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Psychometric Properties of the Thai Gaming Disorder Test (GDT) and Thai Gaming Disorder Scale for Adolescents (GADIS-A)

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ABSTRACT

The present study examined psychometric properties of the Gaming Disorder Test (GDT) and Gaming Disorder Scale for Adolescents (GADIS-A), among Thai university students. A convenience sample of university students ($n = 612$) completed an online survey. . A one-factor structure for GDT, and a two-factor structure for GADIS-A were confirmed . Omega coefficients for both scales were acceptable. . There were positive significant associations between the assessed scales and other related measures indicating convergent validity. Appropriate fit indices were found (across gender and daily time spent gaming supporting measurement invariance. The GDT and GADIS-A are appropriate instruments to assess gaming disorders among Thai university students. .

KEYWORDS

Problematic gaming; emerging adults; gaming disorder; youth; psychometric testing

Introduction

Videogame playing is a popular type of entertainment and can take up considerable leisure time among children, adolescents and emerging adults. Over two billion individuals play such games worldwide and the global revenue of gaming industry is more than 100 billion dollars annually (Lampropoulou et al., 2022; Männikkö et al.,

2019). It has been estimated that there are more than 220 million gamers in the United States and that playing videogames is popular in more than half of the European population (Clement, 2022; Interactive Software Federation of Europe, 2020). On average, gamers spend 10% of their daily time on gaming, and the proportion of active gamers in many developed countries is over 50% while individuals aged 10 to 20 years devote the greatest amount of time in playing such games (Borgonovi, 2016; Vuorre et al., 2022). There are growing numbers of gamers in Asian countries and it is estimated that more than 500 million online gamers live in the China (Pourmand et al., 2017; Wu et al., 2018). According to a recent survey, 83% of Thai participants aged between 18 and 24 years reported they played online games and half of them played online games on a daily basis (Statista Research Department, 2023).

Although playing videogames may include both positive and negative outcomes among players, the negative aspects of videogames have been discussed more in the extant literature (Pourmand et al., 2017). Moreover, problematic use of videogames may cause substantive psychological problems such as addiction, aggression, attention deficits, sleep disorders, social anxiety, and depression that may negatively affect both general and academic life of children and adolescents (Chen et al., 2021; López-Fernández et al., 2021; Ostinelli et al., 2021; Sánchez-Llorens et al., 2021). Problematic gaming may expose younger individuals to higher risks than adults because the abilities related to cognitive control are not fully developed in this population (Jeon et al., 2021).

Additionally, a lot of videogames are specifically developed based on young people's interests and may lead to a strong attachment to games among these individuals (Király et al., 2023). According to epidemiological assessments, the prevalence rate of problematic gaming among adolescents ranges from 1% to 6% in different regions of the world (Fam, 2018), and in a systematic review the global rate was estimated to be

approximately 3% (Ostinelli et al., 2021). In Thailand (where the present study was carried out), a recent study reported that 5.4% of 5497 secondary school students were affected by problematic online gaming (Taechoyotin et al., 2020).

In the 11th revision of the *International Classification of the Diseases* (ICD), gaming disorder (GD) comprises (i) inappropriate control of gaming, (ii) higher priority of gaming compared to other daily activities and personal interests, and (iii) persistent gaming despite the presence of negative outcomes due to it (World Health Organization, 2018). GD increases the risk of physical and mental consequences for both gamers and those around them (Stevens et al., 2021). Disordered gaming usually prevents individuals from engaging in other activities and may cause hazardous behaviors related to gaming or its context (González-Bueso et al., 2018). Individuals with GD may also suffer from significant impairments in their personal, social, occupational and educational functioning due to their gaming (Hernández-Vásquez et al., 2022; Huot-Lavoie et al., 2022). It should also be noted that internet gaming disorder (IGD) is similar to GD and was included in the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) as a behavioral addiction with symptoms such as preoccupation, withdrawal, lack of interest to other activities, relapse, tolerance, and conflict (Diagnostic and Statistical Manual of Mental Disorders: DSM-5, 2014).

The recent inclusion of GD as a mental health disorder in both the ICD and DSM-5 indicates the growing priority of this issue for researchers to further investigate the impact of the disorder. At a global level, standardized instruments are needed to (i) conduct cross-cultural assessments to better understand the diagnostic criteria, (ii) determine prevalence rates, and (iii) identify correlates, comorbidities, and associated factors (Heckert & Parson, 2022).

To date, more than 30 specific instruments have been developed that assess GD, particularly in the English language (Karhulahti et al., 2023; Yoon et al., 2021). However, there is limited evidence regarding their psychometric properties in other cultures and languages. Moreover, many of these instruments were developed based on different definitions of GD and there is a lack of consensus concerning an integrated definition. The use of multiple different instruments has likely caused inconsistencies in the criteria of assessment which explains the many different prevalence rates of GD. Moreover, some of these instruments are relatively lengthy and are therefore are not appropriate for large-scale studies which apply multiple assessments to identify associated factors. Another limitation of the current scales assessing GD is that they may only be assessing a specific kind of GD (e.g., online gaming), even though adolescents and emerging adults engage in both online and offline gaming. Despite the good psychometric properties that have been assessed in many studies (Yoon et al., 2021), most psychometric studies have examined instruments assessing IGD based on the DSM-5 criteria and may not fully address the most recent criteria of GD proposed in the ICD-11.

To overcome the aforementioned limitations, two scales were recently developed (i.e., Gaming Disorder Test [GDT; (Pontes et al., 2021)] and Gaming Disorder Scale for Adolescence [GADIS-A; (Paschke et al., 2020)]). Karhulahti et al. (2023) in a review study assessed all standardized GD scales and concluded that the GDT was the most appropriate scale for assessing the ICD-11 criteria. This brief instrument comprises only four items and has been psychometrically tested in six different languages including English, Chinese, German, Polish, Turkish and Spanish with promising findings (Evren et al., 2020; Maldonado-Murciano et al., 2021; Montag et al., 2019; Pontes et al., 2021). The GADIS-A including 10 items, was developed to assess GD based on ICD-11 criteria

among children and adolescents and has been validated in Russian and Persian languages (Mazaherizadeh et al., 2022; Nazari et al., 2022; Paschke et al., 2020).

Considering the arguably high prevalence rate of GD among the adolescents and youth, it was a necessary to develop an instrument to better understand GD's symptoms, impairments and age-related aspects (Fam, 2018; Stevens et al., 2021). Moreover, given that young adulthood is the next developmental stage of adolescence, it is important to examine if the GADIS-A can also be used among emerging adults (e.g., university students). If the GADIS-A can be used among emerging adults, researchers can use the GADIS-A to conduct longitudinal studies from adolescence to young adulthood to investigate temporal GD patterns.

All previous studies have confirmed the acceptable psychometric properties of these two scales in different settings. However, there are no Thai versions of these scales. Therefore, the present study aimed to (i) translate and validate the first Thai versions of the GDT and GADIS-A; (ii) assess the psychometric properties of the scales based on both classical test theory and item response theory; (iii) determine the factor structure of the scales using confirmatory factor analysis; and (iv) investigate the scales' measurement invariance across gender and daily time spent gaming to find applicability of the scales for using among both genders and those with significant differences on gaming time.

Method

Participants and procedure

Data were obtained from a convenience sample of Thai university students. This period of data collection was conducted from September 2022 to January 2023. Participants were recruited via an online survey using *SurveyMonkey*. This online survey link was distributed using *Facebook* and an online university forum with the help of research

assistants. Participants who provided online informed consent were directed to complete a survey, including demographic information and standard self-report measures including the GDT, GADIS-A, Bergen Social Media Addiction Scale (BSMAS), and nine-item Internet Gaming Disorder Scale–Short-Form (IGDS9-SF). All individuals were required to meet the eligibility criteria in order to be able to participate. These were being (i) aged ≥ 18 years; (i) able to understand and read Thai language; and (iii) enrolled at universities in Thailand (i.e., undergraduates or postgraduates). The study was approved by the Human Research Ethics of National Cheng Kung University (NCKU HREC-E-110-486-2).

The sample comprised 612 Thai university students (72.55% females). The mean age of participants was 20.57 years (SD± 2.29), and most had no chronic condition or diseases (86.92%). The participants used social media for an average of 6.26 hours a day (SD± 3.65) and spent 1.59 hours daily playing videogames (SD±1.83). The mean score of the (i) BSMAS was 14.73 out of 30 (SD±4.45), and (ii) IGDS9-SF was 13.16 out of 45 (SD±4.83) (Table 1).

(Insert Table 1 here)

Translation process of GDT and GADIS-A

Permission was obtained from the original scale developers to conduct the translations, following a standardized translation process (Beaton et al., 2000). First, the GDT and GADIS-A were separately translated into Thai language by two Thai-English researchers (i.e., sport sciences and nursing), and then the two researchers discussed the translations to reconcile the two forward-translations into one forward translation. Second, two independent bilingual translators who were fluent in Thai and English, back-translated the GDT and GADIS-A from Thai reconciled version to an English version. To guarantee conceptual and linguistic equivalence, three experts (i.e., two nurses and a psychologist)

further checked all the translation materials (i.e., three forward-translations and two backward-translations) together with the English versions to finalize the Thai GDT and Thai GADIS-A..

Measures

Demographics

All participants provided demographic information which included age, gender, academic level, study major, and any condition or diseases, as well as daily amount of time spent using social media and gaming.

Gaming Disorder Test (GDT)

The GDT was originally developed by Pontes et al. (2021) to assess the symptoms of gaming disorder (GD) according to ICD-11 criteria (Pontes et al., 2021). The GDT assesses both online and/or offline gaming activities (e.g., consoles, personal computers, smartphones) over the previous year. The scale has four items which are rated on a five-point Likert scale (1 = "never", 2 = "rarely", 3 = "sometimes", 4 = "often", 5 = "very often"). Total scores of the GDT range from 4 to 20, with higher scores demonstrating greater risk of GD. An example item is *"I have had difficulties controlling my gaming activity".* The GDT has been validated in a number of languages, with acceptable to excellent internal consistency ($\alpha = 0.87$ in Chinese; $\alpha = 0.84$ in English; $\alpha = 0.92$ in Polish, $\alpha = 0.89$ in Spanish) (Cudo et al., 2022; Maldonado-Murciano et al., 2021; Pontes et al., 2021). The internal consistency of GDT was acceptable in the present study ($\omega = 0.70$).

Gaming Disorder Scale for Adolescents (GADIS-A)

The GADIS-A was originally developed by Paschke et al. (2020) to assess symptoms of

GD according to ICD-11criteria. The GADIS-A assesses both online and/or offline gaming activities (e.g., consoles, personal computers, smartphones, tablets) over the previous year. The scale comprises two subscales (i.e., cognitive-behavioral symptoms [CBS], negative consequences [NC]) and frequency to indicate GD. The CBS subscale has four items (Items 1,2,4, and 5), and the NC subscale has five items (Items 3,6,7,8, and 9). Gaming frequency was Item 10. Each item of the CBS and NC subscales is rated on a five-point Likert scale (0 = "strongly disagree", 1 = "somewhat disagree", 2 = "partially disagree/partially agree", 3 = "somewhat agree", 4 = "strongly agree"). The total scores of first nine items (i.e., CBS and NC subscales) range from 0 to 36 with a cut-off point: > 9 for CBS subscale; > 5 for NC). An example item of the CBS subscale is *"I often play games more frequently and longer than I planned to or agrees upon with my parents"*. An example item of the NC subscale is *"Due to gaming, I neglect my appearance, personal hygiene, and/ or my health. For instance, I sleep less, eat unhealthily, and/or exercise less because of gaming"*. Item 10 (frequency) is *"In the past year, how often did you experience the conflicts or difficulties described in the statements 1 to 9 due to gaming? Did this only occur on single days, during longer periods of several weeks to months, or was it almost daily?"* The GADIS-A has been validated in a few languages with excellent internal consistency (α = 0.9 for CBS subscale and α = 0.87 in German; α = 0.82 for CBS subscale and α = 0.85 for NC subscale in Russian) (Nazari et al., 2022; Paschke et al., 2020). The internal consistency of GADIS-A was very good in this present study (ω = 0.82 for CBS subscale and ω = 0.88 for NC subscale).

Bergen Social Media Addiction Scale (BSMAS)

The BSMAS is an adaptation from the Bergen Facebook Addiction Scale developed by Andreassen et al. (2012) that assesses problematic social media use over the previous year. The present study used the Thai BSMAS (reference needed). The scale has six items

which are rated on a five-point Likert scale (1 = “very rarely”, 2 = “rarely”, 3 = “sometimes”, 4 = “often”, 5 = “very often”). Total scores on the BSMAS range from 5 to 30, with higher scores demonstrating greater risk of addiction to social media. An example item is *“You spend a lot of time thinking about social media or planning how to use it.”* The BSMAS instrument has been validated in many languages, with excellent internal consistency (e.g., α = 0.88 in English; α = 0.86 in Persian; α = 0.82 in Chinese) (Andreassen et al., 2012; Lin et al., 2017; Yam et al., 2019). The internal consistency of the BSMAS was very good in this present study (ω = 0.81).

Internet Gaming Disorder Scale–Short-Form (IGDS9-SF)

The IGDS9-SF was originally developed by Pontes and Griffiths (2015) to assess the severity of internet gaming disorder. The IGDS9-SF assesses both online and/or offline gaming activities during over the previous year based on the DSM-5 diagnostic criteria (Pontes & Griffiths, 2015). The Thai version was used in the present study. The scale has nine items and each item is rated on a five-point Likert scale (1 = “never”, 2 = “rarely”, 3 = “sometimes”, 4 = “often”, 5 = “very often”). Total scores on the IGDS9-SF range from 9 to 45, with higher scores indicating higher risk of IGD. An example item is *“Do you feel preoccupied with your gaming behavior?”* The IGDS9-SF has been validated in many languages, with excellent internal consistency (e.g., α = 0.87 in English; α = 0.96 in Italian; α = 0.94 in Chinese) (Monacis et al., 2016; Pontes & Griffiths, 2015; Qin et al., 2020). The internal consistency of the IGDS9-SF was very good in the present study (ω = 0.87).

Statistical analysis

Descriptive statistics were applied to analyze the participants’ demographic information, and item scores distribution on GDT, GADIS-A, BSMAS, and IGDS9-SF. Confirmatory

factor analysis (CFA) was used to examine the factor structures of the GDT (one-factor structure) and GADIS-A (two-factor structure). Factor loadings and the corrected item-total correlations from CFA were applied to examine all items of GDT and GADIS-A with values > 0.4 are considered acceptable (> 0.4). For internal consistency, the McDonald's ω coefficient (ω > 0.70) was considered adequate. Additionally, the ceiling and floor effects were calculated to indicate percentages of participants obtaining upper and lower in each scale, both ceiling and floor effects was acceptable with the value < 15% (Liu & Wang, 2021). Moreover, CFA was used with diagonally weighted least square (DWLS) estimator to investigate construct validity because DWLS is an appropriate estimator for Likert-type scales (Li, 2016). To investigate model fits, the analysis used comparative fit index (CFI) and Tucker–Lewis index (TLI) > 0.9; root mean square error of approximation (RMSEA) and standardized root mean square residual (SRMR) < 0.08; non-significant χ^2 to indicate satisfactory model fits (Li, 2016).

Multigroup CFA was also used to examine measurement invariance of the GDR and GADIS-A across gender (male vs. female) and daily time spent gaming (below two hours vs. above two hours) groups. For each comparison, three nested models in the multigroup were assessed: configural model (investigating overall model fits similarly across groups); metric invariance model (investigating model with factor loadings constrained as equal being invariant with configural model); and scalar invariance model (investigating factor loadings and thresholds constrained as equal being invariant with metric invariance model). The measurement invariance was indicated by $\Delta CFI > -0.01$, $\Delta SRMR < 0.03$ (for factor loading) or 0.01 (for item threshold), and $\Delta RMSEA < 0.015$ (23). Furthermore, validity was assessed regarding to relationships between GDT, GADIS-A, BSMAS, and IGDS9-SF using Pearson correlation. All statistical analyses were calculated in *jamovi* (Version 2.3).

Results

According to Tables 2 and 3, the results supported a one-factor structure for the GDT and a two-factor structure for the GADIS-A. All items of GDT demonstrated acceptable factor loadings in the CFA (0.57–0.82) and had acceptable corrected item total correlations (0.48–0.61), except Item 4 of GDT. All items of GADIS-A demonstrated both satisfactory factor loadings in the CFA (0.66–0.82) and corrected item total correlations (0.6–0.78). Additionally, the GDT presented low ceiling (0.2%) and high floor effects (30.7%). Similarly, the GADIS-A presented low ceiling (0.5% for CBS subscale; 0.2% for NC subscale) and high floor effects (30.6% for CBS subscale; 33.5% for NC subscale). The GDT and GADIS-A presented an acceptable McDonald's omega coefficient ($\omega = 0.70$ for GDT; $\omega = 0.82$ for CBS subscale of GADIS-A; $\omega = 0.88$ for NC subscale of GADIS-A). Additionally, the finding showed non-significant χ^2 and adequate values of all items for fit indices of both GDT and GADIS-A.

(Insert Table 2 and Table 3 here)

According to Table 4, the GDT was significantly and positively correlated with GADIS-A (including total score, CBS subscale, NC subscale, and frequency), BSMAS, IGDS9-SF, and daily time spent gaming. The GADIS-A (including total score, CBS subscale, NC subscale, and frequency) was significantly and positively correlated with BSMAS, IGDS9-SF, and daily time spent gaming. The BSMAS was significantly and positively correlated with IGDS9-SF and daily time spent on social media. The IGDS9-SF was significantly and positively correlated with daily time spent gaming. However, daily time spent on social media was not significantly correlated with daily time spent gaming.

(Insert Table 4 here)

For the GDT, the results of each model comparison in the nested CFA presented fit indices with nonsignificant χ^2 difference, and all values of ΔCFI, ΔSRMR, and ΔRMSEA were within the recommended guideline to indicate invariance for both gender and daily time spent gaming (Table 5). For GADIS-A, the results of each model comparison in the nested CFA presented fit indices with nonsignificant χ^2 difference, and all values of ΔCFI, ΔSRMR, and ΔRMSEA were within the recommended guideline to indicate invariance for gender and daily time spent gaming (Table 6).

(Insert Table 5 and Table 6 here)

Discussion

In the present study, the psychometric properties of two recently developed scales designed to assess gaming disorders were examined. Generally speaking, the findings confirmed good reliability and validity for both GD scales in the Thai language. Therefore, the two scales appear to adequately assess GD and are suitable for use among Thai language speaking emerging adult population and to identify the symptoms regarding GD. More specifically, the factor structures of both scales were found to be the same as in the original scale development studies. Results indicated the scales had concurrent and construct validity based on the associations between the other scales and those under investigation. This indicates their sound theoretical foundations for use among the Thai emerging adult population.

When developing the GDT, Pontes et al. (2021) used two samples including Chinese and British emerging adults with an average age of 23 years (SD, 4.7) years old. Similar to the present study, they used the IGDS9-SF to assess concurrent validity. In their study, discriminant and convergent validity of the scale were tested using scales assessing loneliness and depression, whereas the present study used the BSMAS to assess convergent validity. Nevertheless, the findings of the present study are consistent with

the original study (Pontes et al., 2021). Also, the present study used factor analysis to further investigate the construct validity of GDT, and the findings were comparable to the original study. However, there was a difference between the results here and those found in the study by Pontes et al. in terms of item-total correlations. More specifically, one item in the original study (Item 4) was significantly correlated with the total score (r>0.7) whereas it did not show a strong correlation in the present study (r=0.28). This item concerned experiencing significant problems in the life due to severity of gaming behavior such as problems in relationships with family members and social interactions. The nature of this item is mostly related to the problems that an individual may face with regards to social communications, whereas other items basically target the individual problems related to GD (i.e., Item 4 specifically assesses the social aspects of GD, whereas other items assess the personal aspects). Therefore, the difference might be due to cultural differences between the present sample and that of the original validation study. Because the present study reported similar CFA factor loadings to Pontes et al.'s study findings, the slight difference of the specific item-total correlation should not be considered as a serious conflict between the studies. Additionally, the present findings also are congruent with other studies that examined the psychometrics of the GDT in different languages (e.g., Cudo et al., 2022; Evren et al., 2020; Maldonado-Murciano et al., 2021).

Unlike any of the previous studies examining the GDT and GADIS-A, the present study calculated the ceiling and floor effects of both scales. Ceiling and floor effects occur when a considerable proportion of the participants obtain the minimum or maximum scores on a scale indicating the scale may be limited in discriminating participants from each of the two tails of the scales. The standard cut-point to detect such effects is when 15% or greater of the participants get these scores (Liu & Wang, 2021). Regarding the

ceiling effect, both scales got a percentage score equal or less than 5%, but on the floor effect, the percentage was relatively considerable (approximately 31% for the GDT, and between 30% and 34% for the GADIS-A).

Although using such parameters are usually useful to find the easiness or difficulty level of a measure and are mostly applied to cognitive tests, presence of any of these effects may causes problems in data analysis. For example, the floor effect found in the present study may lead to some inflation in mean estimates. The floor effects should be a caution for researchers to address the significant floor effects with these scales and use appropriate statistical methods to reduce any impaired estimations. Nevertheless, because the scales were developed to assess a disorder (i.e., GD) among videogame players, it is reasonable that a considerable number of participants prefer to not be stigmatized by such a disorder and try to achieve good scores on both scales that may easily explain the floor effect here. In other words, they may choose the minimum level on each item, leading to a minimum score resulting in the floor effect.

Another interesting finding of the study was that the time spent on social media was not significantly correlated to the time spent gaming. Whereas it might be expected that most gamers who spend substantial time gaming would also have a strong social media presence (Micallef et al., 2022), the present study did not find such a relationship. A likely explanation for the finding may be that when a gamer is spending a great deal of time gaming, they may not have sufficient time to use social media and vice versa.

Although measurement invariance was not examined in the original validation studies when developing the GDT and GADIS-A, a few of the subsequent validation studies performed such analysis. For example, Maldonado-Murciano et al. (2021) in validation of the Spanish GDT found that there was acceptable measurement invariance across genders. Similarly, Cudo et al. (2022) by assessing multi-group CFA (like that

conducted in the present study) found that the GDT may appropriately be used for both genders with strict measurement invariance. Nazari et al. (2021) when assessing the Russian version of the GADIS-A found that the scale was invariant across the gender and gaming mode (online vs. offline). In the present study, measurement invariance was tested across gender and daily time spent gaming, and the results indicated that both scales (GDT and GADIS-A) were invariant, and appropriate for use among specific subgroups of study. Therefore, a tentative conclusion is that both genders and those who spent different amounts of time on daily gaming had similar interpretation and understanding of the items in the GD scales.

The present study has some limitations and shortcomings that should be noted. First, information was collected from a convenience sample of university students. Because online surveys were distributed via *Facebook*, it might exclude those without access to internet or this specific social media platform. Although the majority of videogame players usually have access to internet and different social media platforms, it cannot be claimed that the present sample was representative of all Thai gamers and using multi-settings clustered samples both online and with paper for data collection may help overcome this limitation. Second, discriminant validity of the scales was not tested using a psychological scale related to GD such as a depression scale or a loneliness scale as were administered in the original validation studies. Third, while the GADIS-A was designed for use among adolescents (i.e., in the original validation study, the scale was tested among adolescents aged between 10 and 17 years), in the present study, the scale was applied to university students. However, because the mean age of the present sample was approximately 20.6 years, it is important for researchers to know if the GADIS-A can be used among the population in the next developmental life stage (i.e., young adulthood). Moreover, similar and adequate psychometric properties were found among

the present study's participants. This suggests that the GADIS-A is suitable for use among university students. Finally, there were no objective measures, such as clinical assessment or structured interview, to screen those with GD. The present study only used self-report measures that are inherently limited by problems such as recall bias and providing socially desirable responses. Therefore, using more objective measures besides self-report measures are recommended in future studies particularly for cross-validation of the scale using clinical criteria and as well as to determine cut-off scores for the scales.

Conclusion

To summarize, the present study showed that both the GDT and GADIS-A are appropriate measures to assess GD among Thai university students (i.e., emerging adults). Confirming the factor structure of both scales assessed here indicates the two scales may be used as axillary diagnostic measures to identify symptoms of GD among both genders that are closely consistent with their theoretical bases developed in accordance to ICD-11. An important achievement of the present study was the cultural assessment of GD among a Thai population that enriches the prior knowledge on the standardization of psychological problems experienced by gamers in different region of the world. Using different psychometric approaches such as Rasch analysis within various communities and settings including measuring invariance for other characteristics for further assessment of the scales are recommended.

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Declaration of interest statement

The authors declare no conflict of interest.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author contributions

Conceptualization: MS, RK, J-AS, Y-NY, C-YL; Data curation: RK, JA, PA, PC; Formal analysis: RK, C-YL; Funding acquisition SEHT, IN, Y-NY, C-YL; Investigation: RK, PC, SEHT, IN, J-AS, Y-NY, C-YL; Methodology: MS, J-AS, J-SC, Y-NY, MDG, C-YL; Project administration: RK, C-YL; Resources: MS, RK, JA, PA, PC, J-AS, Y-NY, C-YL; Software: RK, C-YL; Supervision: C-YL; Validation: MS, RK, SEHT, IN, J-AS, J-SC, Y-NY, MDG, C-YL; Visualization: RK; Roles/Writing - original draft: MS, RK, C-YL; Writing - review & editing: JA, PA, PC, SEHT, IN, J-AS, J-SC, Y-NY, MDG, C-YL

References:

Andreassen, C. S., Torsheim, T., Brunborg, G. S., & Pallesen, S. (2012). Development of a Facebook Addiction Scale. *Psychological Reports*, *110*(2), 501-17. https://doi.org/10.2466/02.09.18.pr0.110.2.501-517

Beaton, D. E., Bombardier, C., Guillemin, F., & Ferraz, M. B. (2000). Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine*, *25*(24), 3186-91. https://doi.org/10.1097/00007632-200012150-00014

Borgonovi, F. (2016). Video gaming and gender differences in digital and printed reading performance among 15-year-olds students in 26 countries. *Journal of Adolescence*, *48*, 45-61. https://doi.org/10.1016/j.adolescence.2016.01.004

Chen, C., Dai, S., Shi, L., Shen, Y., & Ou, J. (2021). Associations between attention deficit/hyperactivity disorder and internet gaming disorder symptoms mediated by depressive symptoms and hopelessness among college students. *Neuropsychiatric Disease and Treatment*, *17*, 2775-82. https://doi.org/10.2147/ndt.s325323

Clement J. (2022, October 20). *Video gaming audiences in the United States - Statistics & Facts*. Statista. https://www.statista.com/topics/3070/us-gamers/

Cudo, A., Montag, C., & Pontes, H. M. (2022). Psychometric assessment and gender invariance of the Polish version of the Gaming Disorder Test. *International Journal of Mental Health and Addiction*, 1-24. https://doi.org/10.1007/s11469-022-00929-4

Guha, M. (2014). Diagnostic and Statistical Manual of Mental Disorders: DSM-5 (5th edition). *Reference Reviews*, *28*(3), 36-7. https://doi.org/10.1108/RR-10-2013-0256

Evren, C., Pontes, H. M., Dalbudak, E., Evren, B., Topçu, M. T., & Kutlu, N. (2020). Psychometric validation of the Turkish Gaming Disorder Test: A measure that evaluates disordered gaming according to the World Health Organization framework. *Psychiatry and Clinical Psychopharmacology*, *30*(2), 1-8. https://doi.org/10.5455/PCP.20200429072430

Fam, J. Y. (2018). Prevalence of internet gaming disorder in adolescents: A meta-analysis across three decades. *Scandinavian Journal of Psychology, 59*(5), 524-31. https://doi.org/10.1111/sjop.12459

González-Bueso, V., Santamaría, J. J., Fernández, D., Merino, L., Montero, E., & Ribas, J. (2018). Association between internet gaming disorder or pathological video-game use and comorbid psychopathology: A comprehensive review. *International Journal of Environmental Research and Public Health*, *15*(4), 668. https://doi.org/10.3390/ijerph15040668

Heckert, C., & Parson, N. (2022). Recalibrating the scales: Enhancing ethnographic uses of standardized mental health instruments. *Culture, Medicine and Psychiatry*, 1-19. https://doi.org/10.1007/s11013-022-09811-3

Hernández-Vásquez, A., Vargas-Fernández, R., Visconti-Lopez, F. J., Comandé, D., & Bendezu-Quispe, G. (2022). Prevalence and factors associated with gaming disorder in Latin America and the Caribbean: A systematic review. *International Journal of Environmental Research and Public Health*, *19*(16), 10036. https://doi.org/10.3390/ijerph191610036

Huot-Lavoie, M., Gabriel-Courval, M., Béchard, L., Corbeil, O., Brodeur, S., Massé, C., Fournier, É., Essiambre, A. M., Anderson, E., Cayouette, A., Giroux, I., Khazaal, Y., Demers, M. F., & Roy, M. A. (2022). Gaming disorder and psychotic disorders: A scoping review. *Psychopathology*, 1-9. https://doi.org/10.1159/000527143

Interactive Software Federation of Europe. (2020). *ISFE publishes annual key facts on Europe's video games industry.* https://www.isfe.eu/news/isfe-publishes-annual-key-facts-on-europes-video-games-industry/

Jeon, H. G., Jeong, E. J., Lee, S. J., & Kim, J. A. (2021). Exploring the mechanism of pathological gaming in adolescents: Focused on the mediation paths and latent group comparison. *Frontiers in Psychology, 12*, 756328. https://doi.org/10.3389/fpsyg.2021.756328

Karhulahti, V. M., Martončik, M., & Adamkovič, M. (2023). Measuring internet gaming disorder and gaming disorder: A qualitative content validity analysis of validated scales. *Assessment*, *30*(2), 402-13. https://doi.org/10.1177/10731911211055435

Király, O., Koncz, P., Griffiths, M. D., & Demetrovics, Z. (2023). Gaming disorder: A summary of its characteristics and aetiology. *Comprehensive Psychiatry*, *122*, 152376. https://doi.org/https://doi.org/10.1016/j.comppsych.2023.152376

Lampropoulou, P., Siomos, K., Floros, G., & Christodoulou, N. (2022). Effectiveness of available treatments for gaming disorders in children and adolescents: A systematic

review. *Cyberpsychology, Behavior and Social Networking, 25*(1), 5-13. https://doi.org/10.1089/cyber.2021.0067

Li, C. H. (2016). Confirmatory factor analysis with ordinal data: Comparing robust maximum likelihood and diagonally weighted least squares. *Behavior Research Methods*, *48*(3), 936-49. https://doi.org/10.3758/s13428-015-0619-7

Lin, C. Y., Broström, A., Nilsen, P., Griffiths, M. D., & Pakpour, A. H. (2017). Psychometric validation of the Persian Bergen Social Media Addiction Scale using classic test theory and Rasch models. *Journal of Behavioral Addictions*, *6*(4), 620-29. https://doi.org/10.1556/2006.6.2017.071

Liu, Q., & Wang, L. (2021). *t*-Test and ANOVA for data with ceiling and/or floor effects. *Behavior Research Methods*, *53*(1), 264-77. https://doi.org/10.3758/s13428-020-01407-2

López-Fernández, F. J., Mezquita, L., Etkin, P., Griffiths, M. D., Ortet, G., & Ibáñez, M. I. (2021). The role of violent video game exposure, personality, and deviant peers in aggressive behaviors among adolescents: A two-wave longitudinal study. *Cyberpsychology, Behavior and Social Networking*, *24*(1), 32-40. https://doi.org/10.1089/cyber.2020.0030

Maldonado-Murciano, L., Pontes, H. M., Barrios, M., Gómez-Benito, J., & Guilera, G. (2021). Psychometric validation of the Spanish Gaming Disorder Test (GDT): Item response theory and measurement invariance analysis. *International Journal of Mental Health and Addiction*, 1-19. https://doi.org/10.1007/s11469-021-00704-x

Männikkö, N., Ruotsalainen, H., Tolvanen, A., & Kääriäinen, M. (2019). Psychometric properties of the Internet Gaming Disorder Test (IGDT-10) and problematic gaming behavior among Finnish vocational school students. *Scandinavian Journal of Psychology*, *60*(3), 252-60. https://doi.org/10.1111/sjop.12533

Mazaherizadeh, A., Taherifar, Z., & Farahani, H. (2022). Psychometric properties of the Farsi version of the gaming disorder scale for adolescents (GADIS-A). *BMC Psychology*, *10*(1), 195. https://doi.org/10.1186/s40359-022-00899-1

Micallef, D., Parker, L., Brennan, L., Schivinski, B., & Jackson, M. (2022). Improving the health of emerging adult gamers - A scoping review of influences. *Nutrients*, *14*(11), 2226. https://doi.org/10.3390/nu14112226

Monacis, L., Palo, V., Griffiths, M. D., & Sinatra, M. (2016). Validation of the Internet Gaming Disorder Scale - Short-Form (IGDS9-SF) in an Italian-speaking sample. *Journal of Behavioral Addictions*, *5*(4), 683-90. https://doi.org/10.1556/2006.5.2016.083

Montag, C., Schivinski, B., Sariyska, R., Kannen, C., Demetrovics, Z., & Pontes, H. M. (2019). Psychopathological symptoms and gaming motives in disordered gaming - A psychometric comparison between the WHO and APA diagnostic frameworks. *Journal of Clinical Medicine*, *8*(10), 1691. https://doi.org/10.3390/jcm8101691

Nazari, N., Shabbir, M. S., Sevbitov, A. V., Sadeghi, M., & Griffiths, M. D. (2022). Psychometric evaluation of the Russian version of the Gaming Disorder Scale for Adolescents. *Current Psychology*, 1-15. https://doi.org/10.1007/s12144-021-02575-w

Ostinelli, E. G., Zangani, C., Giordano, B., Maestri, D., Gambini, O., D'Agostino, A., Furukawa, T. A., & Purgato, M. (2021). Depressive symptoms and depression in individuals with internet gaming disorder: A systematic review and meta-analysis. *Journal of Affective Disorders*, *284*, 136-42. https://doi.org/10.1016/j.jad.2021.02.014

Paschke, K., Austermann, M. I., & Thomasius, R. (2020). Assessing ICD-11 gaming disorder in adolescent gamers: Development and validation of the Gaming Disorder

Scale for Adolescents (GADIS-A). *Journal of Clinical Medicine*, *9*(4), 993. https://doi.org/10.3390/jcm9040993

Pontes, H. M., & Griffiths, M. D. (2015). Measuring DSM-5 internet gaming disorder: Development and validation of a short psychometric scale. *Computers in Human Behavior*, *45*, 137-43. https://doi.org/https://doi.org/10.1016/j.chb.2014.12.006

Pontes, H. M., Schivinski, B., Sindermann, C., Li, M., Becker, B., Zhou, M., & Montag, C. (2021). Measurement and conceptualization of gaming disorder according to the World Health Organization framework: The development of the Gaming Disorder Test. *International Journal of Mental Health and Addiction*, *19*(2), 508-28. https://doi.org/10.1007/s11469-019-00088-z

Pourmand, A., Lombardi, K., Kuhl, E., & O'Connell, F. (2017). Videogame-related illness and injury: A review of the literature and predictions for Pokémon GO! *Games for Health Journal*, *6*(1), 9-18. https://doi.org/10.1089/g4h.2016.0090

Qin, L., Cheng, L., Hu, M., Liu, Q., Tong, J., Hao, W., Luo, T., & Liao, Y. (2020). Clarification of the cut-off score for nine-item Internet Gaming Disorder Scale-Short Form (IGDS9-SF) in a Chinese Context. *Frontiers in Psychiatry*, *11*, 470. https://doi.org/10.3389/fpsyt.2020.00470

Sánchez-Llorens, M., Marí-Sanmillán, M. I., Benito, A., Rodríguez-Ruiz, F., Castellano-García, F., Almodóvar, I., & Haro, G. (2021). Personality traits and psychopathology in adolescents with videogame addiction. *Adicciones*, *20,* 1629. https://doi.org/10.20882/adicciones.1629

Statista (2023). Share of online gamers Thailand 2022, by age https://www.statista.com/statistics/1116685/thailand-online-gamers-share-by-age/

Stevens, M. W., Dorstyn, D., Delfabbro, P. H., & King, D. L. (2021). Global prevalence of gaming disorder: A systematic review and meta-analysis. *Australian and New Zealand Journal of Psychiatry*, *55*(6), 553-68. https://doi.org/10.1177/0004867420962851

Taechoyotin, P., Tongrod, P., Thaweerungruangkul, T., Towattananon, N., Teekapakvisit, P., Aksornpusitpong, C., Sathapornpunya, W., Hempatawee, N., Rangsin, R., Mungthin, M., & Piyaraj, P. (2020). Prevalence and associated factors of internet gaming disorder among secondary school students in rural community, Thailand: A cross-sectional study. *BMC Research Notes*, *13*(1), 11. https://doi.org/10.1186/s13104-019-4862-3

The ICD-11 classification of mental and behavioural disorders: Clinical descriptions and diagnostic guidelines. (1992). World Health Organization.

Vuorre, M., Johannes, N., Magnusson, K., & Przybylski, A. K. (2022). Time spent playing video games is unlikely to impact well-being. *Royal Society Open Science, 9*(7), 220411. https://doi.org/10.1098/rsos.220411

Wu, A. M. S., Chen, J. H., Tong, K. K., Yu, S., & Lau, J. T. F. (2018). Prevalence and associated factors of Internet gaming disorder among community dwelling adults in Macao, China. *Journal of Behavioral Addictions*, *7*(1), 62-9. https://doi.org/10.1556/2006.7.2018.12

Yam, C. W., Pakpour, A. H., Griffiths, M. D., Yau, W. Y., Lo, C. M., Ng, J. M. T., Lin, C. Y., & Leung, H. (2019). Psychometric testing of three Chinese online-related addictive behavior instruments among Hong Kong university students. *Psychiatric Quarterly*, *90*(1), 117-28. https://doi.org/10.1007/s11126-018-9610-7

Yoon, S., Yang, Y., Ro, E., Ahn, W. Y., Kim, J., Shin, S. H., Chey, J., & Choi, K. H. (2021). Reliability, and convergent and discriminant validity of Gaming Disorder Scales: A meta-analysis. *Frontiers in Psychology*, *12*, 764209. https://doi.org/10.3389/fpsyg.2021.764209

Tables

Table 1. The characteristics of participants (*n*=612)

Age in years; Mean (SD)	20.57 (2.29)
Sex (Female); n (%)	444 (72.55%)
Academic level (Undergraduate degree); n (%)	590 (96.40%)
Study major; n (%)	
Science	13 (2.12%)
Liberal Arts and Design	20 (3.27%)
Engineering	45 (7.35%)
Social science	128 (20.92%)
Other	406 (66.34%)
Sick (no); n (%)	532 (86.92%)
Internet use (hours per day); Mean (SD)	
Time spent using social media	6.26 (3.65)
Time spent gaming	1.59 (1.83)
Problematic internet use scale scores; Mean (SD)	
BSMAS (possible score range: 6-30)	14.73 (4.45)
IGDS9-SF (possible score range: 9-45)	13.16 (4.83)

BSMAS, Bergen Social Media Addiction Scale; IGDS9-SF, Internet Gaming Disorder Scale–Short-Form

Table 2. Item properties of the Gaming Disorder Test (GDT) and Gaming Disorder Scale for Adolescents (GADIS-A)

	Item description	Mean (SD)	Factor loading	Item-rest correlation
GDT				
GDT_I1	I have had difficulties controlling my gaming activity	1.75 (0.95)	0.57	0.48
GDT_I2	I have given increasing priority to gaming over other life interests and daily activities	1.60 (0.78)	0.82	0.61
GDT_I3	I have continued gaming despite the occurrence of negative consequences	1.65 (0.92)	0.68	0.53
GDT_I4	I have experienced significant problems in life due to the severity of my gaming behavior	1.35 (0.67)	0.32	0.28
GADIS-A				
GADIS-A_CBS				
GADIS-A_I1	I often play games more frequently and longer than I planned to or agreed upon with my parents.	1.11 (1.10)	0.66	0.63
GADIS-A_I2	I often cannot stop gaming even though it would be sensible to do so or, for example, my parents have told me to stop.	0.99 (1.16)	0.73	0.67
GADIS-A_I4	I neglect daily duties, because I prefer gaming. Daily duties include, e.g., doing grocery shopping, cleaning, tidying up after myself, tidying up my room, fulfilling obligations for school/apprenticeship/job.	0.74 (0.97)	0.78	0.66
GADIS-A_I5	I continue gaming even though it causes me stress with others. This means, e.g., stress with my parents, siblings, friends, partner or teachers because of gaming.	0.59 (0.89)	0.76	0.62

GADIS-A_NC				
GADIS-A_I3	I often do not pursue interests outside the digital world because I prefer gaming. For example, I do not meet with friends/ my partner in real life, do not attend sports clubs/ societies, do not read books or make music because of gaming.	0.78 (0.98)	0.82	0.67
GADIS-A_I6	I continue gaming although it harms my performance at school (or apprenticeship/job). For example, I'm late, I do not participate in class, I neglect homework and I get worse grades because of gaming.	0.53 (0.82)	0.74	0.61
GADIS-A_I7	Due to gaming, I neglect my appearance, personal hygiene, and/ or my health. For instance, I sleep less, eat unhealthy, and/or exercise less because of gaming.	0.97 (1.11)	0.76	0.75
GADIS-A_I8	Due to gaming, I risk losing important contacts or have lost them already. This includes contacts with partners, friends, acquaintances or family.	0.92 (1.15)	0.77	0.78
GADIS-A_I9	Due to gaming, I have disadvantages at school / apprenticeship / job. For example, I got bad (final) grades, I'm unable to continue to next grade or do not graduate, I have no place for training or studying, and/ or I got a poor reference or a warning /dismissal as a result of gaming.	0.83 (1.08)	0.72	0.74

GADIS-A_CBS, Subscale of cognitive behavioral symptoms in GADIS-A; GADIS-A_NC, Subscale of negative consequences in GADIS-A

Table 3. Psychometric properties of the Gaming Disorder Test (GDT) and Gaming Disorder Scale for Adolescents (GADIS-A) in scale level

Psychometric testing	GDT	GADIS-A			Suggested cutoff
Celling effects (%)	1 (0.2)	Whole Scale	CBS	NC	<20
		36 (1.0)	3 (0.5)	1 (0.2)	
Floor effects (%)	188 (30.7)	Whole Scale	CBS	NC	<20
		141 (23.0)	187 (30.6)	205 (33.5)	
Internal consistency (McDonald's ω)	0.70	Whole Scale	CBS	NC	>0.70
		0.91	0.82	0.88	
Confirmatory factor analysis					
χ^2 (df)	0.85 (2)	73.27 (26)			nonsignificant
CFI	0.999	0.988			>0.90
NNFI	0.999	0.983			>0.90
RMSEA	0.000	0.055			<0.08
SRMR	0.013	0.064			<0.08

CBS, Subscale of cognitive behavioral symptoms in GADIS-A; NC, Subscale of negative consequences in GADIS-A; CFI = comparative fit index; NNFI = non-normed fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual

Note: GDT was tested using a one-factor structure; GADIS-A was tested using a two-factor structure in confirmatory factor analysis

Table 4. Pearson correlations among the observed variables

	r (*p*-value)								
	1	2	3	4	5	6	7	8	9
1. GDT	1.00								
2. GADIS-A	.51 (<.01)	1.00							
3. GADIS-A_CBS	.55(<.01)	.92(<.01)	1.00						
4. GADIS-A_NC	.43(<.01)	.95(<.01)	.74(<.01)	1.00					
5. GADIS-A_Time criterion	.48(<.01)	.50(<.01)	.48(<.01)	.46(<.01)	1.00				
6. BSMAS	.26(<.01)	.34(<.01)	.28(<.01)	.35(<.01)	.26(<.01)	1.00			
7. IGDS9-SF	.66(<.01)	.58(<.01)	.60(<.01)	.50(<.01)	.51(<.01)	.27(<.01)	1.00		
8. Time spent using social media	.05(.26)	.08(.06)	.04(.32)	.10(.02)	.01(.82)	.29(<.01)	-.01(.77)	1.00	
9. Time spent gaming	.43(<.01)	.23(<.01)	.29(<.01)	.16(<.01)	.23(<.01)	-.02(.57)	.46(<.01)	-.01(.91)	1.00

GDT, The Gaming Disorder Test; GADIS-A, Gaming Disorder Scale for Adolescents; GADIS-A_CBS, Subscale of cognitive behavioral symptoms in GADIS-A; GADIS-A_NC, Subscale of negative consequences in GADIS-A; GADIS-A_Time criterion, Time criterion frequency in GADIS-A; BSMAS, Bergen Social Media Addiction Scale; IGDS9-SF, Internet Gaming Disorder Scale–Short-Form

Table 5. Measurement invariance across different groups on Gaming Disorder Test (GDT).

	Configural Model	**Loadings Constrained as Equal**	**Loadings and Thresholds Constrained as Equal**
Sex (male and female)			
$X^2(df)$ or $\Delta X^2(\Delta df)$	1.08 (4)	3.21 (3)	1.27 (3)
CFI or Δ*CFI*	0.999	**0.000**	**0.000**
RMSEA or *ΔRMSEA*	0.000	**0.000**	**0.000**
SRMR or *ΔSRMR*	0.013	**0.014**	**0.002**
Daily time spent gaming (below 2 hours and above 2 hours)			
$X^2(df)$ or $\Delta X^2(\Delta df)$	1.10 (4)	1.83 (3)	4.71 (3)
CFI or Δ*CFI*	0.999	**0.000**	**0.000**
RMSEA or *ΔRMSEA*	0.000	**0.000**	**0.000**
SRMR or *ΔSRMR*	0.011	**0.011**	**0.013**

CFI = comparative fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual. the bold value indicates invariance; i.e., ΔCFI > -0.01; ΔRMSEA < 0.015; ΔSRMR < 0.03 (for factor loading) or < 0.01 (for item intercept)

Table 6. Measurement invariance across different groups on Gaming Disorder Scale for Adolescents (GADIS-A)

	Configural Model	**Loadings Constrained as Equal**	**Loadings and Thresholds Constrained as Equal**
Sex (male and female)			
$X^2(df)$ or $\Delta X^2(\Delta df)$	83.72 (52)	19.73 (7)	6.11 (7)
CFI or Δ*CFI*	0.991	**-0.003**	**0.000**
RMSEA or *ΔRMSEA*	0.045	**0.005**	**-0.003**
SRMR or *ΔSRMR*	0.066	**0.006**	**0.001**
Daily time spent gaming (below 2 hours and above 2 hours)			
$X^2(df)$ or $\Delta X^2(\Delta df)$	74.55 (52)	42.74 (7)	16.09 (7)
CFI or Δ*CFI*	0.994	**-0.010**	**-0.003**
RMSEA or *ΔRMSEA*	0.038	**0.019**	**0.001**
SRMR or *ΔSRMR*	0.065	**0.016**	**0.003**

CFI = comparative fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual. the bold value indicates invariance; i.e., ΔCFI > -0.01; ΔRMSEA < 0.015; ΔSRMR < 0.03 (for factor loading) or < 0.01 (for item intercept)