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Psychometric evaluation of the Russian version of the Gaming Disorder Scale for Adolescents

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Abstract
Problematic gaming has become an emerging global health issue. Formal recognition of gaming disorder in the ICD-11 is a new opportunity for the discipline to conduct further investigation concerning the psychological consequences of problematic gaming. The present study investigated the psychometric properties and construct structure of the recently developed Gaming Disorder for Scale for Adolescents (GADIS-A), a multi-dimensional instrument that screens for gaming disorder symptoms, among Russian adolescent gamers. The sample comprised 933 adolescent gamers (547 boys and 386 girls) recruited via a web-based platform, using a multistage sampling method. Analysis showed the GADIS-A had very good internal consistency (Cronbach's alpha coefficient = .891; Composite reliability = .89) and adequate test–retest reliability after two weeks (intraclass coefficient =0.68 with 95% CI [0.61, 0.77]. Exploratory structural equation modeling (ESEM) showed the data fitted well. Measurement invariance testing indicated the GADIS-A was invariant by gender and gaming medium (online vs. offline). As for criterion-related validity, high scores on the GADIS-A positively correlated with scales assessing depression, anxiety, impulsivity, and difficulties in emotion regulation, and negatively correlated with social connectedness and life satisfaction. Using latent profile analysis, four groups of gamers were identified, and problematic gaming was associated with greater mental health problems. The findings indicated that psychological comorbidity (e.g., depression and anxiety) was more prevalent among gamers with higher risk of GD. The findings indicate that GADIS-A is a reliable and valid instrument to assess the symptoms and severity of gaming disorder among Russian adolescents.

Keywords Gaming · Gaming disorder · IGD · Online behavior · Exploratory structural equation modeling · Latent profile analysis · Measurement invariance

Background

The substantial development of online infrastructure and ever improving digital technologies have generated many opportunities for social interaction, educational activities, and leisure (e.g., gaming), and has led to major societal and individual changes (Kuss & Billieux, 2017; van Laer & Van Aelst, 2010). However, there is now a sizeable empirical base demonstrating that human-technology interactions can be problematic and/or addictive for a small minority of individuals (Gómez-Galán, Martínez-López, Lázaro-Pérez, & Sánchez-Serrano, 2020). Particularly for adolescents, excessive gaming is an emerging and has become a global health issue. Gaming behavior may be viewed as being on a continuum with non-problematic gaming at one end and problematic (i.e., addictive or pathological) gaming at the other (Lau, Stewart, Sarmiento, Saklofske, & Tremblay, 2018). Epidemiological studies have reported prevalence rates of pathological gaming among adolescents ranging from 1% to 6% across different countries and jurisdictions (Anthony et al., 2020; (Stevens, Dorstyn, Delfabbro, & King, 2020). Similarly, research into GD has substantially grown on a global level. However, comparison and interpretation of findings can be difficult due to methodological issues such as heterogeneity among the many different screening tools (Pontes et al., 2019).

Gaming disorder assessment

In 2013, internet gaming disorder (IGD) was recognized as a tentative mental health condition and an area for further study in the latest (fifth) edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; American Psychiatric Association, [APA] 2013). IGD is described as *"a pattern of persistent or recurrent gaming behavior ('digital gaming' or 'video-gaming')" leading to clinical impairment*" (APA, 2013, p. 795). Recent research has employed scales assessing the nine core criteria for IGD (e.g., the nine-item Internet Gaming Disorder Scale-Short Form [IGDS9-SF]; Pontes & Griffiths, 2015). More recently, gaming disorder (GD) was included as an official diagnosis in the eleventh revision of the International Classification of Diseases (ICD-11; World Health Organization, 2018).

According ICD-11, three clinical criteria must be met diagnosis of GD: *"(*i) the lack or impaired of control over playing digital games, (ii) given prioritization to playing digital game over other life activities, and (iii) the lack of the ability to stop gaming in spite of awareness of increased the negative consequences*"* (World Health Organization, 2018). Also, to be diagnosed with GD, the disordered behavior must result in significant disruption in key domains of daily functioning (e.g., severe compromising of relationships, educational/occupational activity) for at least 12 months (Jo et al., 2019). The time criterion may be shortened if the symptoms are significantly severe and all diagnostic criteria are met. The inclusion of GD in ICD-11 was based on comprehensive reviews of existing empirical evidence on the phenomenon and represented a general agreement among experts from various disciplines (Griffiths, Kuss & Pontes, 2021; Reed et al., 2019). There is lack of the screening tools that assess optimal dimensions of the GD construct as defined by the WHO. Also, the recognition of GD in the ICD-11 is a new opportunity for the discipline to conduct further investigations concerning the psychological consequences of problematic gaming (King et al., 2020). The new challenge for the field is the development of a theoretically and psychometrically standardized instrument to assess GD within this new framework (King et al., 2020; Rumpf et al., 2018).

The four-item Gaming Disorder Test (GDT) is the first reliable instrument developed based on the new ICD-11 criteria for GD (Pontes et al., 2019). However, the scale currently has no cut-off score to diagnose GD and the framework is arguably too narrow in covering all GD criteria based on previous research. For example, based on the ICD-11 criteria, both the GD symptoms and the impairment to daily life must be presented for a valid GD diagnosis, which underlines the different conceptualization and diagnostic approach of the ICD-11 compared to the DSM-5. Therefore, a bi-dimensional framework may be more accurate in GD diagnosis than a unidimensional one. Also, instruments must be able to clearly differentiate the less severe and non-disordered types of problematic gaming.

According to the ICD-11, hazardous gaming (HG) refers to gaming (online or offline) which appreciably increases the risk of harmful physical or mental health consequences to the individual or to others around the individual. The amplified risk can be from the (i) frequency of gaming, (ii) amount of time spent on gaming, (iii) neglect of other interests and needs, (iv) hazardous behaviors related with gaming or its setting, (v) harmful consequences of gaming, or (vi) a combination of these. Also, a GD time criterion should be included in screening instruments to reduce potential overestimation of GD diagnosis (something which was not included in the GDT).

Adolescence is among the most vulnerable periods for the acquisition of potentially addictive disorders, including addiction to gaming (King & Delfabbro, 2020). In relation to disordered gaming, adolescents are recognized as the one of the key vulnerable populations at risk (Aydın, Güçlü, Ünal-Aydın, & Spada, 2020; Paulus, Ohmann, von Gontard, & Popow, 2018). Adolescence is a transitional stage for young individuals that is characterized by physical and psychological changes. According to neuroscientific research, adolescence is associated with rapid brain development that can impact emotional, physical, and mental ability. Evidence indicates that problematic gaming may impede brain development among affected adolescents (Han, Lyoo, & Renshaw, 2012). Neuroimaging studies support the similarities of problematic gaming with substance-related addictions at different levels. Research has demonstrated significant associations between problematic gaming behaviors and depression (Brunborg, Mentzoni, & Frøyland, 2014), anxiety (Bonnaire & Baptista, 2019), and sleep disturbance (Burleigh, Griffiths, Sumich, Stavropoulos, & Kuss, 2019; Lam, 2014). However, there is only limited empirical evidence as to whether GD is the cause or just the consequence of such psychopathologies (González-Bueso et al., 2018). For an accurate GD assessment, a developmental approach in designing a specific instrument may provide the opportunity to carry out more robust research among adolescents.

The Gaming Disorder Scale for Adolescents (GADIS-A; Paschke et al., 2020) was developed based upon the ICD-11 diagnostic criteria for GD. The GADIS-A comprises two factors: (i) cognitive-behavioral symptoms and (ii) negative consequences. This bi-dimensional framework may provide an assessment of both symptom and disability aspects. Also, GADIS-A suggests a cut-off score for GD diagnosis. Adolescents are defined as being gaming disordered if the cut-offs for both factors are reached and the time criterion is met. Reaching the cut-off of the factor for cognitive-behavioral symptoms only suggests hazardous gaming. This indicates a higher risk for negative consequences due to the gaming behavior. Reaching the cut-off of the factor negative consequences might only indicate the existence of substantial psychological problems that should be further investigated. Reaching cut-off values without the time criterion being fulfilled may be suggestive of hazardous gaming behavior, which should be further observed. Developmentally, the GADIS-A items are related to the adolescent developmental stage (Lemmens, Valkenburg, & Gentile, 2015). According to findings of the original study, the GADIS-A is reliable and valid instrument in assessing GD among adolescents and indicates good evidence for psychometric properties and factor structure (Paschke et al., 2020).

The present study

While research into GD continues to grow globally, there have been few specific theoretically and psychometrically sound instrument to assess GD among adolescents using the ICD-11 criteria. However, the aforementioned GADIS-A has good preliminary evidence for both its psychometric properties and factor structure but initial evaluation was arguably basic. Therefore, the present study was designed to evaluate the GADIS-A with more robust statistical analysis to help both research and practice in the field. The factor structure of the GADIS-A was originally tested utilizing confirmatory factor analysis (CFA) models. Recently, exploratory structural equation modeling (ESEM), a more robust psychometric method, has been utilized to overcome the limitations of CFA such as overestimated correlations between latent constructs, and by cross-loadings estimation between indicators and latent factors (Marsh, Liem, Martin, Morin, & Nagengast, 2011). ESEM also incorporates the benefits of an exploratory factor analysis (EFA) approach (cross-loadings) and CFA approach (*a priori* defined structure; Asparouhov & Muthén, n.d.). ESEM is a promising framework, representing superior model fit over CFA, and a possible alternative to CFA (Asparouhov & Muthén, 2009; Marsh et al., 2010, 2011).

In addition to ESEM, measurement invariance is a statistical property of a scale demonstrating that the scale assesses the same construct in the intended way across different participants (e.g., different genders, different age groups, different nationalities, etc.). Measurement invariance testing is critical to ensure that scale accuracy is not influenced by different conditions, unrelated to the measurement of the construct (Schumacker & Lomas, 2016; Byrne, 2017). The ESEM approach and measurement invariance were not considered in the development of the GADIS-A. Although problematic offline and online gaming are both associated with mental health problems, there is a lack of research comparing these two gamer groups. Therefore, the present study also uses structural equation modeling (SEM) to investigate associations between mental health indicators and GD among offline and online gamers.

Therefore, the present study investigated the psychometric properties and construct structure of the GADIS-A among Russian adolescent gamers utilizing ESEM and also testing its measurement invariance. Criterion-related validity was investigated by correlating GADIS-A scores against several psychological constructs. More specifically it was expected that the GADIS-A would be associated with low life satisfaction, depression, anxiety, poor emotion dysregulation, high impulsivity, and low social connectedness.

Method

Participants and ethics

The sample comprised 933 adolescent gamers (547 boys [58.6%], 386 girls [41.4%]) recruited via a web-based platform. A multistage sampling method was used for participant recruitment (see 'Procedure' below). Eligibility criteria included (i) having experience of playing online or offline videogames or online gaming during the past 12 months, (ii) being able to read and complete an online consent form and survey, (iii) being fluent in the Russian language, and (iv) providing written informed consent (including consent from parents or legal guardians). The study was approved by the Ethics Committee of Sechenov First Moscow State Medical University (Code 119991).

Measures

Gaming Disorder for Scale for Adolescents (GADIS-A; Paschke et al., 2020): The nine-item GADIS-A (plus a tenth 'time criterion' item) was used to assess GD symptoms according to the ICD-11 criteria. The scale comprises two sub-scales: cognitive-behavioral symptoms comprising four items (e.g., *"I often continue gaming even though it causes me stress with others"*) and (ii) negative consequences comprising five items (e.g., *"Due to gaming, I risk losing important contacts"*). The nine items are rated on a five-point scale from 0 (*strongly disagree*) to 4 (*strongly agree*) with total scores ranging from 0-36. For an adolescent diagnosed with GD, the (i) obtained scores in both sub-scales must exceed the cut-off scores (negative consequences > 5, cognitive-behavioral symptoms > 9), and (ii) time criterion (Item 10: "*How often did you experience such problems, conflicts, or difficulties due to gaming during the past 12 months"*) requires a score of 2 (daily) or 3 (for longer periods). The scale demonstrated good psychometric properties (see 'Results' section).

Satisfaction With Life Scale (SWLS; Diener et al., 1985): The five-item SWLS was used to assess perceived satisfaction with life. The SWLS items (e.g., *"I am satisfied with my life"*) are rated on seven-point scale from 1 (*strongly disagree*) to 7 (*strongly agree*) with total scores ranging from 5-35. Higher scores indicate greater well-being and life satisfaction levels. The SWLS has high reliability and validity in adolescents and can be used at the age of 13 to 21 years (Silva, Taveira, Marques, & Gouveia, 2015). The scale demonstrated good internal consistency in the present study (α=.85).

Depression, Anxiety and Stress Scale (DASS-21; Lovibond & Lovibond, 1995). The 21-item DASS was used to assess depression (seven items: e.g., "*I couldn't seem to experience any positive feeling at all*") and anxiety (seven items: e.g., "*I felt scared without any good reason*") over the past week. Only the depression and anxiety items were used in the present study. Each of the subscale's seven items are rated on a four-point scale from 0 (*never*) to 3 (*almost always*) with total subscale scores ranging from 0-21. Higher scores indicate more severe depression or anxiety symptoms respectively. The two subscales demonstrated a good internal consistency in the present study (depression: α=.81; anxiety: α=.83).

Internet Gaming Disorder Scale-Short Form (IGDS9-SF; Pontes & Griffiths, 2015): The nine-item IGDS9-SF was used to assess IGD symptoms according to nine DSM-5 criteria. The items (e.g., "*Have you deceived any of family member, or therapist or others because the amount of your gaming activity*?") are rated on a five-point scale from 1 (*never*) to 5 (*very often*) with total scores ranging from

9-45. Higher scores indicate higher severity of IGD over the past 12 months. The scale had very good internal consistency in the present study (α=.88).

Difficulties in Emotion Regulation Scale Short Form (DERS-SF; Kaufman et al., 2016): The 18-item DERS-SF was used to emotion dysregulation. The items (e.g., *"When I'm upset, I have difficulty focusing on other things"*) are rated on a five-point scale from 1 (*almost never*) to 5 (*almost always*) with total scores ranging from 18-90. Higher scores indicate greater difficulty in emotion regulation. The scale demonstrated very good internal consistency in the present study (α=.86).

Abbreviated Barratt Impulsiveness Scale (ABIS; Coutlee, Politzer, Hoyle, & Huettel, 2015) The ABIS is a 13-item self-report tool for assessing impulsiveness. Items (e.g., *"I am a careful thinker" reveres coded*), on a four-point scale from 1 (*rarely/never*) to 4 (*almost always /always*) with total scores ranging from 13-52. Higher scores indicate higher impulsiveness scale demonstrated good internal consistency in the present study (α=.89).

Social Connectedness Scale-Revised (SCS-R, Lee, et al., 2001): The SCS-R is a 20 item unidimensional scale that assesses social connectedness. Items (e.g., *"I say things without thinking"*) are rated on seven-point scale from 1 (*strongly disagree*) to 7 (*strongly agree*) with total scores ranging from 20-140. Higher scores indicate greater social connectedness. The scale demonstrated good internal consistency in the present study (α=.84).

Demographic variables: Participants were asked their age and gender. However, socioeconomic status (SES) information was not requested because younger adolescents may not have reliable knowledge of their family's SES. Participants were also asked whether they played videogames predominantly online or offline.

Procedure

Transcultural adaptation of the survey: Transcultural adaptation of the GADIS-A was carried out utilizing a standardized procedure (Beaton, Bombardier & Guillemin, 2000). Two native Russian bilingual translators translated the GADIS-A English version. One of the translators was cognizant of psychology and the concepts in the scale whereas the second translator was not. A panel of experts reviewed the two translated versions to synthesize a single consensual version. Backward Russian-to-English translation of the GADIS was then carried out by a native English translator. This version was compared with the original English scale by another native English translator and panel of experts. The consensus-translated Russian GADIS-A was subjected to a pilot study.

Pilot study: In the pilot study, the GADIS was first pre-tested with 28 participants selected from the target population to evaluate scale readability to be delivered in an online survey. A participant debriefing was conducted to address linguistic problems as well as actual and potential ambiguity.

Sampling: The participants were enrolled from secondary schools utilizing a two-stage cluster random sampling method. In the present study: (i) a list of the 60 secondary schools was provided by the Ministry of Education of the Russian Federation, (ii) 22 schools were randomly selected by an online number generated, and (iii) two grades (Grade 10 and Grade 12) were randomly selected, comprising 1800 students. Of the 1800 distributed web-based surveys, a total of 933 useable surveys were included in the final analysis. To enroll adolescent gamers, an item was included in the survey: "*I have played videogames or online videogames over the past 12 months (yes/no)?"* Also, additional item was added to differentiate offline gamers from online gamers ("*I usually play digital games on offline platforms/online platforms"*. Once the link was clicked, it led to an informed consent page to be read and agreed upon before they could proceed to the survey. The informed consent page included information about the study such as the study's objectives and duration, assurances of anonymity and confidentiality, and voluntary participation. It is also stated that the participants could only complete the survey once. The provision of informed consent was provided by the participants and their parents, teachers or legal guardians. They could withdraw their children from the study by sending a note to the school. The study was conducted during the COVID-19 pandemic (November 2020 to March 2021), so all data were collected online because face-to-face data collection was not possible. The participants were recruited over a 12-week period. The sample size of 913 being between 500 and 1000 participants is considered a very good to almost excellent size for validation studies (Comrey& Lee, 2013).

Data analysis

Descriptive statistics were used to calculate sample characteristics. Univariate normality was checked by the values of skewness and kurtosis and those within <|1| suggest absence of severe violations of normality. The values of the variance inflation factor (VIF) was checked for the GADIS-A's 10 items' multicollinearity risk (Tabachnick & Fidell, 2014). Chi-squares and independent *t*-tests were used to examine the differences between groups. Cronbach's alpha reliability coefficient and Cronbach's alpha coefficient if item deleted were calculated to assess internal consistency. Also, the composite reliability (CR) values for GADIS-A and the two sub-scales were also calculated for scale reliability. After two weeks, test-retest analysis was conducted and reliability was calculated utilizing the intraclass coefficient. The average variance extracted (AVE) was calculated to evaluate convergent and discriminate validity (Henseler, Hubona, & Ray, 2016). Also, maximum shared variance (MSV) and maximum reliability (MaxR [H]) values were calculated. Statistically, convergent and discriminate validity are established when the following relationship is obtained: (MSV < AVE<CR< MaxR (H), and .5<AVE).

Construct validity

Primarily, a series of the confirmatory factor analyses (CFAs) were carried out to evaluate the construct validity for GADIS-A higher order model, and two-factor first order model, using the estimation method of maximum likelihood. The benchmark suggested by Hu and Bentler (1999) was considered to goodness of fit the three models (Hu & Bentler, 1999): $1 < \chi^2/df < 3$, comparative fit index (CFI) >.95; Tucker-Lewis index (TLI) >.95; and root mean square error of approximation (RMSEA) <.06, and standardized root mean square residual (SRMR) <.06.

Measurement invariance

Measurement invariance was evaluated across gaming environment (online/offline), and gender (male/female) for the preferred model. The three CFAs models were compared utilizing better goodness of fits, higher factor loadings, and lower values of the Bayesian information criterion (BIC) and Akaike information criterion (AIC). The superior CFA model was evaluated across both male and female samples to evaluate gender invariance. Also, the superior CFA model was evaluated across both online and offline gamers. Once the quality of respective models had been established, multi-group CFA was conducted with four models including more constrained models that evaluated configural invariance, metric invariance, scalar invariance, and error variance invariance. The changes in the CFA (△*CFA* <.01), TLI (△*T*LI) <.01), and a change in RMSEA (△RMSEA <.015) demonstrate non-invariance between groups (Cheung & Rensvold, 2009; Chen, 2007; Cheung & Rensvold, 2002).

Criterion-related validity

To establish criterion-related validity of the GADIS-A and its two subscales, correlation analyses was performed using the scores on the scales assessing internet gaming disorder, depression, anxiety, social connectedness, difficulties in emotion regulation, and impulsivity. Finally, once the GADIS-A measurement invariance across online and offline gamers was established, SEM was used to investigate the associations between online and offline GD and anxiety, depression, difficulties in emotion regulation, and social connectedness. Cohen's f^2 values of .02, .15, and .35 signify small, moderate, and large effect sizes, respectively (Cohen, 1992).

Latent profile analysis

Latent profile analysis (LPA) is a person-oriented analytic strategy that helps describe hidden sub-groups of individuals in data. LPA was carried out to identify adolescent gamer subgroups based on the obtained score in cut-off score in GADIS-A subscales. The lower values of the AIC, BIC, and sample-size adjusted BIC (SSABIC) were evaluated in deciding the model selection. Also, higher entropy values demonstrate a better quality of classification. Finally, significant improvement between models was compared utilizing the Lo–Mendell–Rubin (LMR) test. Analysis of variance (ANOVA) was conducted to compare differences in scores between the identified groups in relation to internet gaming disorder, depression, anxiety, social connectedness, difficulties in emotion regulation, and impulsivity scores.

Results

The sample's demographic characteristics, means (*Ms*), and standard deviations (*SDs*) of the variables are reported in Table 1. The participants' mean age was 15.08 years (*SD*=.82, range 13-17 years), and 58.2% of the sample was male. Boys were more likely to engage in digital gaming than girls over the past 12 months (χ^2=27.78, *p*<.001). Based on the GADIS-A cut-off scores of two factors and time criterion, 4.00% (*n*=37) were identified as disordered gamers. Of these, 60% (*n*=27) of the disordered gamers were males and 73% (*n*=27) of the adolescents with GD were online gamers. Females experienced significantly more anxiety than males (*t*[931]=3.01, *p*=.003, Cohen's *d*=.26, 95% [.13, .39]). Compared to females, males exhibited significantly higher levels of GD (*t*[931]=4.18, *p*<.001, Cohen's *d*=.34, 95% [.20, .46]), emotion dysregulation (*t*[931]=3.02, *p*=.002, Cohen's *d*=.27, 95% [.14, .40]), and IGD (*t*[931]=2.76, *p*=.006, Cohen's *d*=.23, 95% [.10, .36]).

Table 1

Skewness, kurtosis, and VIF checks showed the absence of severe violations of normality and multicollinearity risk (see Table 2). The Cronbach's alpha reliability coefficient (α=.891), GADIS-A CR (.890), and Cronbach's alpha coefficient values if item deleted (see Table 2, last column) all indicated very good internal reliability for the scale. Also, the Cronbach alpha coefficients for GADIS-A subscales (CBS=.82, negative symptoms=.85), CRs for GADIS-A subscales (CBS=.834, negative symptoms=.847), and AVEs (CBS=.520, negative symptoms=.628) were all satisfactory. Moreover, GADIS-A subscales MSV (CBS=.19, negative symptoms=.19) and GADIS-A subscales MaxR (H) (CBS=.853, negative symptoms=.866) indicated that the following relationship was obtained:

MSV<AVE<CR<MaxR (H), and .5<AVE. Test-retest correlations were obtained among a randomly selected sub-sample of the participants (*n*=400) two weeks after the initial validation study. The test–retest correlations were high for the GADIS-A factors: cognitive behavioral symptoms (*r*[210]=.78, *p*<.001) and negative consequences (*r*[210 =. 72, *p*<.001) (Table 2). In terms of consistency, the ICC for GADIS-A was .68 with 95% CI (.61, .77).

CFA analyses were performed on the two-factor higher order model (χ^2/df=4.71, CFI=.983, SRMR=.048, PCLOSE=.30 >.05, RMSEA=.064, 90% CI [.53, .76]), correlated two-factor model (χ^2/df=4.26, CFI=.990, SRMR=.039, PCLOSE=.09 >.05, RMSEA=.052, 90% CI [.039, .066])., and the two-factor ESEM (χ^2/df=2.20, CFI=.996, SRMR=.026, PCLOSE=.93 >.05, RMSEA=.036, 90% CI [.020, .052]). The models' standardized factor loadings showed that the GADIS-A's nine items loaded significantly on their specific factors (see Table 2, factor loadings > .30). The higher-order and correlated two-factor CFA models showed acceptable to excellent goodness of fit (see Table 3). The ESEM model demonstrated excellent goodness of fit. Also, the ESEM model loading factors were higher than loading factors for two-factor CFA model.

Table 3 & Figure 1

Measurement invariance was conducted across gender (male/female) and preferred gaming medium (online/offline) for the ESEM (see Table 4). The analysis produced excellent fit for both the male sample (χ^2/df=2.61, CFI=.991, SRMR=.024, PCLOSE=.91>.05, RMSEA=.05, 90% CI [.032, .064]), and female sample (χ^2/df=1.91, CFI=.977, SRMR=.044, PCLOSE=.52>.05, RMSEA=.056, 90% CI [.049, .064]). The analysis also indicated excellent fit for both the offline gamer sample (χ^2/df=2.68, CFI=.965, SRMR=.06, PCLOSE=.32>.05, RMSEA=.059, 90% CI [.049, .068]), and the online gamer sample (χ^2/df=2.52, CFI=.97, SRMR=.053, PCLOSE=.61>.05, RMSEA=.048, 90% CI [.039, .052]). Finally, the results of the multi-group CFA analysis are presented in Table 4 ($\triangle$*T*LI < .01, $\triangle$*CFI* < .01).

Table 4

The full correlation matrix between all the variables is presented in Table 4. The SEM analysis showed that offline gaming was significantly associated with depression (β=-.18, *SE*=.04, $p<.001$, t=4.36, Cohen's f^2=.04), anxiety (β=-.22, *SE*=.03, $p<.001$, t=6.57, Cohen's f^2=.06), and emotion dysregulation (β=-.22, *SE*=.03, $p<.001$, t=6.09, Cohen's f^2=.05). Also, online gaming was significantly associated positively with depression (β=-.16, *SE*=.04, $p<.001$, t=4.43, Cohen's f^2=.03), anxiety (β=-.35, *SE*=.04, $p<.001$, t=9.90, Cohen's f^2=.15), and emotion dysregulation (β=-.32, *SE*=.04, $p<.001$, t=8.58, Cohen's f^2=.12). Furthermore, both offline gaming (β=-.24, *SE*=.04, $p<.001$, t=7.13, Cohen's f^2=.06) and online gaming (β=-.14, *SE*=.04, $p<.001$, t=3.80, Cohen's f^2=.02), were negatively associated with social connectedness (see Figure 1). Online gaming was more significantly associated with higher anxiety (Z score=2.39; p=.009), and higher emotion dysregulation (Z score=1.79; p=.04), compared with offline gaming. There were no significant associations with depression among the two gamer groups (Z score=.32; p=.38). Offline gaming was significantly associated with lower social connectedness (Z score=-1.91; p=.03).

Table 4 & Figure 2

The results of the LPA are reported in Table 5. Based on best combination of lower AIC, BIC, higher entropy, and significant likelihood ratio tests, the four-class profile model was an improvement on the three-class model. The four identified profiles were labeled as the regular gamers (RGs), low-risk gamers (LGs), hazardous gamers (HGs), and problematic gamers (PGs). The riskier the gaming, the greater association with mental health problems. RGs did not exceed cut-off scores in either the CBS or negative consequences factors. LGs only exceeded cut-off scores in the CBS factor without daily or prolonged problems. HGs exceeded cut-off scores in the negative consequences factor with daily or prolonged problems. PGs exceeded cut-off scores in both CBS and negative consequence factors with daily or prolonged problems. The four groups were clearly differentiated in respect to depression (F[3, 929]= 39.39, $p<.001$, η^2p=.11), anxiety (F[3, 929]=411.89, $p<.001$, η^2p=.57), emotion dysregulation (F[3, 929]= 44.05, p<.001, η^2p=.12), impulsivity (F[3, 929]=192.31, p<.001, η^2p=.38), IGD (F[3, 929]= 262.2, p<.001, η^2p=.46), social connectedness (F[3, 929]=338.54, p<.001, η^2p=.52), and life satisfaction (F[3, 929]=311.92 , p<.001, η^2p=.50).

Tables 5 & Figures 3

Discussion

Given that research into gaming disorder (GD) is growing globally and given the fact that GD and its criteria were recently included in the ICD-11, developing a theoretically and psychometrically sound instrument has become essential to evaluate GD based upon the new ICD-11 criteria. Therefore, the study explored to psychometric properties of the GADIS-A among a Russian population of adolescents. The findings demonstrated that GADIS-A is a reliable psychometric instrument to assess GD symptoms among adolescent gamers. The Cronbach's alpha reliability coefficient and CRs generated values indicate that the GADIS-A and its two subscales have very good reliability.

The results of the construct validity confirmed the two-factor structure found in original GADIS-A validation study. Measurement invariance of the GADIS-A was not evaluated in the original validation study. The measurement invariance analysis in the present indicated that the GADIS-A was fully invariant across gender and gaming medium. Therefore, the GADIS-A can be used to make reliable comparisons between gaming medium (online/offline), and gender (male/female) (i.e., the items in the GADIS-A are interpreted the same whether the respondent is male or female, or is an online gamer or offline gamer).

In concurrence with the extant literature, the results of criterion-related validity analysis indicated that GADIS-A was negatively associated with low life satisfaction (Cudo et al., 2020) and low social connectedness (Chen, Oliffe & Kelly, 2018), and positively associated with depression (Liu et al., 2018), anxiety (Bonnaire & Baptista, 2019), difficulties in emotion regulation (Lin, Lin, Lin, Yen, & Ko, 2020), and impulsivity (Kuss & Lopez-Fernandez, 2016). Overall, these findings indicate acceptable criterion-related validity of the GADIS-A. Also, further analysis of the GADIS-A indicated acceptable convergent and discriminant validity.

An SEM analysis showed that both offline and online gaming were directly associated with depression, anxiety, and emotion dysregulation, and negatively associated with social connectedness. A large body of more recent literature focuses on the online gaming and often involves specific Internet games (Király, Griffiths, & Demetrovics, 2015). However, gaming disorder can also result from offline digital gaming (e.g., console gaming), but has received significantly less attention in recent years. Research has shown that among a small minority, digital gaming – whether played online or offline – can have adverse effects on mental health (Columb, Griffiths, & O'Gara, 2019; Griffiths & McLean, 2017; Von Der Heiden, Braun, Müller, & Egloff, 2019). The present study's findings indicate that compared to problematic offline gaming, problematic online gaming was significantly associated with higher levels of anxiety and emotion dysregulation. Previous research has also shown that compared to problematic offline gaming, problematic online gaming is associated with a higher risk for the development of psychopathology (Smohai et al., 2017; Tejeiro, Espada, Gonzalvez, Christiansen, & Gomez-Vallecillo, 2016). Compared with problematic online gaming, in the present study, problematic offline gaming was more significantly associated with lower social connectedness. Online users try to compensate for social shortcoming by gaining the support or the respect of other online gamers (e.g., Chen, 2014; Cole & Griffiths, 2007). Therefore, the social displacement effects of multiplayer online games will increase the risk of continued gaming behavior because the player increasingly prioritizes online social obligations over real-world relationships. In relation to depression, there was no significant differences between to gamer groups. While the harm-related problematic gaming is well documented, the offline gaming has received much less attention over the past decade. Therefore, promotion of the public awareness about harm-related offline gaming is as important as online gaming.

LPA results showed the four-profile solution was the best solution among other solutions. Four identified groups clearly differentiated Russian gamers in respect to psychological variables examined.

Also, the findings indicated that comorbidity (e.g., depression and anxiety) may be present among gamers with higher risk of GD. Previous research has also shown that major contributing factors for GD include both depression (Liu et al., 2018) and anxiety disorders (Bonnaire & Baptista, 2019; Jeong et al., 2018; Paulus et al., 2018), and that such comorbidities are key factors in vulnerability to GD (Laconi, Pirès, & Chabrol, 2017). Numerous studies have identified the associations between disordered gaming and a range of psychological problems (e.g., Billieux et al., 2020; Cerniglia et al., 2019; Männikkö, Ruotsalainen, Tolvanen, & Kääriäinen, 2019; Marmet, Studer, Rougemont-Bücking, & Gmel, 2018). Neuroimaging studies support the similarities of problematic gaming with substance-related addictions such as impaired pre-frontal cortex connectivity, cognitive control impairment, deficit in working memory, and emotion dysregulation (Kuss, Pontes, & Griffiths, 2018). In addition, individuals experiencing problematic technology use often have impaired social functioning and poor interpersonal relationships (Li, O'Brien, Snyder, & Howard, 2015).

Male adolescents obtained higher significantly higher scores on scales assessing GD, IGD, emotion dysregulation, and impulsiveness than female adolescents. These findings concur with previous studies indicating that disordered gaming is strongly associated with male gender (Chen et al., 2018). Male gamers had higher levels of impulsivity than female gamers (although the effect size was small) but also concurs with previous (Blinka et al., 2016). Impulsivity is a strong predictor and risk factor both substance addictions and in non-drug-related behavioral addictions (Chuang et al., 2017, Mitchel & Potenza, 2014) including gaming disorder (Şalvarlı & Griffiths, 2019). Female gamers reported higher levels of the anxiety than male gamers. These findings concur with previous studies more generally, indicating that females report greater psychological problems and are more likely to develop anxiety symptoms than males (Blüml et al., 2013).

Limitations

The present study suffers from a number of limitations – notably related to the participants and data collection. The study was conducted during the COVID-19 pandemic. Therefore, to minimize infection risk, online data collection was utilized rather than a traditional face-to-face method. Data were collected using self-report instruments and are subject to common methods biases. Also, the stressful pandemic situation may be a confounding factor that may have elevated mental health problems and daily psychological life distress among the participants. Finally, the study was cross-sectional, therefore determining directions of causality between the study's variables is not possible.

Despite these limitation, the findings indicate that the GADIS-A is a reliable and valid instrument to assess the symptoms and severity of gaming disorder among Russian-speaking adolescents. Following replication and expansion of the original study's findings, the present study provides further empirical evidence of the psychometric robustness of the GADIS-A and its factor structure, using the novel ESEM framework and the testing of measurement invariance. The SEM analysis also suggests new insights into differences between online and offline disordered gaming.

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Table 1. Demographic characteristics of the sample (N=932)			
Item	**Value**	**Test**	***p*-value**
Categorical variables			
Gender, *n (%)*			
Female	386 (41.4)	χ^2=27.78	.001
Male	547(58.6)		
Profile classification, *n (%)*			
Regular gamers	361 (38.7)		
Hazardous gaming	250 (26.8)		
Moderate risk gamers	285 (30.5)	χ^2=247	.001
Gaming disorder	37 (4)		
Gaming environment, *n (%)*			
Offline gamers	401 (42.9)	χ^2=11	.001
Online gamers	532(57.1)		
Continuous variables - *Mean (and standard deviation)*			
Age (in years)	15.08 (.82)	t(1, 931)=.811	.33
Gaming disorder	12.48 (7.28)	t(1, 931)=4.18	p<.001
Internet gaming disorder	13.7 (3.9)	t(1, 931)=2.76	.006
Emotion dysregulation	47.93 (14.12)	t(1, 931)=3.02	.002
Anxiety	8.3 (5.2)	t(1, 931)=3.01	.003
Depression	7.9 (4.3)	t(1, 931)=-1.11	.26
Life satisfaction	19.59 (5.73)	t(1, 931)=-1.92	.06
Impulsiveness	16.88 (4.22)	t(1, 931)=2.02	.03
Social connectedness	72.13 (14.61)	t(1, 931)=-1.8	.07

Note: *n*=frequency; y=years

t=independent *t*-test to compare gender; negative *t*-value=females obtained higher score

Table 2: Item and facture structure of GADIS-A

Item	**Factor**	**HO**	**Two-factor**		**ESEM**		**Skew**	**Kur**	**VIF**	***M***	***SD***	**α if item deleted**
			CBSs	**NSs**	**CBSs**	**NSs**						
1	CBS	**.91**	**.93**		**.94**	-.10	.41	.53	1.49	1.57	1.10	.871
2	CBS	**.78**	**.74**		**.72**	.06	-.05	.52	1.54	1.47	1.14	.874
4	CBS	**.72**	**.67**		**.61**	-.14	.51	.26	2.33	1.86	1.15	.867
5	CBS	**.84**	**.82**		**.82**	-.01	.70	.45	1.54	2.37	1.26	.875
3	N.C	**.86**		**.78**	-02	**.79**	.45	.72	1.58	1.38	1.14	.870
6	N.C	**.44**		**.42**	.05	**.43**	.38	.88	1.58	1.89	1.18	.871
7	N.C	**.79**		**.90**	-.08	**.91**	.05	.80	2.66	1.42	1.14	.872
8	N.C	**.76**		**.69**	.07	**.67**	.53	.69	2.66	1.52	1.17	.873
9	N.C	**.73**		**.85**	-.11	**.86**	.35	.74	2.76	1.55	1.10	.873

Note. CBSs=cognitive behavioral symptoms; NCs=negative consequences; HO= higher order; ESEM=exploratory structural equation modeling; Skew= skewness; Kur=kurtosis; VIF=variance inflation factor; M==mean; SD= standard deviation; α= Cronbach alpha coefficient,

Table 3: ***Measurement invariance of GADIS-A across gender and gaming environment***

Model	Invariance type	χ^2/df	CFI	ΔCFI	TLI	ΔTLI	AIC	RMSEA 90% [CI]
Gender								
	Configural	2.276	.991	-	.980	-	224.846	.037 [.06, .048]
	Weak (metric)	2.099	.989	.02	.983	.05	220.766	.024 [.025, .044]
	Strong (scalar)	2.013	.988	-.07	.984	.03	216.757	.033 [.024, .042]
	Strict	1.981	.988	-.07	.985	.04	214.871	.032 [.024, .041]
Gaming environment								
	Configural	1.666	.982	-	.971	-	202.652	.033 [.018, .046]
	Weak (metric)	1.538	.984	.02	.976	.05	191.040	.029 [.016, .041]
	Strong (scalar)	1.605	.977	-.07	.974	.03	191.086	.033 [.019, .042]
	Strict	1.575	.977	-.07	.975	.04	188.401	.030 [.018, .041]

Note. CFI=comparative fit index; TLI=Tucker-Lewis index; RMSEA=root mean square error of approximation (RMSEA); CI=confidence interval. AIC=Akaike information criterion

Table 4. Correlation matrix of variables

	1	2	3	4	5	6	7	8	9	10
Gaming disorder	1.00									
Internet gaming disorder	.50**	1.00								
Life satisfaction	-.18**	-.09*	1.00							
Anxiety	.32**	.16**	-.26**	1.00						
Emotion Dysregulation	.28**	.14**	-.35**	.28**	1.00					
Social Connect	-.29**	-.15**	.30**	-.29**	-.20**	1.00**				
Depression	.21**	.10**	-.24**	.32**	.16**	-.16**	1.00			
Impulsiveness	.15**	.18**	-.38**	.20**	.22**	-.19**	.34**	1.00		
Cognitive behavioral symptoms	.88**	.45**	-.35**	.36**	.29**	-.25**	.22**	.19**	1.00	
Negative consequences	.79**	.52**	-.33**	.38**	.25**	-.30**	.29**	.21**	.82**	1.00

Table 5. Latent profile analysis

Model	**AIC**	**BIC**	**SSABIC**	**Entropy**	***p*-value for LMR test**
One-class	6202.6	6143.69	6259.25	-	-
Two-class	5258.3	5375.3	5208.00	.88	*p*<.001
Three-class	4565.79	4562.42	4704.82	.89	*p*<.001
Four-class	**4360.52**	**4349.93**	**4290.8**	**.90**	***p*<.001**
Five-class	4560.52	4549.93	4690.8	.90	*p* > .05

AIC, Akaika's information criterion; BIC, Bayesian information criterion; SSABIC, sample-size adjusted BIC; L-M-R test, Lo-Mendell-Rubin's likelihood ratio test. The bold values indicate the best solution in identifying the number of group by latent class analysis.

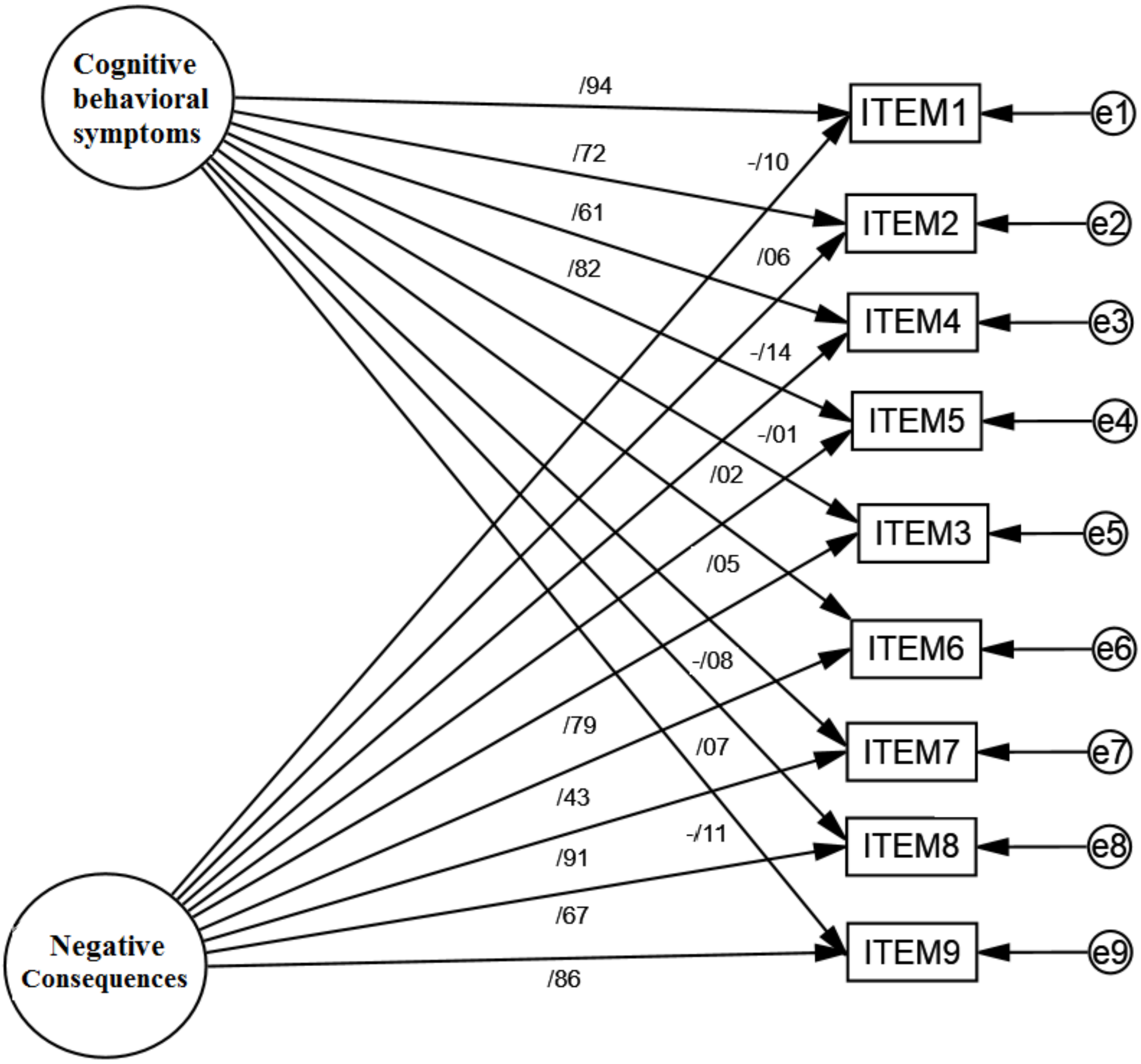


Figure 1. the GADIS-A ESEM model

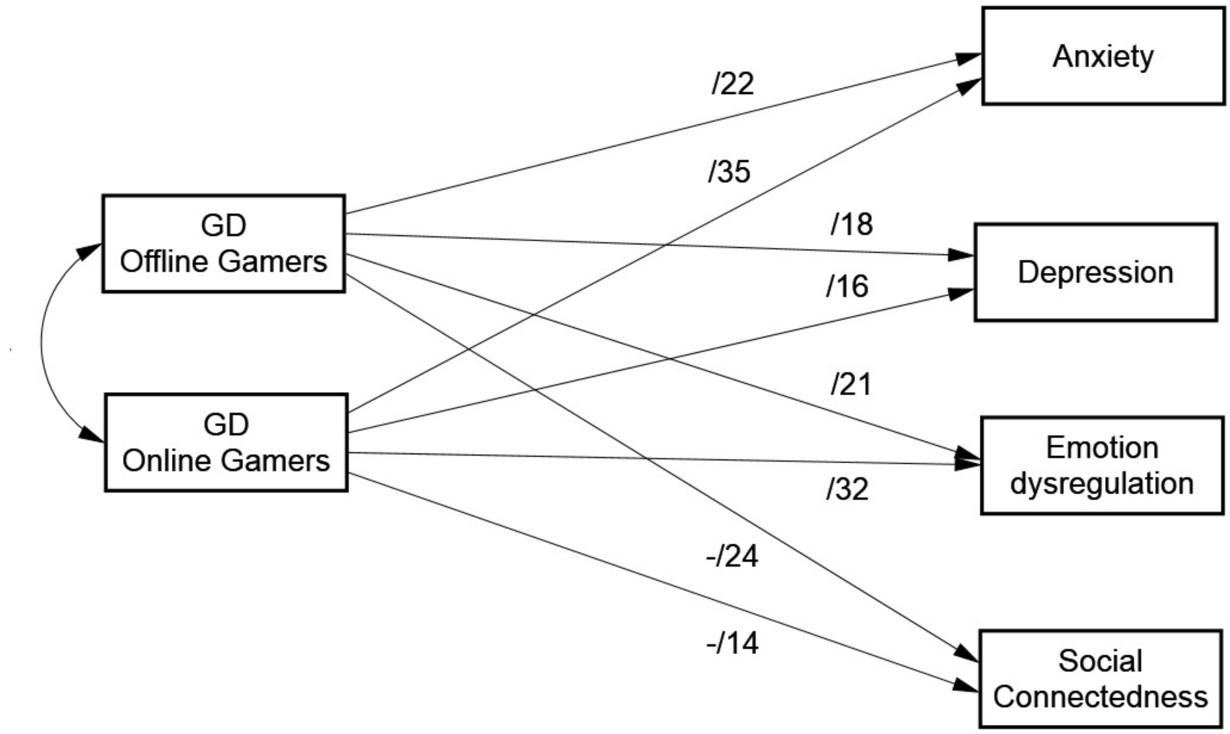
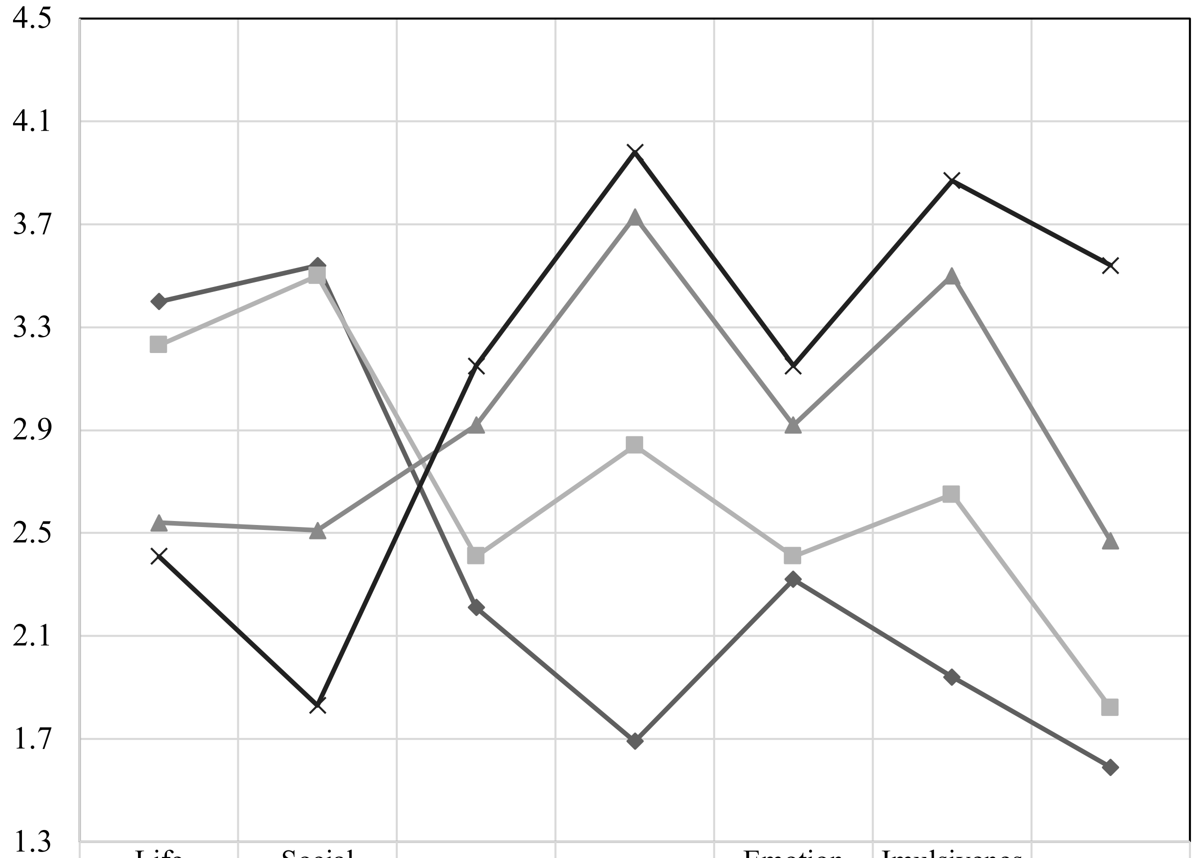


Figure 2. Standardized structural equation modeling to compare online and offline gamers



	Life satisfaction	Social Contds	Depression	Anxiety	Emotion difficulties	Imulsivenes s	IGD
RG	3.4	3.54	2.21	1.69	2.32	1.94	1.59
LG	3.23	3.5	2.41	2.84	2.41	2.65	1.82
HG	2.54	2.51	2.92	3.73	2.92	3.5	2.47
PG	2.41	1.83	3.15	3.98	3.15	3.87	3.54

Figure 3. The LPA graph for identified profiles

Note. RG: regular gamers; LG= low risk gamers; HG= hazardous gamers; PG=problematic gamers