| Gender | MLR$\chi^2$ (df)* | TLI | CFI | RMSEA [90% CI] | ΔCFI/ΔRMSEA |
|---|---|---|---|---|---|
| Nine-item scale | | | | | |
| Female | 151.17 (27) | .949 | .961 | .047 [.043–.051] | / |
| Male | 135.68 (27) | .943 | .958 | .059 [.052–.065] | / |
| Configural Invariance | 290.40 (54) | .947 | .960 | .052 [.049–.055] | / |
| Metric Invariance | 316.42 (62) | .951 | .957 | .050 [.047–.053] | .003/.002 |
| Scalar Invariance | 364.98 (70) | .949 | .951 | .051 [.048–054] | .006/.001 |
| | | | | | |
| Four-item scale | | | | | |
| Female | 5.164(2) | .988 | .996 | .028 [.013–.042] | / |
| Male | .513 (2) | 1.007 | 1.000 | .000 [.000–.000] | / |
| Configural Invariance | 5.97 (4) | .996 | .999 | .017 [.000–.031] | / |
| Metric Invariance | 16.11 (7) | .989 | .994 | .028 [.018–.038] | .005/.011 |
| Scalar Invariance | 21.34 (10) | .991 | .992 | .026 [.017–.036] | .002/.002 |

*Note.* MLR = Robust maximum likelihood estimator; TLI = Tucker–Lewis index; CFI = comparative fit index; RMSEA = root mean square error of approximation.

## Internal Consistency Reliability and Known Group Validity

Cronbach's alpha (α) was used to test the internal consistency of the composite score for the nine-item and four-item scale. For the total sample and across all language groups α was above .73 (Table 6).

Table 6
*Mean (SD) values and Cronbach's alpha (α) for the nine-item and four-item scale*

| Sample | Nine-item scale *M* (*SD*), range | α | Four-item scale *M* (*SD*), range | α |
|---|---|---|---|---|
| Total (*N* = 3270) | 13.12 (6.25), 9–45 | .93 | 5.42 (2.75), 4–20 | .89 |
| Croatian (*n* = 464) | 10.90 (3.68), 9–32 | .86 | 4.54 (1.44), 4–15 | .73 |
| English (*n* = 1208) | 15.10 (7.58), 9–45 | .94 | 6.37 (3.44), 4–20 | .91 |
| Polish (*n* = 161) | 11.43 (4.42). 9–35 | .89 | 4.87 (1.94), 4–17 | .80 |
| Portuguese (*n* = 412) | 11.07 (5.08), 9–45 | .95 | 4.64 (2.13), 4–20 | .85 |
| Serbian (*n* = 321) | 10.65 (4.07), 9–45 | .91 | 4.47 (2.12), 4–20 | .81 |
| Turkish (*n* = 251) | 13.09 (6.38), 9–35 | .92 | 5.38 (2.65), 4–20 | .83 |
| Vietnamese (*n* = 453) | 14.35 (4.67), 9–36 | .87 | 5.42 (2.27), 4–16 | .81 |

Based on a one-way analysis of variance (ANOVA), statistically significant differences in the composite score of the nine-item scale ($F(2, 3267) = 134.15$, $p < .01$, Cohen's $f = .29$) and four-item scale ($F(2, 3267) = 73.96$, $p < .01$, Cohen's $f = .23$) were found when comparing students who were using the Internet for gaming only, students who were using the Internet for different activities including gaming, and students who were using the Internet for different activities without gaming. Students reported using the Internet mainly

for gaming had both composite scores statistically higher ($n$ = 56; $M$ $[SD]_{\text{nine-item}}$ = 17.96 [9.29]; $M$ $[SD]_{\text{four-item}}$ = 7.39 [3.94]) compared to those students who were using the Internet for different activities including gaming ($n$ = 1275; $M$ $[SD]_{\text{nine-item}}$ = 15.03 [6.80]; $M$ $[\text{SD}]_{\text{four-item}}$ = 6.02 [3.05]; $p < .01$, Cohen's $d$ = .36 and Cohen's $f$ = .39, respectively) or to those students using the Internet for different activities without gaming ($n$ = 1939; $M$ $[SD]_{\text{nine-item}}$ = 11.73 [5.30]; $M$ $[SD]_{\text{four-item}}$ = 4.97 [2.37]; Cohen's $d$ = .82 and Cohen's $f$ = .74, respectively). Low Pearson correlations were found between the nine-item and the four-item scale and scores of the GPIUS 9 item-scale ($r_{\text{nine-item}}$ = .33. 95% CI [.30–.36]; $r_{four\text{-item}}$ = .29. 95% CI [.26–.33]), GAD–7 ($r_{\text{nine-item}}$ = .15, 95% CI [.11–.18]; $r_{\text{four-item}}$ = .14. 95% CI [.10 –.17]), and PHQ–9 ($r_{\text{nine-item}}$ = .20. 95% CI [.17–.23]; $r_{\text{four-item}}$ = .19.95% CI [.17–.23]). The nine-item and the four-item scale scores were highly correlated ($r$ = .95; 95% CI [.94–.96]).

## Discussion

By studying IGD symptoms among college/university students across multiple countries, this study provides additional data on Internet gaming addiction assessment instruments, with a possibility to generalize the findings worldwide.

Recent findings with the IGD scale (Lemmens et al., 2015), IGDT–10 (Király et al., 2017; Király et al., 2019), IGDS9–SF (Evren et al., 2018; Monacis, Palo, Griffiths & Sinatra, 2016; Pontes & Griffiths, 2015; Wu et al., 2017) and C–IGDS (Sigerson et al., 2017) confirmed that the IGD symptoms proposed by the DSM–5 can be measured as a single underlying factor both among individuals at risk, namely online gamers and in the general population. Results of our factor analyses are in line with these findings (Yam et al., 2019) indicating the undimensionality of the nine-items scale among college/university students of the countries participating in the study. Findings indicate that four symptom-items tapping directly into the main ICD–11 criteria are also represented as a single underlying factor. The single underlying factor represented by nine and four items of IGD was confirmed across different language samples included, namely Croatian, English, Polish, Portuguese, Serbian, Turkish, and Vietnamese, which extends previous findings reported from Hong Kong (Yam et al., 2019). However, three items out of nine (i.e., *pre-occupation with Internet games*, *loss of interests in previous hobbies and entertainment*, and *use of Internet games to escape or relieve a negative mood*) were found to be non-invariant across the languages studied, which indicates that these items are perceived differently and that they likely do not convey equal importance in representing IGD across multiple languages. Thus, we found partial scalar invariance for both the nine- and four-item versions of the scale. This result is in line with the findings from a study using data from gamers in the United States of America, India and the United Kingdom, which confirmed only configural invariance and found five non-invariant symptom-items including items 1 and 8 as in ours

(Pontes, Stavropoulos, & Griffiths, 2017). In a similar study among American, Australian, and British gamers, non-invariant loadings of items 1, 2, and 5, with non-invariant intercepts for items 1, 5, 7, and 9 were found (Stavropoulos et al., 2018), while in a study with Albanian, American, British, and Italian gamers, factor loadings of items 1, 2, 4, 7, and 9 and intercepts of items 1, 2, 3, 4, 5, 7, and 8 appeared to be non-invariant (de Palo et al., 2018). On the contrary, Király et al. (2019) found the full measurement invariance for IGD symptoms across Hungarian, Iranian, English-speaking, French-speaking, Norwegian, Czech, and Peruvian online gamers. Taken together, there might be some IGD symptoms sensitive to language/cultural/societal influences, likely pre-occupation with Internet games and loss of interests in previous hobbies and entertainment, and this needs to be considered in cross-cultural/language comparisons.

Separate analyses in our study showed that the nine-item and four-item model are invariant across genders, which indicates that the IGD construct is relatively independent of the gender effects, as previously observed (Király et al., 2019; Monacis et al., 2016; Sigerson et al., 2017). In this regard, our findings indicate that both scales could be used for cross-gender comparisons.

Further findings showed that self-reports with nine and four items in our study have sound internal consistency in the overall and separate language samples. These findings indicate similar co-variances between the nine item-symptoms and a satisfactory homogeneity (Wyrwich, Nienaber, Tierney, & Wolinsky, 1999) in the measurements with composite scores, which all correspond to previous findings with the similar nine-item measure (Evren et al., 2018; Monacis et al., 2016; Pontes & Griffiths, 2015; Wu et al., 2017). In addition to the internal consistency aspects, the results also showed that both self-reports have appropriate aspects of construct validity, known-group and discriminant validity. Students using the Internet for gaming only had the highest scores in the study, thus at the greatest risk for IGD (Long et al., 2018), compared to students who use the Internet for different activities including gaming and students using the Internet for different activities but without gaming. The self-reports are likely measuring different symptoms in relation to problematic Internet use, as well as anxiety and depressive symptoms. Previous research showed that problematic Internet use and problematic online gaming are not the same construct (Király et al., 2014), which is confirmed by our results.

There are some limitations to be acknowledged regarding the methodology of our study. It should be noted that only students who agreed to participate were included and that the response rates varied substantially between countries. The sampling was convenient and those who may have different or more pronounced patterns of IGD might not have participated. An important limitation could be using the English language in the survey for participants, to whom this is not the first language, like those from Bangladesh, Italy, Nepal, Nigeria, Sweden, or the UAE, although these students might have been required to speak English during their studies. In addition, we could not obtain enough data for different sub-cultural and sub-racial groups, which could limit the generalizability of the findings. Next, data was based solely on self-reports, which could have affected

the findings, and no behavioral observations or clinical indices were used to confirm this self-report measure. Finally, additional psychometric aspects, such as screening properties, test-retest, responsiveness or predictive validity, and diagnostic accuracy were not tested.

Summarizing, this study confirmed that the proposed nine DSM symptoms of IGD could be measured as a single underlying factor among college/university students. Nine items representing the DSM–5 and a four-item scale representing the ICD–11 symptoms were found to be unidimensional measures with sound internal consistency and construct validity. In addition, the IGD construct was gender invariant, although some symptoms could be sensitive to language/cultural influences. This should be taken into consideration in cross-cultural comparisons. In order to replicate the findings, future research on IGD should consider the limitations presented above and include more diverse samples of college/university students worldwide.

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## Procenjivanje simptoma poremećaja igranja kompjuterskih igara na internetu (eng. Internet Gaming Disorder) kod studenata: internacionalna validaciona studija mere samoprocene

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U ovoj studiji su procenjena psihometrijska svojstva skale samoprocene koja je namenjena proceni simptoma poremećaja igranja kompjuterskih igrara na internetu (eng. Internet Gaming Disorder–IGD) prema DSM–5 i ICD–11 klasifikacijama mentalnih bolesti na uzorku od 3270 studenata (2095 [64.1%] devojaka; prosečna starost 21.6 [3.1] godina) iz više zemalja. Ispitana je hrvatska, engleska, poljska, portugalska, srpska, turska i vijetnamska verzija skale. Rezultati su pokazali da se kod studenata IGD simptomi mogu izmeriti instrumentom u čijoj osnovi leži jedan faktor. Skala od devet stavki koje se odnose na DSM–5 kriterijume i kratka skala od četiri stavke koja se odnosi na glavne simptome prema ICD–11 kriterijumima imaju zadovoljavajuću internu konzistentnost i konstruktnu validnost. Merna invarijantnost u odnosu na različite jezike je utvrđena za tri ajtema (preokupiranost igranjem onlajn igara, gubljenje interesovanja za dotadašnje hobije i zabavu i korišćenje igranja za rasterećenje od negativnih emocija). Ova studija je ponudila početne podatke za procenu simptoma poremećaja igranja kompjuterskih igrara na internetu kod studenata i nadamo se da će podstaći buduća istraživanja zavisnosti od kompjuterskih igrara u populacijama širom sveta uzimajući u obzir jezičke/kulturološke razlike.

**Ključne reči:** igranje igara, internet, kros-kulturološka ekvivalentnost.

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## Appendix 1

Internet gaming disorder self-report for college/university students by the ICMH-SG (ICMH– IGD scale)

| DSM–5 Symptom (APA, 2013) | Item | *Always* | *Almost always* | *Sometimes* | *Almost never* | *Never* |
|---|---|---|---|---|---|---|
| Pre-occupation with Internet games (The individual thinks about previous gaming activity or anticipates playing the next game; Internet gaming becomes the dominant activity in daily life) | I constantly think about games I play on the Internet | | | | | |
| | I anticipate playing the next Internet game | | | | | |
| | Internet gaming becomes a dominant activity in my life | | | | | |
| Withdrawal symptoms when Internet gaming is taken away (Symptoms are typically described as irritability, anxiety, or sadness) | If I am not playing my Internet games, I feel irritable, anxious, distressed or sad | | | | | |
| Tolerance – the need to spend increasing amounts of time engaged in Internet games | I feel a continued need to play more and more Internet games | | | | | |
| Unsuccessful attempts to control the participation in Internet games | I cannot control my Internet gaming | | | | | |
| Loss of interests in previous hobbies and entertainment as a result of, and with the exception of, Internet games | I am not interested in hobbies, social activities, or entertainment because I have Internet games | | | | | |
| Continued excessive use of Internet games, despite knowledge of psychosocial problems | I continue to play my Internet games, even when I no longer feel good about it | | | | | |
| Has deceived family members, therapists, or others regarding the amount of Internet gaming | I hide the fact that I play Internet games a lot from other people or tell them that I have decreased the amount of Internet gaming, even when I had not | | | | | |
| Use of Internet games to escape or relieve a negative mood (e.g. feelings of helplessness, guilt, anxiety) | I play Internet games to escape or relive a negative mood I have like feelings of helplessness, guilt, sadness or anxiety | | | | | |
| Has jeopardized or lost a significant relationship, job, or educational career opportunity because of participation in Internet games | I jeopardized or lost a significant relationship, job or educational or career opportunity because of playing Internet games | | | | | |

*Instruction*. Please, think about your Internet gaming activities over the **past 12 months** and select one response for each question that best describes you.

*Scoring instructions.* When using the scale, the column with DSM-5 symptoms should be removed.

Use the following scores for responses: *Always* = 5, *Almost always* = 4, *Sometimes* = 3, *Almost never* = 2, and *Never* = 1. Use the highest score from all items answered for Item 1, 2 and 3. To obtain the total score, summarize all nine scores. The total score could range from 9 to 45, where the higher score indicates more problematic Internet gaming and symptoms of Internet gaming disorder.

Items in Italic (i.e., item 4, 5, 6, and 9) represent the ICD–11 criteria for Gaming disorder (GD), predominantly online; lacking control over gaming habits (Item 4), prioritizing gaming over other interests and activities (Item 5), and continuing gaming despite its negative consequences (Item 6 and 9). These items can be summated and can be used as a separate scale with a score ranging from 4 to 20.