Psychometric validation of the Compulsive Internet Use Scale in Spanish adolescents

Abstract

Despite problematic Internet use being especially high among adolescents, there are no screening instruments in Spain specifically for adolescents that would facilitate early detection of this problem. The main goal of this study was to validate the Compulsive Internet Use Scale (CIUS) in the adolescent Spanish population, as well as to analyze the discriminative capacity of CIUS based on sociodemographic characteristics, grade point average, and other addictive behaviors. Data were obtained from the ESTUDES, a representative survey of addictive behaviors of Spanish adolescents. The sample consisted of a total of 34,308 adolescents aged between 14-18 years old (M_{age} =15.70; *SD*=1.19; 51.7% females). Results indicated that **t**he CIUS fit a unidimensional structure, exhibited measurement invariance with respect to sex and age, and demonstrated excellent reliability (ω=.94). Past-month tobacco, alcohol, and cannabis use, as well as past-year gambling and gaming, were related to CIUS scores. A standardized screening instrument that provides valid, reliable information on young people's use of the Internet in Spain is a critical requirement for successful early detection and intervention in this population.

Keywords: internet use; compulsive internet use scale; validation; adolescents; Spanish

Internet use has grown exponentially in recent years. Even though the Internet enhances our lives by facilitating information-gathering, job opportunities, and ease of communication, evidence also indicates that impulsive, compulsive or uncontrolled Internet use could affect our wellbeing (see Griffiths, 2018; Mihajlov & Vejmelka, 2017; Ryding & Kaye, 2018 for review).

Internet use has a particular impact on adolescents. The prevalence of problematic Internet use worldwide stood at 7% (between 0.30% and 40%) in the general population (Pan et al., 2020). The rate of problematic Internet use in Spanish adolescents has been reported as 16.4% in men, and 23.4% in women (National Drugs Plan [PNSD], 2020). Problematic Internet use in adolescents and young adults has been related to poor quality of life (Machimbarrena et al., 2019), psychological problems (Restrepo et al., 2020), depression (Bhandari et al., 2017; Jeong et al., 2019), anxiety (Marino et al., 2020), eating disorders (Hinojo-Lucena et al., 2019), sleep problems (Alimoradi et al., 2019; Yang et al., 2018), declines in academic performance (Díaz-Cárdenas et al., 2019; Javaeed et al., 2020), and other addictive behaviors (e.g., substance use and gambling; Kotyuk et al., 2020; Lanthier-Labonté et al., 2020; Tsitsika et al., 2011; Yau et al., 2014).

Although several studies have underlined the negative impact of problematic Internet use, diagnostic classifications do not include Internet addiction as a diagnostic category but do consider Internet Gaming Disorder. The DSM-5 includes it in the research appendix (Müller et al., 2019; Petry et al., 2014; Petry & O'Brien, 2013), whereas the World Health Organization will incorporate Gaming Disorder for the first time in the 11th version of the International Classification of Diseases (Higuchi et al., 2017; Jo et al., 2019). It is worth noting that these classifications do not consider

Internet addiction *per se* as a diagnostic category, but rather what the Internet offers (e.g., gaming, shopping).

Several instruments have been developed to assess Internet addiction or problematic Internet use (e.g., The Internet Addiction Test and the Internet Disorder Scale; Monacis et al., 2018; Moon et al., 2018). One of the most widely used is the Compulsive Internet Use Scale (CIUS; Meerkerk et al., 2009). The items are made up of the DSM-IV diagnostic criteria for gambling (American Psychiatric Association, 2000) plus six items based on Griffiths' components model of addiction (Griffiths, 2009). There is no agreement on a cut-off, which has been set at 18 or 21 (Guertler, Rumpf, et al., 2014). The scale evaluates five characteristics of addictions, namely withdrawal symptoms, preoccupation, loss of control, conflict, and coping. It has been translated to many languages and validated in a wide range of countries, all of which confirmed a unifactorial structure (see e.g., Dhir et al., 2015; Downing et al., 2014; Fernandes et al., 2021; Jovičić-Burić et al., 2021; Khazaal et al., 2011, 2012; Meerkerk et al., 2009; Sarmiento et al., 2021; Wartberg et al., 2014; Yong et al., 2017).

The only attempt to validate the CIUS in a Spanish population included a heterogeneous, non-representative convenience sample of Spaniards, Mexicans and Colombians aged between 15 and 30 years old (Sarmiento et al., 2021). In addition, very few studies validating the CIUS have been conducted in adolescents (i.e., under 18 years old; Dhir et al., 2015; Gmel et al., 2019; Jovičić-Burić et al., 2021; Wartberg et al., 2014), a population with a higher prevalence of problematic Internet use. Furthermore, to our knowledge, no previous studies have examined the discriminative capacity of CIUS with other addictive behaviors in adolescents. Examining the relationship between Internet use and other addictive behaviors (both substance use and

behavioral addictions), is crucial for identifying risk behaviors in adolescents, as well as designing preventive programs tailored to this new profile.

The present study aimed to address this gap in the research by validating the CIUS in a large, nationally representative sample of Spanish adolescents, and by studying the discriminative capacity of CIUS based on sociodemographic characteristics (i.e., sex and age), grade point average, and other addictive behaviors (i.e., substance use, gambling, and gaming). A standardized screening instrument that provides valid and reliable information on young people's problematic Internet use in Spain is a fundamental requirement for successful early detection and intervention in this population. To that end, we examined the psychometric properties from both classical test theory and item response theory (IRT) frameworks. The latter adds methodological accuracy to the findings, given that it allows the precision of the CIUS to be studied throughout the different levels of problematic Internet use.

Method

Participants and procedure

The Survey on Drug Use in Secondary Education (ESTUDES) is based on a representative sample of 14 to 18-year-olds in Spain. The survey is a paper-and-pencil questionnaire which is self-administered and anonymous, taking 45-60 minutes to complete. The inclusion criteria were being between 14 and 18 years old, and being in the 3rd or 4th year of compulsory secondary education (i.e., 15 and 16 years old), 1st or 2nd years of baccalaureate level (i.e., 17 and 18 years old), or 1st or 2nd years of basic and intermediate vocational training. Participants who did not attend class on the day of the survey, 18-year-old university students, or those were not enrolled in school, were

excluded from the study. All participants provided informed parental consent to participate in the survey. Data were collected between February 4th and April 5th, 2019. Details on ESTUDES survey methodology and procedures are available elsewhere (PNSD, 2021). This study was not preregistered.

The total sample comprised 34,308 adolescents (M_{age} = 15.70; *SD* = 1.19; 51.7% females). Just over half (55.1%) of the participants were in compulsory secondary education, 37.4% in baccalaureate, and the remaining 7.5% in vocational training. The sample was taken from 917 schools (68.4% state-funded schools), and 1,769 classes.

Measures

The survey included sociodemographic characteristics (i.e., sex and age), academic performance (i.e., grade point average on a 10-point scale, with the pass mark being 5), and other addictive behaviors. The participants also completed three standardized scales: the CIUS, 9-items on gaming disorder, and a cannabis abuse screening test (CAST).

Compulsive Internet Use Scale. The CIUS consists of 14 items using a 5-point Likert scale (0 = totally disagree, 4 = totally agree), with scores ranging from 0 to 56. Its reliability (α) in the original version was .89 (Meerkerk et al., 2009), whereas in an adult Spanish population it was .95 (Sarmiento et al., 2021). The Spanish version used in this study was based on the validation by Sarmiento et al. (2021), which was back translated and carefully reviewed by native speakers.

Gaming disorder. Gaming was assessed through nine items based on diagnostic criteria with a yes/no answer. The following items were included: 1) Even if you are not playing a game, do you spend a lot of time thinking about gaming or planning what to do next?; 2) Do you experience restlessness, irritability, depression, anxiety, sadness,

etc., when you reduce or stop gaming, or do not allow yourself to play a game?; 3) Do you need to spend more time gaming?; 4) Do you feel you should reduce game playing, but cannot reduce the time you spend gaming?; 5) Because of gaming, are you less interested in participating in other leisure activities such as hobbies or meeting friends?; 6) Despite the negative consequences, do you continue to play games?; 7) Do you lie or hide how much time you spend gaming to your family or friends?; 8) Do you use gaming to avoid/relieve negative feelings (e.g., helplessness, depression, guilt, anxiety, etc.)?; and 9) Due to gaming, have you ever been troubled or fallen out with somebody inside or outside of work or school? The reliability (α) in the current sample was .73.

Cannabis Abuse Screening Test. CAST (Cuenca-Royo et al., 2013) consists of 6 items using a 5-point Likert scale (1 = never, 2 = rarely; 3=from time to time; 4 = quite often; 5 = very often). It assesses problematic patterns of cannabis use (i.e., non-recreational use, memory disorders, motivation to reduce or stop, unsuccessful attempts to quit, problems related to cannabis use). The reliability in a Spanish population is .75 (Cuenca-Royo et al., 2012). The reliability (α) in the current sample was .81.

Other addictive behaviors. Participants self-reported past-month tobacco, alcohol, and cannabis use, as well as past-year online and offline gambling, on a dichotomized scale (i.e., yes/no).

Data analysis

Descriptive statistics of the items (i.e., mean, standard deviation, skewness, and kurtosis) and discrimination indices (i.e., corrected item-test correlation) were calculated.

Based on Samejima's graduated model (Samejima, 1969), within the IRT framework, we calculated the *a* parameter of item discrimination, in which values higher than 0.64 are adequate and higher than 1.7 are very high (Baker, 1985).

In order to analyze the impact of CIUS items on sex, Differential Item Functioning (DIF) was examined using logistical regression (Gómez-Benito et al., 2013).

The total sample was randomly divided into two subsamples. The first (n = 11,208) was used to conduct exploratory factor analyses (EFA), and the second (n = 23,100) was used to confirm the factorial structure. KMO and Bartlett's test were used to study sampling adequacy for factor analysis. The EFA was performed on the Pearson correlation matrix, using Maximum Likelihood (ML) as the estimation method (Ferrando et al., 2022; Ferrando & Lorenzo-Seva, 2017). The dimensionality of the instrument was determined through the optimal implementation of Parallel Analysis (Timmerman & Lorenzo-Seva, 2011) with 1,000 matrices of random correlations. Finally, in order to study the fit of the data to a single dimension, Unidimensional Congruence (UniCo > .95), Explained Common Variance (ECV > .85), and Mean of Item Residual Absolute Loadings (MIREAL < .30) indices were used (Garrido-Calderón et al., 2019). Goodness Fit Index (GFI), and Standardized Root Mean Square Residual (SRMR), were used as fit indices, establishing a good fit when GFI > .95, and SRMR < .08 (Hu & Bentler, 1999).

The second subsample was used to confirm the factorial structure through confirmatory factor analyses (CFA) on the Pearson correlation matrix using ML as the estimation method. Three models were tested: 1) A one-factor model with uncorrelated error terms. 2) In line with the study by Guertler, Broda, et al. (2014), we tested a model with one factor and four correlated errors (Items 1 and 2; 6 and 7; 8 and 9; 12 and 13). 3) Finally, a one-factor model, inspected for correlated error terms. Modification indices (MI > 3.84) and standardized expected parameter changes (SEPC > .20) were used to determine which correlated error to include in the current model to achieve a better fit

(Whittaker, 2011). Specifically, a model with one factor and five correlated errors (Items 1 and 2; 6 and 7; 8 and 9; 12 and 13; 3 and 8) was tested. GFI, Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square of Error Approximation (RMSEA), and SRMR were used as fit indices, with an adequate fit when GFI, CFI and TLI > .95, SRMR < .08, and RMSEA < .06 (Hu & Bentler, 1999). To select the model with the best fit, we considered various indices of parsimony: the Bayesian Information Criterion (BIC) and its sample-adjusted version (ABIC) to correct for the possible effects of large sample sizes, and the Akaike Information Criterion (AIC). The criterion considered was that a difference of nine points or more between the AIC and BIC indices is indicative that the model with a lower index has a better fit to the data (Anderson, 2008). In contrast, if ΔAIC and ΔBIC are < 2, the difference is considered non-significant (Burnham & Anderson, 2004).

In addition, given the importance of studying the factorial structure of a construct in different populations, we assessed measurement invariance based on sex and age, calculating configural, metric, and scalar invariance through multi-group confirmatory factor analysis (MG-CFA). Given that we are dealing with nested models, we allowed a change in CFI lower than -.01 for accepting measurement invariance (Chen, 2007).

The reliability of the different dimensions' scores in the CIUS and the total score were also calculated using Cronbach's α coefficient and McDonald's ω coefficient. From an IRT perspective, the precision of the instrument was examined through the test information function. Item Characteristic Curves (ICCs) were also calculated (see Figure S1).

In order to study evidence of validity in relation to other variables, Pearson's correlation was calculated between CIUS, the 9-items of gaming disorder, and CAST. To obtain evidence about the discriminatory capacity of the CIUS, several ANOVAs

were performed to study differences in problematic Internet use according to the sociodemographic variables (i.e., age and sex), grade point average, and addictive behaviors, such as gambling (both online and offline) and substance use (i.e., tobacco, alcohol and cannabis). The Bonferroni post-hoc test was used to determine which groups there were differences between. Cohen's *d* was used to estimate the effect size, considering it as small for values between 0.2 and 0.4, medium for values between 0.4 and 0.8, and large from 0.8 (Cohen, 1988).

Descriptive statistics, discrimination indices, DIF, and differences between groups were calculated using SPSS 24 software (IBM Corp, 2016). The EFA and the reliability coefficients were calculated with FACTOR software (Ferrando & Lorenzo-Seva, 2017). The CFA and CFA-MG were carried out with R and the lavaan package (Rosseel, 2012). IRTPro software was used for IRT analyses (Cai et al., 2011).

Results

Descriptive statistics and item analysis

The descriptive statistics of the CIUS items are displayed in Table 1. The items showed adequate values in skewness (i.e., between 0.12 and 1.21) and kurtosis (i.e., between -1.10 and 0.72). The discriminatory power for each of the items was very high, both from a classical test theory perspective (between .669 and .784) and from IRT (parameter *a* between 1.66 and 2.44).

---- Please, insert Table 1 near here ----

Evidence based on internal structure

In the first subsample, both KMO (.896) and Bartlett's statistic ($p < .001$) showed a good data fit for EFA. Optimal implementation of parallel analysis suggested a single dimension. In addition, the unidimensional indicators met the criteria to support a

unidimensional structure: UniCo = .979, ECV = .893, MIREAL = .179. The percentage of variance explained by the first factor was 50% and the fit indices of the unidimensional model were adequate (GFI = .988; SRMR = .067), which allowed us to determine the instrument to be essentially unidimensional.

In the second subsample, using the fit of the various models to the data (see Table 2), the unidimensional model showed poor fit, where all fit indices except SRMR had values not indicative of a good fit. Thus, we confirmed that the one-dimensional model with five correlated errors gave the best overall indices of fit (items 1 and 2; 6 and 7; 8 and 9; 12 and 13; 3 and 8). Similarly, comparing the values of AIC, BIC, and ABIC for the different models, the one-dimensional model with five correlated errors provided the lowest values in all indices, with the differences greater than nine points (Anderson, 2008). In addition, as Table 1 shows, the factor loadings were all very high [.598 - .738]. Regarding impact and DIF, 12 items (except item 4 and 9) demonstrated an impact depending on sex, but none exhibited DIF (all $R^2 \leq .016$).

---- Please, insert Table 2 near here ---

Once the unidimensional factor structure (with five correlated errors) was shown to be the best model, measurement invariance in relation to sex and age were explored, as displayed in Table 3. Measurement invariance was confirmed at the three levels examined (i.e., configural, metric, and scalar) in relation to age, and partial scalar invariance in relation to sex, with items 6 and 10 varying freely (Chen, 2007). Full configural models for each subgroup (i.e., sex and age), with parameters and their standard errors are available as supplementary material (see Tables S1 and S2).

---- Please, insert Table 3 near here ----

Reliability and precision

Table 4 shows the correlation matrix between the CIUS items. The correlation indexes were high ($r \geq .331$), especially between items whose errors correlated. In terms of reliability from the classical theory framework, both Cronbach's α and McDonald's ω indicated excellent reliability (α = .94; ω = .94). From an IRT standpoint, Figure 1 depicts the information function, where the standard error was very low (i.e., SE < .50) for ability levels between -2 and 3 and indicates low precision for ability levels below -2. The ICCs are shown in Figure S1, indicating the similarity between the probabilities of alternative selection in each of the items, especially between items whose errors were correlated in the structural model.

---- Please, insert Table 4 near here ----

---- Please, insert Figure 1 near here ----

Validity evidence based on relationships with other variables

With regard to evidence of validity in relation to other variables, CIUS demonstrated a weak-medium relationship with gaming ($r = .234$), and a weak relationship with CAST scores ($r = .056$).

The discriminative capacity of CIUS

There were differences in outcomes based on all sociodemographic characteristics, academic performance, and addictive behaviors (all p-values < .001). As Table 5 shows, women had higher scores than men in problematic internet use, CIUS scores increased with age, and were inversely proportional to the grade point average. Adolescents who had used tobacco, alcohol or cannabis in the previous month and those

who had gambled in the previous year (either online or offline) had significantly higher scores in the scale.

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Discussion

This is the first study validating the CIUS in an adolescent Spanish population. The findings indicate that CIUS is essentially unidimensional and presents adequate psychometric properties in terms of reliability and validity. Furthermore, the CIUS was related to sociodemographic characteristics and inversely associated with grade point average. Past-month substance users and past-year gamblers exhibited greater problematic Internet use. In addition, the gaming disorder rate was directly related to CIUS score.

Consistent with previous studies, the CIUS demonstrated an essentially unidimensional internal structure (see e.g., Dhir et al., 2015; Downing et al., 2014; Fernandes et al., 2021; Jovičić-Burić et al., 2021; Khazaal et al., 2011, 2012; Meerkerk et al., 2009; Sarmiento et al., 2021; Wartberg et al., 2014; Yong et al., 2017). More specifically, a confirmatory factor analysis indicated the best fit for a unidimensional structure with five correlated errors (Items 1 and 2; 6 and 7; 8 and 9; 12 and 13; 3 and 8). Some of these item pairs were strongly correlated, although most were not correlated enough to claim item redundancy. One feasible option would be to reduce the number of items in the scale in order to improve efficiency in terms of time to respond, fatigue, and reduction of biases (see e.g., Blanca et al., 2020; Greer & Liu, 2016; Postigo et al., 2020). An item could only be removed from those pairs exhibiting very similar substantive content and very strong correlations (such as items 12 and 13; r = .813),

with very similar ICCs. The strong correlations between items 1 and 2 (difficulty stopping using the Internet), 6 and 7 (thinking about using the Internet), 8 and 9 (using the Internet less frequently or spending less time on the Internet), 12 and 13 (using the Internet when feeling depressed or to escape negative feelings) have been reported previously (Cartierre et al., 2011; Gmel et al., 2019; Guertler, Broda, et al., 2014; Jovičić-Burić et al., 2021; Meerkerk et al., 2009). Additionally, in line with our results, Jovičić-Burić et al. (2021) found a correlation between items 3 and 8, which assess the reduction in Internet use, whether recommended by others or by oneself.

None of the items exhibited DIF, and the CIUS demonstrated measurement invariance, indicating that the scale measures the same construct in all of the age and sex groups. This suggests that the scale has the same factorial structure between the groups (i.e., configural invariance), the items have the same importance for the factor (i.e., metric invariance), and even that the groups have the same probability of selecting one alternative or the other in the items (i.e., scalar invariance) (Millsap, 2011; Thompson, 2016). Given the importance of examining potential differences between groups (AERA, APA, NCME, 2014), this scale allows us to examine which age or sex groups have higher scores of problematic Internet use. However, it is also worth noting that measurement invariance with respect to sex was satisfied when items 6 and 10 varied freely. Item 6 (“How often do you think about the Internet, even when not online?”) seems to assess rumination and FOMO (fear of missing out) related to Internet use. Both variables, rumination and FOMO, have been extensively studied with regard to sex, with conclusions that women have higher levels than men (see e.g., Arpaci, 2020; Li et al., 2021; Mari et al., 2023). On the other hand, item 10 ("How often do you rush through your (home) work to go on the Internet?") seems to assess impulsivity-

related characteristics, where men have higher scores than women, and it is even a potential mediator Internet addiction (see e.g., Chen et al., 2017; Li et al., 2021).

Looking at the reliability of the CIUS, the scale demonstrated excellent values in terms of both classical test theory ($\alpha = .94$; $\omega = .94$) and IRT, which means that it has adequate precision over all the ability levels, with particular caution being advised when evaluating adolescents with very low CIUS scores. The scale provides a slightly higher level of internal consistency than other validations (see e.g., Dhir et al., 2015; Downing et al., 2014; Jovičić-Burić et al., 2021; Khazaal et al., 2011, 2012; López-Fernández et al., 2019; Meerkerk et al., 2009; Sarmiento et al., 2021). In addition, the discriminatory power of each item was very high, both discrimination indices ($\geq .669$) and the IRT parameter α (≥ 1.66).

Finally, concerning validity evidence, the results revealed discriminative capacity, given that the CIUS scores were significantly related to higher gaming disorder, past-month substance use (i.e., tobacco, alcohol, and cannabis), and past-year gambling. Furthermore, girls reported higher CIUS scores than boys, older adolescents presented greater problematic Internet use than younger ones, and adolescents with lower grade point averages showed higher levels of problematic internet use. These findings are in line with previous research (Al-Khani et al., 2021; Guo et al., 2021; Kotyuk et al., 2020; Marín-Vila et al., 2018; Rücker et al., 2015), which highlighted the steady relationship between problematic internet use and sociodemographic characteristics, as well as other addictive behaviors, and hence the need to consider this profile in adolescents in order to carry out selective and indicate prevention programs.

When interpreting the results of this study, several limitations should be borne in mind. Firstly, information on problematic Internet use was based on self-reports, which may have led to an underestimate. Secondly, we did not consider other problematic

Internet use scales (e.g., Internet Addiction Test) to compare with CIUS scores and obtain convergent validity. In addition, the sample was made up of 14–18-year-old adolescents, so the results cannot be extrapolated to other ages. Furthermore, grade point average was collected as a categorical variable, meaning that some information on the relationship between this variable and problematic Internet use was lost. Finally, one potential future line of study will be to develop a short version of CIUS omitting the five correlated items, given that the remaining items would provide the same information and the scale would be shorter and easier to administer.

Despite these limitations, the current study indicates that the CIUS is a reliable, valid instrument for assessing problematic Internet use in Spanish adolescents, with high internal consistency, and relationships to other addictive behaviors, both substance use and behavioral addictions.

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