**Metacognitions as a predictor of online gaming in adolescents: Psychometric properties of the Metacognitions about Online Gaming Scale among Iranian adolescents**

Highlights:

* The Persian MOGS demonstrates good psychometric properties.
* A three-factor structure was confirmed as in the parent self-report measure.
* Metacognitions about online gaming predict problematic online gaming independently of personality traits, negative affect, and both cognitions and motives.
* Interaction between the factors of MOGS and types of game and tools of gaming was significant.

**Abstract**

The Metacognitions about Online Gaming Scale (MOGS) measures maladaptive metacognitions about online gaming. The purpose of the present study was to evaluate psychometric properties of the MOGS, including its factor structure, reliability, and predictive validity among Iranian adolescents. The scale was administered to 769 Iranian adolescents (577 male, mean age = 16.39± 1.68 years) with an age range of 15-19 years. The participants completed the Persian-translated version of the MOGS, the Big Five Inventory-10, the Depression, Anxiety and Stress Scale 21, the Video-Game Related Cognitions Scale, the Motives for Online Gaming Questionnaire, and the Problematic Online Gaming Questionnaire. The results of the Exploratory Factor Analysis (n=350) and Confirmatory Factor Analysis (n = 419) confirmed three-factors similar to the parent version, including “negative metacognitions about uncontrollability of online gaming” (N-MOGU), “negative metacognitions about dangers of online gaming” (N-MOGD), and “positive metacognitions about online gaming” (P-MOG). The Persian MOGS’s reliability showed a suitable internal consistency for the P-MOG, the N-MOGU, the N-MOGD, and the total score in both confirmatory and exploratory samples (range 0.79 to 0.93). A hierarchical regression analysis showed that the Persian MOGS predicted 33.9% of the variance in problematic online gaming independently of personality traits, anxiety, depression, stress, and both gaming-related cognitions and gaming motives. Furthermore, the results of analyses of variance with follow-up Bonferroni pairwise comparisons showed that interaction between the factors of MOGS and types of game and tools of gaming was significant. The findings provide evidence that the Persian MOGS among Iranian adolescents appears psychometrically appropriate to be used by researchers and practitioners dealing with the prevention and treatment of problematic online gaming.

***Keywords*:** Gaming motives; gaming-related cognitions; metacognitions about online gaming; psychometric properties; problematic online gaming.

**1. Introduction**

In the latest version of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; APA, 2013) Internet Gaming Disorder (IGD) has been added to the research appendix section. IGD is defined by symptoms such as loss of interest in real-life, loss of control, preoccupation with games, tolerance, withdrawal, and continuing to game despite its negative consequences (Müller et al., 2019). According to a recent national poll, 40% of boys and 20% of girls play video games every day, and 37% of these boys compared to 20% of these girls play video games more than 3 hours per day (National Poll on Children's Health, 2020). The prevalence of online gaming is higher in adolescents than in adults (Hawi, Samaha, & Griffiths, 2018). Furthermore, earlier age in the inception of gaming is related to more symptoms of IGD (Beard et al., 2017). In a meta-analysis, the prevalence of IGD among adolescents was 4% (Fam, 2018). IGD in adolescents is also associated with adverse psychological and behavioral outcomes (Fioravanti, Dèttore, & Casale, 2012; Milani et al., 2017). These include depression (Ko et al., 2014; Wartberg, Kriston, & Thomasius, 2020), anxiety (Bonnaire & Baptista, 2019; Stavropoulos et al., 2017), self-esteem problems (Wartberg, 2019), and impulse control problems (Du et al., 2016). In a study conducted in Iran on 1,024 students, the prevalence of IGD was estimated at 5.3% (Ahmadi et al., 2014). Furthermore, in Iran the social, educational, and financial problems caused by IGD have increased significantly over the last decade (Shadloo et al., 2017). Many studies have shown the relationship between psychological distress, depression, insomnia, anxiety and IGD among the Iranian population (Amini et al., 2014; Fazeli et al., 2020; Lin et al., 2020).

*1.1. Metacognitions, problematic online gaming, and IGD*

There are several factors involved in the development and maintenance of problematic online gaming and IGD (Marino et al., 2020). Metacognitions are beliefs about cognitive-affective experiences and means of controlling them (Wells, 2002). Two types of metacognitions have been identified in the literature: positive and negative. Positive metacognitions relate to the benefits of engaging in coping strategies for controlling cognitive-affective experience (e.g., “Using alcohol will help me to reduce my self-consciousness”) and are linked to the activation of such coping strategies. Negative metacognitions are judgements relating to the perceived control over adopted coping strategies and resultant cognitive-affective states (e.g., “I cannot stop thinking about gambling”; “My thoughts about alcohol use are uncontrollable”). The ubiquitous role of both positive and negative metacognitions in addictive behaviors has been widely evidenced across numerous studies (e.g., Spada et al., 2015; Hamonniere & Varescon, 2018).

Metacognitions have also been identified as predictors of problematic online gaming and IGD. Spada and Caselli (2017) designed a self-report measure for assessing metacognitions about online gaming, the Metacognitions about Online Gaming Scale (MOGS). In this study an initial analysis supported a two-factor solution: (i) positive metacognitions about online gaming (P-MOG); and (ii) negative metacognitions about the uncontrollability of online gaming (N-MOG). P-MOG refers to metacognitions about the benefits of online gaming as a coping strategy to regulate cognitive-affective states, for example “Online gaming makes my worries more bearable”. N-MOG refers to metacognitions about the uncontrollability of online gaming, for example “I continue to play despite I think it would be better to stop”. A further analysis led to the identification of a three-factor structure: (i) positive metacognitions about online gaming (P-MOG); (ii) negative metacognitions about the uncontrollability of online gaming (N-MOG1); and (iii) negative metacognitions about the dangers of online gaming (N-MOG2). In this three-factor structure negative metacognitions were divided into two factors: N-MOG1 relating to dangers about online gaming (e.g., “Thoughts about online gaming interfere with my functioning”) and N-MOG2 relating to the uncontrollability of online gaming (e.g., “I have no control over how much time I play”). These factors were found to be linked to weekly online gaming hours and problematic Internet use (Spada & Caselli, 2017). Similarly, subsequent studies showed the role of generic metacognitions (Aydın et al., 2020) and metacognitions about online gaming in IGD (e.g., Marino et al., 2020; Caselli et al., 2020).

*1.2. Gaming motives, problematic online gaming, and IGD*

Motivation is a predictor of both problematic online gaming and IGD, which turns the fun use of online gaming into excessive use, negatively impacting quality of life (Mills et al., 2018). Examining gaming motives is a crucial step in understanding how gaming can become an addictive behavior (Lafrenière, Verner-Filion, & Vallerand, 2012; King & Delfabbro, 2009; Moudiab & Spada, 2019). Demetrovics and colleagues (2011), using exploratory factor analysis, identified seven different motives for gaming: social connections, escaping from reality, competition with others, coping with distress, skill development, fantasy world engagement, recreation, and relation. In another study, social motives, immersion, and achievement were introduced as three main components of problematic gaming behavior; achievement motivation is related to the development of power, domination, challenging others, provocation, and similar motives. Social motives lead to goals such as making friends, helping others, self-disclosure, and getting support and teamwork. Immersion is related to searching and finding hidden or mysterious things, fantasy, and interest in role-playing and escaping from the real world and its problems (Yee, 2006). These gaming motives appear to be key determinants of IGD (Király et al., 2015). For example, individuals who game for skill development are less prone to IGD, whilst players who play for social motives are more involved in gaming than others because they want to have greater social connections (Wu et al., 2016). Although few studies have been done on female gamers, in one study, achievement and social motivations were also related to IGD among women gamers (Lopez-Fernandez, Williams, & Kuss, 2019). In Iran a key study by Aminimanesh and colleagues (2017) has confirmed the relationship between gaming motives and IGD in 409 Iranian students.

*1.3. Gaming-related cognitions, problematic online gaming, and IGD*

Although many studies have shown that gaming motives predict both problematic online gaming and IGD, maladaptive gaming-related cognitions also appear to be important predictors of both problematic online gaming and IGD, particularly in the presence of negative affect (Moudiab & Spada, 2019; Marino & Spada, 2017). Maladaptive gaming-related cognitions can lead to the persistence and over-involvement in online gaming (Forrest, King, & Delfabbro, 2017; Marino & Spada, 2017; Billieux et al., 2020). Maladaptive gaming-related cognitions have also been found to affect the overestimation of rewards and activities of the games, leading gamers to set strict rules for completing and continuing gaming (King & Delfabbro, 2014). King and Delfabbro (2014) identified four broad categories of maladaptive gaming-related cognitions: (1) Cognitions regarding game reward value and tangibility (including cognitions relating to reward regulation and obsession); (2) Cognitions regarding maladaptive and inflexible rules about Internet gaming (including cognitions relating to sunk cost bias and procrastination); (3) Cognitions regarding over-reliance on gaming to meet self-esteem needs (including cognitions relating to control and gaming self-esteem); and (4) Cognitions regarding social acceptance in the gaming community rather than the real-world (including cognitions relating to social avoidance and sense of belonging). The findings and observations of King and Delfabbro were broadly supported by recent reviews of the literature (e.g., Marino & Spada, 2017).

*1.4. Personality traits, problematic online gaming, and IGD*

A further predictor of IGD has been found to be differences in gamers’ personality traits (González-Bueso et al., 2020). High neuroticism and low conscientiousness have been linked to problematic Internet use and low conscientiousness and low openness have been linked to IGD (Wang et al., 2015). Many studies have shown that personality traits are associated with IGD (e.g., Collins, Freeman, & Chamarro-Premuzic, 2012; Throuvala et al., 2019; Liao et al., 2020). Low agreeableness, extraversion, and conscientiousness are typically associated with IGD (Gervasi et al., 2017). A systematic review has shown that higher novelty-seeking and harm avoidance are also risk factors for IGD (Şalvarlı & Griffiths, 2019). Another study on 30 individuals aged between 12 and 21 presenting with IGD found that they were more introverted, inhibited, and histrionic than a control group (González-Bueso et al., 2018). Also, González-Bueso and colleagues (2020) have shown that individuals presenting with symptoms of IGD have significant differences in personality traits compared to non-clinical samples. They are more introverted, oppositional, and self-demeaning, and have borderline tendency traits.

*1.5. The aims of the current study*

Considering the importance of the role of metacognitions in predicting addictive behaviors, including IGD, the first aim of the current study was to evaluate the psychometric properties of the MOGS in an Iranian population. The second aim of the study was to explore the relative contribution of gaming-related cognitions, gaming motives, and metacognitions about online gaming to problematic online gaming controlling for personality traits and negative affect (anxiety, depression, stress). No study, to date, has investigated the relative contribution of gaming-related cognitions, gaming motives, and metacognitions about online gaming to problematic online gaming.

**2. Methods**

*2.1. Participants*

In the present study, 769 participants (577 male, 192 female) were selected via convenience sampling from the adolescent population in Iran (mean age = 16.39± 1.68 years). The call to participate in the study was initially published in groups, channels, pages of public messengers, social media (e. g., Telegram, Instagram and WhatsApp) and web forums related to online gaming. Participants were sent an invitation link and had the opportunity to read an information sheet. If agreeing to consent to participation in the study they were directed to questions about the inclusion criteria and contacting channels, including phone number or email for themselves and their parents. This process was managed and screened by two authors of the present study. All final participants, who completed a battery of questionnaires between December 20, 2020 and January 10, 2021, met the following inclusion criteria: (1) minimum age of 14 years and maximum age of 19 years; (2) understand spoken and written Persian; (3) engaging in online gaming at least one hour per week (with the exclusion of online gambling since the psychopathology of online gambling and online gambling may be different; e g., Tonioni et al., 2014); and (4) consent to participate in the study. In this study, 7253 people clicked the invitation link and among and 1117 people who agreed to participate 233 of them were excluded because they did not meet all inclusion criteria. In the next stage, the parental consent form of 53 people was not received. Finally, the questionnaire was emailed or texted to 831 people, 62 of whom did not complete it.

*2.2. Socio-demographics and self-report measures*

**2.2.1. Socio-demographic form:** The socio-demographic factors in the study included age, gender, the total count of siblings, school grade point average, socio-economic status of the adolescent’s family, residential area, presence of Internet connection at home, average daily Internet use, tools for gaming, self-recognition as a problematic gamer, and type of game. This form was developed based on the purpose of the current study.

**2.2.1. Metacognitions about Online Gaming Scale (MOGS)**: The MOGS (Spada & Caselli, 2017) is a self-report measure of metacognitions about online gaming consisting of 12 items and three factors as follows: (1) positive metacognitions about online gaming (P-MOG; e. g., “Online gaming reduces my negative feelings”), (2) negative metacognitions about the uncontrollability of online gaming (N-MOGU; e. g., “I have no control over how much time I play”), and (3) negative metacognitions about the dangers of online gaming (N-MOGD; e. g., “Thoughts about online gaming are becoming an obsession”). Each item is scored on a four-point Likert scale from “do not agree” to “agree very much”. Higher scores indicate greater levels of maladaption in metacognitions about online gaming. The Cronbach's alpha coefficient for the P-MOG factor was 0.84, for the N-MOGU factor was 0.86 and for the N-MOGD factor was 0.79. The MOGS has shown to have good internal consistency, predictive, and divergent validity (Spada & Casseli, 2017).

**2.2.2. Problematic Online Gaming Questionnaire (POGQ):** The POGQ (Demetrovics et al., 2012) is a self-report measure to assess online gaming problems consisting of 18 items and six factors (i.e., preoccupation, overuse, immersion, social isolation, interpersonal conflicts, and withdrawal). Each item is scored on a five-point Likert scale from "never" to "always". Higher scores indicate greater levels of problematic online gaming. The Cronbach alpha and two-week test-retest reliability of this questionnaire were 0.85 and 0.81, respectively. Because the POGQ has not been validated in Iran, for the present study, the English version of the POGQ was translated into Persian by the Iranian authors and a bilingual psychologist. Following this, the equivalence of the two versions was checked and confirmed. The first version for rating the understandability and fluency of each item was completed by 102 participants from the general population of Tehran (F= 23.52%; mean age = 16.76 ± 1.34 years) in a pilot study. This process did not result in any changes in items, and the final version of the Persian POGQ was confirmed. In this pilot study the Cronbach's alpha was 0.79. The Cronbach's alpha in the current study was 0.93.

**2.2.3. Big Five Inventory-10 item (BFI-10):** The BFI-10 [(Rammstedt](https://scholar.google.nl/citations?user=-uCKs_sAAAAJ&hl=en&oi=sra) &  [John](https://scholar.google.nl/citations?user=Iin2LSIAAAAJ&hl=en&oi=sra), 2007) is a self-report measure to assess the Big Five personality traits consisting of 10 items. The BFI-10 is the shortest valid version of the Big Five Inventory (BFI; [Rammstedt](https://scholar.google.nl/citations?user=-uCKs_sAAAAJ&hl=en&oi=sra) & [John](https://scholar.google.nl/citations?user=Iin2LSIAAAAJ&hl=en&oi=sra), 2007). The five personality traits measured are: extroversion, agreeableness, conscientiousness, neuroticism, and openness. Each item is scored on a five-point Likert scale from "completely disagree" to "completely agree". Higher scores indicate greater levels of a given personality trait. The Persian version of this measure also has acceptable validity and reliability (Mohammad zadeh and Najafi, 2010). The Cronbach's alpha in the current study for the five factors ranged from 0.60 to 0.75.

**2.2.4. Depression, Anxiety and Stress Scale 21 (DASS-21):** The DASS-21 (Lovibond & Lovibond, 1995) is a self-report measure to assess anxiety, depression and stress consisting of 21 items (7 for each factor). Each item is scored on a four-point Likert scale from "not at all" to "very much". Higher scores indicate greater levels of anxiety, depression, and stress.

The three factors identified by the DASS-21 are common to general psychological distress (Henry and Crawford, 2005). In the Persian version of this scale, Cronbach's alpha for depression, anxiety, and stress were reported as 0.80, 0.76, and 0.77, respectively (Samani & Jokar, 2007). The Cronbach's alpha in the current study for depression, anxiety, and stress are reported as 0.79, 0.87, and 0.82, respectively.

**2.2.5. Video-Game related Cognitions Scale (VGCS).** The VGCS (Forrest, King, & Delfabbro, 2016) is a self-report measure to assess maladaptive cognitions related to video games consisting of 18 items and four factors (i.e., perfectionism, cognitive salience, regret, and behavioral salience). Each item is scored on a five-point Likert scale from “never” to “always”. Higher scores indicate greater levels of maladaption in cognitions. Because the VGCS has not been validated in Iran, for the present study, the English version of the VGCS was translated into Persian by the Iranian authors and a bilingual psychologist. Following this, the equivalence of the two versions was checked and confirmed. The first version for rating the understandability and fluency of each item was completed by 102 participants from the general population of Tehran (F = 23.52%; mean age = 16.76 ± 1.34 years) in a pilot study. This process did not result in any changes in items, and the final version of the Persian VGCS was confirmed. In this pilot study the Cronbach's alpha was 0.79. The Cronbach's alpha in the current study was 0.89.

**2.2.6. Motives for Online Gaming Questionnaire (MOGQ):** The MOGQ (Demetrovics et al., 2011) is a self-report measure to assess motives related to online gaming consisting of 27 items and seven factors (i.e., escape, coping, fantasy, skill development, recreation, competition, and social). Each item is scored on a four-point Likert scale from “(almost never/never” to “almost always/always”. Higher scores indicate greater levels of motives. Because the MOGQ has not been validated in Iran, for the present study, the English version of the MOGQ was translated into Persian by the Iranian authors and a bilingual psychologist. Following this, the equivalence of the two versions was checked and confirmed. The first version for rating the understandability and fluency of each item was completed by 102 participants from the general population of Tehran (F = 23.52%; mean age = 16.76 ± 1.34 years) in a pilot study. This process did not result in any changes in items, and the final version of the Persian MOGQ was confirmed. In this pilot study, the Cronbach's alpha for its factors ranged from 0.84 to 0.90. The Cronbach's alpha of its factors ranged from 0.82 to 0.92 in the current study.

*2.3. Procedure*

To prepare a Persian version of the MOGS, two English language experts translated the self-report measure into Persian, and then the translated text was edited. Following this, the translated text was translated back into English, by English language experts, and the two versions were matched. The self-report measure was then given to two psychologists to check its face validity. After comparing the two translated versions and the original text and correcting the objections, the self-report measure was administered to 40 adolescents (F = 30%; mean age = 16.37 ± 1.27 years) for rating the understandability and fluency of each item, and ultimately the final version of the self-report measure was prepared for use. After the participants voluntarily responded to participate in the study, their parents' contact information was requested. As they signed informed consent, the study pack was sent to parents to review and sign parent consent so adolescents could be allowed to participate in the study. Participants were then asked to complete the survey online at home without anyone else present. When the study link was sent, the researchers followed the adolescents with an online briefing session. The average completing time was 9.21 minutes/seconds.

*2.3. Statistical analyses*

In this study, data were analyzed using SPSS (version 25; IBM Corp, 2017) and LISREL 8.80 (Jöreskog & Sörbom, 2006). The factor structure of the Persian MOGS was examined through a two-step analytic approach. First, the main dataset was divided into two random subsamples: the first subsample had a random allocation of 350 participants (256 male and 94 female) for the Exploratory Factor Analysis (EFA). The second subsample included 419 participants (321 male and 98 female) for the Confirmatory Factor Analysis (CFA). There were no significant differences between the two subsamples in terms of age (*t* (765) = 2.69, *p* = 0.351), gender (χ2(1) = 1.48, *p* = 0.305), average daily Internet use (*t*(765) = 2.11, *p* = 0.19), tools for gaming (χ2(1) = 1.86, *p* = 0.341), and type of game (χ2(1) = 2.12, *p* = 0.359) or other demographic variables (*all ps > 0.27*). Factor structure was assessed using Principal Component Analysis (PCA) with Varimax rotation in the first subsample (n = 350). Horn's (1965) parallel analysis was used to determine the number of factors to extract since it allows us to estimate the number of factors more accurately relative to the eigenvalue > 1 criterion (Brown, 2006; Fabrigar et al., 1999). Next, data from the second subsample (n = 419) were subjected to CFA to test the fit of the factor structure previously identified through PCA. The model fit (Kline, 2015) was evaluated through the Chi-square index (χ2; good fit: < 5), Normed Fit Index (NFI; good fit: ≥0.90), Comparative Fit Index (CFI; good fit: ≥0.90), Incremental Fit Index (IFI; good fit: ≥0.90), Standardized Root Mean Square Residual (SRMR; good fit: ≤0.08), and Root Mean Square Error of Approximation (RMSEA; good fit: ≤0.06). The Persian MOGS’s reliability was examined by the internal consistency coefficient (Cronbach's alpha for total score and factors of MOGS). Also, to establish the predictive validity of the Persian MOGS we aimed to determine its contribution to levels problematic online gaming independently of gaming-related cognitions and gaming motives, controlling for personality traits and negative affect (anxiety, depression and, stress). Finally, to explore interaction between the factors of MOGS and types of game and tools of gaming, as well as between the motives for online gaming and types of game, a series of one-way analyses of variance with follow-up Bonferroni pairwise comparisons were conducted.

**3. Results**

In this study, in terms of Internet connection at home, 98.3% (n = 756) of the participants indicated that they had an Internet connection, with 96.4% (n = 741) indicating using the Internet for more than two hours per day and average time spent per day with online game was 3.06. The most common gaming tool was the mobile phone (52.3%, n = 402), and the most common type of game played was action (50.1%, n = 385). Of the sample, 77.9% of participants reported living in the city center. Participants spent an average of 21.45 hours gaming online per week. Mean scores and standard deviations of the study variables are presented in Table 1.

*3.1. EFA for the Persian MOGS*

To evaluate the factor structure of the Persian MOGS, EFA was used to identify the underlying factors of this self-report measure. In this study, 350 people were selected as the research sample. Kaiser-Mir-Olkin (KMO) and Bartlett's tests were used as the default of EFA and to determine sampling adequacy. The results of the KMO (0.895) indicated the adequacy of the sample for the application of factor analysis (n = 350, 73.1% male; mean age = 16.42± 1.67 years). To evaluate the power of research data to derive a specific factor structure, the Bartlett sphericity test was used, the results of which were significant (χ2 = 3101.988, *p* < 0.001).

EFA was performed on 12 items using the principal component extraction method and varimax rotation, accepting the eigenvalue condition ≥ 1 and the factor loading ≥ 0.40 (Costello & Osborne, 2005). Additionally, parallel analysis (Horn, 1965) suggested a three-factor solution; therefore, in the next step, a PCA was conducted by setting the number of factors to be extracted at 3. This solution accounted for 77.91% of the total variance of the Persian MOGS. Eigenvalues of 4.71, 2.36, and 2.27 explained variances of 39.25%, 19.67%, and 18.98% were observed for the three factors, respectively. Item-factor loadings for the three-factor model are presented in Table 1. Factors were named according to their content and the original version by Spada and Caselli (2017): Factor one relates “Negative metacognitions about the uncontrollability of online gaming” (N-MOGU), factor two relates to “Negative metacognitions about dangers of online gaming” (N-MOGD), and factor three relates to “Positive metacognitions about online gaming” (P-MOG).

*3.2. CFA for the Persian MOGS*

Firstly, a CFA was conducted on the data obtained from the factor-validation sample using LISREL 8.8 (Jöreskog & Sörbom, 1996). We compared three models on the second subsample (n = 419, 76.6% male, mean age=16.27± 1.68 years) to further evaluate the three-factor structure explored and following the parent study (Spada & Caselli, 2017). In the first model, we defined a single latent variable with all 12 items as indicators. In the second model, we defined a two-factor model, in which latent variables were positive and negative metacognitions. Finally, we tested a three-factor model identified through the previously described PCA and the original version study (Spada & Caselli, 2017). As shown in Table 2, the three-factor solution had the best model fit indices (χ2 = 261.11, df = 51, CFI = 0.96, IFI = 0.96, NFI = 0.96, SRMR = 0.048, RMSEA = 0.076).

The inter-correlations between the three factors were all positive and moderate. The strongest correlation (*r* = 0.635) was found between N-MOGU and N-MOGD. In addition, the weakest correlation was found between N-MOGD and P-MOG (*r* = 0.268). The correlation coefficient between N-MOGU and P-MOG was 0.341.

*3.3. Internal consistency of the Persian MOGS*

Internal consistencies of the Persian MOGS were computed by Cronbach's alphas. The results showed that Cronbach's alpha for the total score in the first sample (exploratory sample; n = 350) was 0.894. Cronbach's alphas for Persian MOGS factors in this sample were N-MOGU = 0.823, N-MOGD = 0.809, and P-MOG = 0.939. Cronbach's alpha for the second sample’s total score (confirmation sample; n = 419) was 0.892. Cronbach's alphas for Persian MOGS factors in this sample were N-MOGU = 0.814, N-MOGD = 0.791, and P-MOG = 0.933. Following the European Federation of Psychologists' Association (EFPA; Muniz, 2009) proposed cut-offs, the internal consistency value was deemed to be adequate for the total scale and the factors of the Persian MOGS. All item-corrected total correlations were above 0.70. Cronbach's alphas were then calculated for all the items if any single item was removed from the three factors, but this did not improve in internal consistency.

*3.4. Predictive validity of the Persian MOGS*

Descriptive statistics and inter-correlations for all the self-report scales are shown in Table 4. An inspection of histograms, skewness, and kurtosis showed that all scores were normally distributed. Therefore, a Pearson Product Moment correlation was undertaken. The results indicated a positive and significant correlation between both N-MOGU and N-MOGD factors of the Persian MOGS and all the other variables except for two factors of the BFI-10 (i.e., conscientiousness and neuroticism). The results also showed a positive and significant correlation between the P-MOG of the Persian MOGS and all the other variables except for all factors of the BFI-10. Furthermore, the correlation matrix results showed positive and significant correlations between the POGQ (as the outcome variable in the current study), all three factors of the Persian MOGS and all other variables (with the exception of two factors of the BFI-10: conscientiousness and agreeableness).

To verify the specific predictive value of the Persian MOGS factors to the validation constructs, a multiple hierarchical regression analysis was run with only for variables that had a significant correlation coefficient with the outcome variable (POGQ). That is, all variables except the two variables of conscientiousness and agreeableness were entered in the regression equation. In this analysis the POGQ was the outcome variable and the Persian MOGS factors were the predictor variables, together with the total scores of the VGCS (gaming-related cognitions) and the MOGQ (gaming motives), three factors of BFI-10, and the factors of the DASS-21. In step 1, three factors of BFI-10 were entered. Anxiety, depression, and stress (the factors of the DASS-21) were then entered on Step 2. In steps 3 and 4, the total scores of the VGCS and MOGQ were entered, respectively. Finally, in step 5, all three factors of the Persian MOGS were entered. The results of this analysis indicated that the Persian MOGS factors accounted for 33.9% (*p* < 0.001) of the variance in POGQ scores above the variance accounted for by the three factors of the BFI-10 in step 1 (10.1%, *p* < 0.001), the three factors of the DASS-21 in step 2 (14.1%, *p* < 0.001), the total scores of the VGCS in step 3 (10.4%, *p* < 0.001), and the total scores of the MOGQ in step 4 (0.05%, *p* < 0.028). On step 5, Beta coefficients of stress, gaming-related cognitions, and all three factors of the Persian MOGS significantly predicted POGQ scores (see Table 5).

In addition to the above analysis, in order to establish group differences in terms of types of game and tools of gaming on MOGS factors, a series of one-way analyses of variance with follow-up Bonferroni pairwise comparisons were conducted with the participant group (types of game and tools of gaming) as a fixed factor and all the MOGS factors as the dependent variables. These analyses revealed that the interaction between types of game with P-MOG was significant [*F*(3,415)=8.25, *p*<0.001]. So that action and strategy games scored significantly higher than other games (racing and sport) on P-MOG, respectively. It should also be noted that there were no significant differences in N-MOGU [*F*(3,415)=2.01, *p*=0.11] and N-MOGD [*F*(3,415)=1.24, *p*=0.29] stratifying the sample for type of game. Furthermore the results showed that the interaction between tools of gaming with P-MOG [*F*(3,415)=9.05, *p*<0.001] and N-MOGU [*F*(3,415)=4.38, *p*<0.001] was significant. Among the gaming tools, computer games on N-MOGU and computer and console games on P-MOG were significantly higher than tools of gaming on these two factors of the MOGS.

Moreover, the results of analysis of variance for exploring group differences in motives for online gaming on types of game revealed that an interaction between types of game with some motives, such as competition [*F*(6,412)=3.37, *p*<0.01], coping [*F*(6,412)=4.16, *p*<0.001], skill development [*F*(6,412)=3.63, *p*<0.01], and recreation [*F*(6,412)=12.29, *p*<0.001]. The results of Bonferroni pairwise comparisons showed that participants’ scores in race, action, strategy, and sport games were significantly higher than other games on competition, coping, skill development, and recreation, respectively.

**4. Discussion**

The present study aimed to examine psychometric properties of the Persian MOGS among adolescents. Overall, the results from the EFA and CFA corroborated the original study on the development of the MOGS suggesting that metacognitions about online gaming can be optimally measured by the Persian MOGS within a three-factor latent construct (“Negative metacognitions about the uncontrollability of online gaming” (N-MOGU), “Negative metacognitions about dangers of online gaming” (N-MOGD), and “Positive metacognitions about online gaming” (P-MOG). In this study, three models including one factor, two factors (N-MOGU and P-MOG), and three factors (N-MOGU, N-MOGD, and P-MOG) were compared. The CFA revealed three-factor model had the best fit against others. These results are in line with the second study in Spada and Caselli’s (2017) work on the development of the MOGS. The three-factor model of metacognitions about addictive behaviors is confirmed as in earlier studies in other technological addictions (e.g., Metacognitions about Smartphone Use Questionnaire; Casale, Caponi, & Fioravanti, 2020; Akbari et al., 2020). Furthermore, the Persian MOGS showed a suitable internal consistency for factors of the P-MOG, the N-MOGU, the N-MOGD, and the total score using Cronbach's alpha coefficients in both confirmatory and exploratory samples. The Cronbach's alpha coefficients for all factors and the total score were good (ranged from 0.79 to 0.93) and in line with the original self-report measure development (Spada & Caselli, 2017). The current findings also support the predictive validity of the Persian MOGS. The three factors of the Persian MOGS predicted 33.9% of the variance in POGQ scores independently of personality traits, anxiety, depression, stress, and both gaming-related cognitions and gaming motives. It is also noteworthy that negative metacognitions and gaming-related cognitions do not appear to overlap. Previous research, in line with our findings, has reported that gaming-related cognitions predict problematic gaming because they can contribute to overvaluing the reward of online gaming (King & Delfabbro, 2014; Moudiab & Spada, 2019). But the question that arises is why do metacognitions about online gaming predict problematic online gaming independently of all these constructs?

Perhaps this predictive power stems from the fact that metacognitions are purported to directly affect time spent on online gaming as well as exacerbate cognitive-affective states that may bring to increased engagement in online gaming (Caselli, Marino & Spada, 2020). Furthermore, it has been argued that metacognitions may influence and control cognitions about online gaming (Marino & Spada, 2017) as well as coping strategies and motivations relating to online engagement (e.g., escaping from reality) (Spada et al., 2008). In support of this view, studies have shown that metacognitions predict other forms of addictive behavior (e.g., alcohol use, nicotine use) independently of negative affect and cognitions (Nikčević et al., 2017; Spada, Moneta & Wells, 2007; Casale, Caplan, & Fioravanti, 2016; Casale, Rugai, & Fioravanti, 2018). Very recent research has also shown that metacognitions predict online gaming independently of motives to game (Marino et al., 2020). Within the metacognitive model of addictive behaviors (Spada et al., 2015) a significant emphasis is placed on the presumed uncontrollability of thoughts and behavior in predicting problematic behavior. Our observations support this view as the N-MOGU factor was found to play a greater role in predicting POGQ scores than any other variable. The N-MOGU reflects beliefs the gamer holds about lacking control over the playing. These types of beliefs, possibly activated during or after playing, may lead to continued playing to reduce negative affect with the paradoxical effect of increasing it (Marino & Spada, 2017).

As metacognitions are one of the factors that play a key role across behavioral addictions, including IGD (Spada et al., 2007; Spada et al., 2015; Hamonniere et al., 2018; Caselli et al., 2018; Akbari et al., 2020; Marino et al., 2020; Caselli, Marino, & Spada, 2020), and since gaming is more attractive for adolescents and children, with this group being at higher risk for IGD (Kuss & Griffiths, 2012; Hawi, Samaha, & Griffiths, 2018), it may be worthwhile considering interventions aimed at modifying metacognitions. There is a large literature demonstrating the effectiveness of Metacognitive Therapy (MCT) in treating psychological distress (see Wells, 2013) and growing evidence of its application to addictive behaviors (see Spada et al., 2015; Caselli et al., 2018). These interventions may include the direct restructuring of metacognitions as well as techniques aimed at potentiating attentional flexibility (attention training technique) and interrupting rumination and worry (detached mindfulness and postponement) which may free up valuable resources for problem-solving and engagement with the environment. The growing positive outcomes of third-wave therapies in the treatment of addictive behaviors have been showcasing the important of focusing on process-oriented and transdiagnostic treatments (Garey, Zvolensky, & Spada, 2020).

This study offers several notable strengths, including the large sample size, the investigation of the psychometric properties of the Persian MOGS in a sample of adolescents, and using different personality, cognitive, and motivational variables for predictive validity to compare the contribution of the Persian MOGS to problematic online gaming. There are also some limitations for the present study that should be considered. First, the sampling and data collection were performed at the time of the COVID-19 pandemic. Considering that school closures and quarantine changed adolescents' lifestyles, current pandemic conditions may have affected the relationships between the present study variables and reduce their generalizability to pre-and post-epidemic times. Second, due to convenience sampling, the research sample may not represent Iranian adolescents. Third, some of the questionnaires used to evaluate the MOGS in this study have not yet been translated in Persian and the authors of this study have only piloted them. Future studies can complement the present research by evaluating the reliability of the Persian MOGS using test-retest. Finally, future studies should be conducted on other age ranges of adolescents or adult samples and in other Persian-speaking countries to further generalize the results. It would also be interesting to explore mediating or moderating role of cognitive-affective factors like rumination, worry and desire thinking (Mansueto, [Caselli](https://www.researchgate.net/profile/Gabriele-Caselli-2?_sg%5B0%5D=IvnfewMeTGyz8XJU9DeltqrqM__Fq9zAD-p_E-imq3qKohi2MGEvLhbJwGDHvr1BZ0ndcm8.B9fXjEHuqwg1wGbeXKIiVaFFITjyLSjmZRPUymz80V4t-D1YOledKN6VLgj8cOtuNlqJSLZACQjILtOBHXe_gQ&_sg%5B1%5D=mT8CHnM77U9AkQdQf4paO6mrEUY4TASqG0dX3St7QzKVWpTLWab5yHYGb3HGWiLGCsBn6vI.qP134PzDqtTtrbbhs3-gsQNK1hX9DJ82aKVp916fsmFjrSm4gD8vlx0lTb38xhtwJEt-4L7JWayq7NtlKej8Iw), & Spada, 2021; Mansueto et al., 2019) and their relationship to metacognitions and problematic online gaming.

Overall, whereas the characteristics of the online gaming phenomenon highlighted in the present study are in line with the international literature, this study has been conducted with Iranian adolescents, and some limitations regarding external validity might be related to the specificity of the sample. Despite the limitations we are confident our results provide evidence that the Persian MOGS for adolescents appears psychometrically appropriate to be used by researchers and practitioners dealing with the issue of prevention and treatment of problematic online gaming.

**Declaration of Competing Interests**

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

**Acknowledgments**

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

**Table 1:** Socio-demographic features of the sample (n=769).

|  |  |  |  |
| --- | --- | --- | --- |
| Socio-demographic features | Mean | S.D. | Count (%) |
| Age | 16.39 | 1.68 |  |
| Gender |  |  |  |
| *Male* |  |  | 577 (75%) |
| *Female* |  |  | 192 (25%) |
| Grade point average (out of 20) | 17.12 | 2.07 |  |
| Family economic status(converted to U.S. Dollar) |  |  |  |
| *Less than $250* |  |  | 264 (34.3%) |
| *$250- $500* |  |  | 346 (45%) |
| *More than $500* |  |  | 159 (20.7) |
| Residential area |  |  |  |
| *City center* |  |  | 599 (77.9%) |
| *Not city center* |  |  | 170 (22.1%) |
| Presence of Internet connection at home |  |  | 765 (98.3%) |
| Average internet usage (hour/day) |  |  |  |
| *Less than 2 h* |  |  | 28 (3.6%) |
| *More than 2 h* |  |  | 741 (96.4%) |
| Tools of gaming |  |  |  |
| *Computer* |  |  | 255 (33.2%) |
| *Tablet* |  |  | 11 (1.4%) |
| *Mobile phone* |  |  | 402 (52.3%) |
| *Game console* |  |  | 101 (13.1%) |
| Type of game |  |  |  |
| *Action* |  |  | 385 (50.1%) |
| *Strategic* |  |  | 227 (29.5%) |
| *Racing* |  |  | 112 (14.6%) |
| *Sport* |  |  | 45 (5.9%) |
| Do you consider yourself a problematic gamer? |  |  |  |
| *No*  |  |  | 42 (5.4%) |
| *I have no idea*  |  |  | 71 (9.2%) |
| *Maybe* |  |  | 358 (46.5%) |
| *Yes* |  |  | 299 (38.9%) |

**Table 2:** Factor loadings for 12 items of the MOGS based on exploratory factor analyses (n = 350).

|  |  |  |  |
| --- | --- | --- | --- |
| Factor 3 | Factor 2 | Factor 1 | Items |
| 0.186 | 0.126 | **0.830** | 1. I continue to play despite I think it would be better to stop. |
| 0.137 | 0.298 | **0.831** | 2. I have no control over how much time I play. |
| 0.153 | 0.486 | **0.716** | 3. Once I start online gaming I cannot stop. |
| 0.039 | **0.715** | 0.474 | 4. Online gaming makes me lose control. |
| 0.156 | **0.833** | 0.198 | 5. Thoughts about online gaming interfere with my functioning. |
| 0.118 | **0.860** | 0.177 | 6. Thoughts about online gaming are becoming an obsession. |
| **0.862** | 0.150 | 0.153 | 7. Online gaming makes my worries more bearable. |
| **0.878** | 0.086 | 0.154 | 8. Online gaming reduces my negative feelings. |
| **0.881** | 0.144 | 0.123 | 9. Online gaming helps me to control my negative thoughts. |
| **0.898** | 0.148 | 0.129 | 10. Online gaming stops me from worrying. |
| **0.886** | 0.034 | 0.089 | 11. Online gaming reduces my anxious feelings. |
| **0.843** | 0.032 | 0.074 | 12. Online gaming distracts my mind from problems. |

*Note*: Factor 1: Negative Metacognitions about Uncontrollability of Online Gaming (N-MOGU); Factor 2: Negative Metacognitions about Dangers of Online Gaming (N-MOGD); Factor 3: Positive Metacognitions about Online Gaming (P-MOG). Factor loadings present the factor matrix values. The values in bold indicate the item loading on each factor.

**Table 3:**  Model fit indices of confirmatory factor analysis for the Persian version of the MOGS (n = 419).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| IFI | CFI | NFI | SRMR | RMSEA | $X$2/df | Df | χ2 |  |
| 0.80 | 0.81 | 0.80 | 0.180 | 0.259 | 29.03 | 54 | 1568.10 | One-factor model |
| 0.95 | 0.95 | 0.94 | 0.058 | 0.116 | 6.63 | 53 | 351.76 | Two-factor model |
| 0.96 | 0.96 | 0.96 | 0.048 | 0.076 | 5.11 | 51 | 261.11 | Three-factor model |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Skewness | Kurtosis | M (SD) | Variables |
|  |  |  |  |  |  |  |  |  |  |  |  |  | 1 | -0.39 | 0.56 | 41.96 (15.0) | 1. POGQ |
|  |  |  |  |  |  |  |  |  |  |  |  | 1 | 0.106\* | 0.17 | -0.12 | 6.24 (1.70) | 2. BFI-E |
|  |  |  |  |  |  |  |  |  |  |  | 1 | 0.225\*\* | 0.091 | -0.37 | 0.19 | 7.04 (1.43) | 3. BFI-A |
|  |  |  |  |  |  |  |  |  |  | 1 | 0.104\* | 0.113\* | 0.026 | -0.21 | 0.14 | 7.02 (1.58) | 4. BFI-C |
|  |  |  |  |  |  |  |  |  | 1 | 0.137\* | 0.174\* | 0.116\* | 0.175\* | 0.24 | -0.19 | 6.36 (1.35) | 5. BFI-N |
|  |  |  |  |  |  |  |  | 1 | 0.187\* | 0.079\* | 0.084 | 0.121\* | 0.114\* | -0.11 | 0.23 | 6.70 (1.67) | 6. BFI-O |
|  |  |  |  |  |  |  | 1 | 0.173\* | 0.037 | -0.098 | 0.106\* | 0.123\* | 0.440\*\* | 0.17 | -0.25 | 6.01 (2.02) | 7. DASS-21-D |
|  |  |  |  |  |  | 1 | 0.611\*\* | 0.193\* | 0.047 | -0.070 | 0.157\* | 0.199\* | 0.440\*\* | -0.20 | 0.31 | 8.66 (3.67) | 8. DASS-21-A |
|  |  |  |  |  | 1 | 0.724\*\* | 0.633\*\* | 0.186\* | 0.079 | -0.143\* | 0.142\* | 0.170\* | 0.376\*\* | -0.15 | 0.27 | 7.34 (2.05) | 9. DASS-21-S |
|  |  |  |  | 1 | 0.433\*\* | 0.460\*\* | 0.447\*\* | 0.184\* | 0.123 | -0.041 | 0.177\* | 0.182\* | 0.608\*\* | -0.48 | 0.63 | 43.91 (15.5) | 10. VGCS |
|  |  |  | 1 | 0.592\*\* | 0.212\*\* | 0.244\*\* | 0.254\*\* | 0.070 | 0.081 | -0.004 | 0.098 | 0.017 | 0.579\*\* | 0.58 | -0.74 | 78.15 (20.5) | 11. MOGQ |
|  |  | 1 | 0.388\*\* | 0.635\*\* | 0.313\*\* | 0.337\*\* | 0.342\*\* | 0.111\* | 0.029 | -0.019 | 0.181\* | 0.125\* | 0.703\*\* | -0.13 | 0.16 | 5.81 (2.65) | 12. N-MOGU |
|  | 1 | 0.635\*\* | 0.328\*\* | 0.648\*\* | 0.376\*\* | 0.433\*\* | 0.435\*\* | 0.141\* | 0.045 | -0.090 | 0.163\* | 0.143\* | 0.700\*\* | -0.15 | 0.24 | 4.66 (2.24) | 13. N-MOGD |
| 1 | 0.268\*\* | 0.341\*\* | 0.649\*\* | 0.472\*\* | 0.241\*\* | 0.262\*\* | 0.233\*\* | 0.066 | 0.008 | -0.053 | 0.096 | 0.003 | 0.498\*\* | 0.18 | -0.23 | 14.97 (4.49) | 14. P-MOG |

**Table 4:** Pearson correlation coefficients among variables (n = 419).

*Note*. \*p<0.05; \*\* p<0.01; POGQ: Problematic Online Gaming Questionnaire; BFI-E: Big Five Inventory- Extroversion; BFI-A: Big Five Inventory- Agreeableness; BFI-C: Big Five Inventory- Conscientiousness; BFI-N: Big Five Inventory- Neuroticism; BFI-O: Big Five Inventory- Openness; DASS-21-D: Depression, Anxiety and Stress Scale 21 - Depression subscale; DASS-21-A: Depression, Anxiety and Stress Scale 21 - Anxiety subscale; DASS-21-S: Depression, Anxiety and Stress Scale 21 - Stress subscale; VGCS: Video-Game related Cognitions Scale; MOGQ: Motives for Online Gaming Questionnaire; N-MOGU: Negative Metacognitions about Uncontrollability of Online Gaming; N-MOGD: Negative Metacognitions about Dangers of Online Gaming; P-MOG: Positive Metacognitions about Online Gaming.

**Table 5:** Hierarchical multiple regression statistics with POGQ as outcome variable and MOGS factors as predictor variables whilst controlling for personality traits, anxiety, depression, stress, and cognitions and motives related to online gaming (n = 419).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *VIF* | Tolerance | *P* | *T* | β | R2Δ |  | Step |
|  |  |  |  |  | 0.101\*\* |  |  |
| 1.023 | 0.954 | 0.005 | -2.811 | -0.140 |  | BFI-E | Step 1 |
| 1.034 | 0.951 | 0.000 | -3.714 | -0.183 |  | BFI-A |  |
| 1.012 | 0.980 | 0.501 | -0.573 | -0.031 |  | BFI-O |  |
|  |  |  |  |  | 0.141\*\* |  |  |
| 1.093 | 0.909 | 0.252 | -1.056 | -0.049 |  | BFI-E | Step 2 |
| 1.092 | 0.907 | 0.019 | -2.251 | -0.113 |  | BFI-A |  |
| 1.022 | 0.967 | 0.771 | -0.263 | -0.021 |  | BFI-O |  |
| 2.642 | 0.377 | 0.005 | 2.780 | 0.192 |  | HADS- D |  |
| 4.054 | 0.242 | 0.223 | 1.192 | 0.104 |  | HADS- A |  |
| 3.503 | 0.282 | 0.001 | 3.275 | 0.260 |  | HADS- S |  |
|  |  |  |  |  | 0.104\*\* |  |  |
| 1.107 | 0.901 | 0.641 | -0.463 | -0.024 |  | BFI-E | Step 3 |
| 1.103 | 0.907 | 0.052 | -1.929 | -0.082 |  | BFI-A |  |
| 1.031 | 0.974 | 0.920 | -0.097 | -0.011 |  | BFI-O |  |
| 1.724 | 0.667 | 0.686 | 0.404 | 0.021 |  | DASS-21-D |  |
| 2.071 | 0.743 | 0.369 | 0.907 | 0.055 |  | DASS-21-A |  |
| 2.551 | 0.681 | 0.020 | 2.371 | 0.140 |  | DASS-21-S |  |
| 1.297 | 0.775 | 0.000 | 6.239 | 0.461 |  | VGCS |  |
|  |  |  |  |  | 0.005\* |  |  |
| 1.107 | 0.901 | 0.669 | -0.424 | -0.019 |  | BFI-E | Step 4 |
| 1.127 | 0.892 | 0.023 | -2.216 | -0.081 |  | BFI-A |  |
| 1.039 | 0.964 | 0.912 | -0.104 | -0.007 |  | BFI-O |  |
| 2.727 | 0.762 | 0.720 | 0.350 | 0.018 |  | DASS-21-A |  |
| 2.077 | 0.647 | 0.321 | 0.981 | 0.061 |  | DASS-21-D |  |
| 2.554 | 0.783 | 0.014 | 2.424 | 0.140 |  | DASS-21-S |  |
| 1.885 | 0.634 | 0.000 | 5.943 | 0.307 |  | VGCS |  |
| 1.577 | 0.637 | 0.029 | 2.207 | 0.088 |  | MOGQ |  |
|  |  |  |  |  | 0.339\*\* |  |  |
| 1.117 | 0.893 | 0.593 | -0.524 | -0.017 |  | BFI-E | Step 5 |
| 1.146 | 0.871 | 0.290 | -1.011 | -0.037 |  | BFI-A |  |
| 1.040 | 0.962 | 0.688 | -0.375 | -0.013 |  | BFI-O |  |
| 2.733 | 0.761 | 0.807 | 0.252 | 0.011 |  | DASS-21-D |  |
| 2.132 | 0.642 | 0.853 | 0.207 | 0.014 |  | DASS-21-A |  |
| 1.588 | 0.678 | 0.019 | 2.375 |  0.122\* |  | DASS-21-S |  |
| 2.604 | 0.784 | 0.000 | 4.434 |  0.276\*\* |  | VGCS |  |
| 1.994 | 0.603 | 0.631 | 1.001 | 0.031 |  | MOGQ |  |
| 1.895 | 0.727 | 0.000 | 9.335 |  0.433\*\* |  | N-MOGU |  |
| 2.105 | 0.774 | 0.000 | 5.314 |  0.370\*\* |  | N-MOGD |  |
| 1.640 | 0.806 | 0.000 | 4.908 |  0.286\*\* |  | P-MOG |  |

*Not*e. \*\*p < 0.01, \*p < 0.05. POGQ: Problematic Online Gaming Questionnaire (as outcome variable); BFI-E: Big Five Inventory- Extroversion; BFI-A: Big Five Inventory- Agreeableness; BFI-C: Big Five Inventory- Conscientiousness; BFI-N: Big Five Inventory- Neuroticism; BFI-O: Big Five Inventory- Openness; Depression, Anxiety and Stress Scale 21 - Depression subscale; DASS-21-A: Depression, Anxiety and Stress Scale 21 - Anxiety subscale; DASS-21-S: Depression, Anxiety and Stress Scale 21 - Stress subscale; VGCS: Video-Game related Cognitions Scale; MOGQ: Motives for Online Gaming Questionnaire; N-MOGU: Negative Metacognitions about Uncontrollability of Online Gaming; N-MOGD: Negative Metacognitions about Dangers of Online Gaming; P-MOG: Positive Metacognitions about Online Gaming.

.

**References**

Ahmadi, J., Amiri, A., Ghanizadeh, A., Khademalhosseini, M., Khademalhosseini, Z., Gholami, Z., & Sharifian, M. (2014). Prevalence of addiction to the internet, computer games, DVD, and video and its relationship to anxiety and depression in a sample of Iranian high school students. *Iranian Journal of Psychiatry and Behavioral Sciences, 8*, 75–80.

Akbari, M., Zamani, E., Fioravanti, G., & Casale, S. (2020). Psychometric properties of the Metacognitions about Smartphone Use Questionnaire (MSUQ) in a sample of Iranians. *Addictive Behaviors, 114*, 106722. https://doi.org/[10.1016/j.addbeh.2020.106722](https://doi.org/10.1016/j.addbeh.2020.106722).

American Psychiatric Association (2013). *Diagnostic and statistics manual of mental disorders* (5th ed). Arlington: American Psychiatric Association.

Amini, M. S., Nazari, A. M., Moradi, A., & Farzad, V. (2014). Youth online gaming addiction: the role of self-esteem, anxiety and depression. [*Strategic Studies on Youth and Sports*](https://www.sid.ir/en/Journal/JournalList.aspx?ID=30841)*, 13*, 97–117.

Aminimanesh, S., Nazari, A. M., Farzad, F., & Khanzade, M. (2017). The role of psychological motivations in online gaming addiction among adolescents. *Journal of Health and Care, 19*, 147-157.

Aydın, O., Güçlü, M., Ünal-Aydın, P., & Spada, M. M. (2020). Metacognitions and emotion recognition in Internet Gaming Disorder among adolescents. *Addictive Behaviors Reports, 12*, 100296. https://[doi.org/10.1016/j.abrep.2020.100296](https://doi.org/10.1016/j.abrep.2020.100296).

Beard, C. L., Haas, A. L., Wickham, R. E., & Stavropoulos, V. (2017). Age of initiation and internet gaming disorder: The role of self-esteem. *Cyberpsychology, Behavior, and Social Networking, 20*, 397-401. https://[doi.org/10.1089/cyber.2017.0011](https://psycnet.apa.org/doi/10.1089/cyber.2017.0011).

Billieux, J., Potenza, M. N., Maurage, P., Brevers, D., Brand, M., & King, D. L. (2020). Cognitive factors associated with gaming disorder*. Cognition and Addiction, 16*, 221-230. Academic Press.

Bonnaire, C., & Baptista, D. (2019). Internet gaming disorder in male and female young adults: The role of alexithymia, depression, anxiety and gaming type. *Psychiatry Research, 272*, 521-530. <https://doi.org/10.1016/j.psychres.2018.12.158>.

Brown, T. A. (2006). *Confirmatory factor analysis for applied research*. New York, NY: Guilford Press.

Casale, S., Caplan, S. E., & Fioravanti, G. (2016). Positive metacognitions about Internet use: The mediating role in the relationship between emotional dysregulation and problematic use. *Addictive Behaviors, 59*, 84-88. https://doi.org/10.1016/j.addbeh.2016.03.014.

Casale, S., Caponi, L., & Fioravanti, G. (2020). Metacognitions about problematic Smartphone use: Development of a self-report measure. *Addictive Behaviors, 109*, 106484. <https://doi.org/10.1016/j.addbeh.2020.106484>.

Casale, S., Rugai, L., & Fioravanti, G. (2018). Exploring the role of positive metacognitions in explaining the association between the fear of missing out and social media addiction. *Addictive Behaviors, 85*, 83-87. <https://doi.org/10.1016/j.addbeh.2018.05.020>.

Caselli, G., Fernie, B., Canfora, F., Mascolo, C., Ferrari, A., Antonioni, M., ... & Spada, M. M. (2018). The metacognitions about gambling questionnaire*:* Development and Psychometric Properties*. Psychiatry Research, 261*, 367-374. https://doi.org/10.1016/j.psychres.2018.01.018.

Caselli, G., Marino, C., & Spada, M. M. (2020). Modelling online gaming metacognitions: The role of time spent gaming in predicting problematic Internet use. *Journal of Rational-Emotive & Cognitive-Behavior Therapy*. https://doi.org/10.1007/s10942-020-00365-0.

Caselli, G., Martino, F., Spada, M. M. & Wells, A. (2018). Metacognitive Therapy for Alcohol Use Disorder: A systematic case series. *Frontiers in Psychology, 9*, 1-11. <https://doi.org/10.3389/fpsyg.2018.02619>.

Collins, E., Freeman, J., & Chamarro-Premuzic, T. (2012). Personality traits associated with problematic and non-problematic massively multiplayer online role playing game use. *Personality and Individual Differences, 52*, 133-138. https://doi.org/10.1016/j.paid.2011.09.015.

Costello, A. B., & Osborne, J. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. *Practical Assessment, Research, and Evaluation, 10*. https://doi.org/10.7275/jyj1-4868.

Demetrovics, Z., Urbán, R., Nagygyörgy, K., Farkas, J., Griffiths, M. D., Pápay, O., ... & Oláh, A. (2012). The development of the problematic online gaming questionnaire (POGQ). *PloS one*, *7*, e36417. <https://doi.org/10.1371/journal.pone.0036417>.

Demetrovics, Z., Urbán, R., Nagygyörgy, K., Farkas, J., Zilahy, D., Mervó, B., ... & Harmath, E. (2011). Why do you play? The development of the motives for online gaming questionnaire (MOGQ). *Behavior Research Methods*, 43, 814-825. https://doi.org/10.3758/s13428-011-0091-y.

Du, X., Qi, X., Yang, Y., Du, G., Gao, P., Zhang, Y., ... & Zhang, Q. (2016). Altered structural correlates of impulsivity in adolescents with internet gaming disorder. *Frontiers in Human Neuroscience, 10*. <https://doi.org/10.3389/fnhum.2016.00004>.

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods, 4*, 272. https://[doi.org/10.1037/1082-989X.4.3.272](https://psycnet.apa.org/doi/10.1037/1082-989X.4.3.272).

Fam, J. Y. (2018). Prevalence of internet gaming disorder in adolescents: A meta‐analysis across three decades. *Scandinavian Journal of Psychology, 59*, 524-531. https://doi.org/10.1111/sjop.12459.

Fazeli, S., Zeidi, I. M., Lin, C. Y., Namdar, P., Griffiths, M. D., Ahorsu, D. K., & Pakpour, A. H. (2020). Depression, anxiety, and stress mediate the associations between internet gaming disorder, insomnia, and quality of life during the COVID-19 outbreak. *Addictive Behaviors Reports, 12*, 100307. <https://doi.org/10.1016/j.abrep.2020.100307>.

Fioravanti, G., Dèttore, D., & Casale, S. (2012). Adolescent Internet addiction: testing the association between self-esteem, the perception of Internet attributes, and preference for online social interactions. *Cyberpsychology, Behavior, and Social Networking, 15*, 318-323. <https://doi.org/10.1089/cyber.2011.0358>.

Forrest, C. J., King, D. L., & Delfabbro, P. H. (2016). The measurement of maladaptive cognitions underlying problematic video-game playing among adults. *Computers in Human Behavior, 55*, 399-405. https://doi.org/10.1016/j.chb.2015.09.017.

Forrest, C. J., King, D. L., & Delfabbro, P. H. (2017). Maladaptive cognitions predict changes in problematic gaming in highly-engaged adults: A 12-month longitudinal study. *Addictive Behaviors, 65*, 125-130. <https://doi.org/10.1016/j.addbeh.2016.10.013>.

Garey, L., Zvolensky, M. J., & Spada, M. M. (2020). Third Wave Cognitive and Behavioural Processes and Therapies for Addictive Behaviours: An Introduction to the Special Issue. *Addictive Behaviors*, *108*, 106465. https://doi.org/10.1016/j.addbeh.2020.106465.

Gervasi, A. M., La Marca, L., Costanzo, A., Pace, U., Guglielmucci, F., & Schimmenti, A. (2017). Personality and Internet gaming disorder: a systematic review of recent literature. *Current Addiction Reports, 4*, 293-307. https:// doi.org/10.3389/fpsyt.2018.00304.

González-Bueso, V., Santamaría, J. J., Fernández, D., Merino, L., Montero, E., Jiménez-Murcia, S., ... & Ribas, J. (2018). Internet gaming disorder in adolescents: Personality, psychopathology and evaluation of a psychological intervention combined with parent psychoeducation. *Frontiers in Psychology, 9*, 787. https://doi.org/10.3389/fpsyg.2018.00787.

González-Bueso, V., Santamaría, J. J., Oliveras, I., Fernández, D., Montero, E., Baño, M., ... & Ribas, J. (2020). Internet Gaming Disorder Clustering Based on Personality Traits in Adolescents, and Its relation with Comorbid Psychological Symptoms. *International Journal of Environmental Research and Public Health, 17*, 1516. https://doi.org/10.3390/ijerph17051516.

Hamonniere, T., & Varescon, I. (2018). Metacognitive beliefs in addictive behaviours: A systematic review. *Addictive Behaviors, 85*, 51-63. https://doi.org/10.1016/j.addbeh.2018.05.018.

Han, J., Seo, Y., Hwang, H., Kim, S. M., & Han, D. H. (2020). Efficacy of cognitive behavioural therapy for internet gaming disorder. *Clinical Psychology & Psychotherapy, 27*, 203-213. https://doi.org/10.1002/cpp.2419.

Hawi, N. S., Samaha, M., & Griffiths, M. D. (2018). Internet gaming disorder in Lebanon: Relationships with age, sleep habits, and academic achievement. *Journal of Behavioral Addictions, 7*, 70-78. https://doi.org/10.1556/2006.7.2018.16.

Henry, J. D., & Crawford, J. R. (2005). The short‐form version of the Depression Anxiety Stress Scales (DASS‐21): Construct validity and normative data in a large non‐clinical sample. *British Journal of Clinical Psychology*, *44*, 227-239. <https://doi.org/10.1348/014466505x29657>.

Horn, J. L. (1965). A rationale and test for the number of factors in factor analysis. *Psychometrika, 30*, 179-185. https://[doi.org/10.1007/BF02289447](https://psycnet.apa.org/doi/10.1007/BF02289447).

Jöreskog, K. G., & Sörbom, D. (2006). *LISREL 8.80 for windows*. Lincolnwood, IL: Scientific Software International Inc.

Kline, R. B. (2015). *Principles and Practice of Structural Equation Modeling*. Guilford publications.

King, D. L., & Delfabbro, P. (2009). Motivational differences in problem video game play. *Journal of Cybertherapy and Rehabilitation*, *2*, 139–149.

King, D. L., & Delfabbro, P. H. (2014). The cognitive psychology of Internet gaming disorder. *Clinical Psychology Review*, *34*, 298-308. <https://doi.org/10.1016/j.cpr.2014.03.006>.

Király, O., Urbán, R., Griffiths, M. D., Ágoston, C., Nagygyörgy, K., Kökönyei, G., & Demetrovics, Z. (2015). The mediating effect of gaming motivation between psychiatric symptoms and problematic online gaming: an online survey. *Journal of Medical Internet Research*, *17*, e88. [https://doi.org/10.2196%2Fjmir.3515](https://doi.org/10.2196/jmir.3515).

Ko, C. H., Liu, T. L., Wang, P. W., Chen, C. S., Yen, C. F., & Yen, J. Y. (2014). The exacerbation of depression, hostility, and social anxiety in the course of internet addiction among adolescents: A prospective study. *Comprehensive Psychiatry*, *55*, 1377–1384. <https://doi.org/10.1016/j.comppsych.2014.05.003>.

Kuss, D. J., & Griffiths, M. D. (2012). Online gaming addiction in adolescence: a literature review of empirical research. *Journal of Behavioral Addictions, 1*, 3–22. <https://doi.org/10.1556/jba.1.2012.1.1>.

Lafrenière, M. A. K., Verner-Filion, J., & Vallerand, R. J. (2012). Development and validation of the Gaming Motivation Scale (GAMS)*. Personality and Individual Differences, 53*, 827-831. <https://doi.org/10.1016/j.paid.2012.06.013>.

Lemmens, J. S., Valkenburg, P. M., & Peter, J. (2009). Development and validation of a Game Addiction Scale for adolescents. *Media Psychology*, *12*, 77-95. <https://doi.org/10.1080/15213260802669458>.

Liao, Z., Huang, Q., Huang, S., Tan, L., Shao, T., Fang, T., & Shen, H. (2020). Prevalence of Internet gaming disorder and its association with personality traits and gaming characteristics among adolescent gamers. *Frontiers in Psychiatry*, *11*, 1266. https:// doi.org/10.3389/fpsyt.2020.598585.

Lin, C. Y., Imani, V., Broström, A., Årestedt, K., Pakpour, A. H., & Griffiths, M. D. (2019). Evaluating the psychometric properties of the 7-item Persian Game Addiction Scale for Iranian adolescents*. Frontiers in Psychology, 10*, 149. https://doi.org/10.3389/fpsyg.2019.00149.

Lin, C. Y., Potenza, M. N., Broström, A., & Pakpour, A. H. (2020). Internet gaming disorder, psychological distress, and insomnia in adolescent students and their siblings: An actor-partner interdependence model approach. *Addictive Behaviors Reports, 13*, 100332. <https://doi.org/10.1016/j.abrep.2020.100332>.

Lopez-Fernandez, O., Williams, A. J., & Kuss, D. J. (2019). Measuring female gaming: gamer profile, predictors, prevalence, and characteristics from psychological and gender perspectives. *Frontiers in Psychology, 10*, 898. <https://doi.org/10.3389/fpsyg.2019.00898>.

Lovibond, P. F., & Lovibond, S. H. (1995). The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour Research and Therapy*, *33*, 335-343. [https://doi.org/10.1016/0005-7967(94)00075-u](https://doi.org/10.1016/0005-7967%2894%2900075-u).

Mansueto, G., [Caselli](https://www.researchgate.net/profile/Gabriele-Caselli-2?_sg%5B0%5D=IvnfewMeTGyz8XJU9DeltqrqM__Fq9zAD-p_E-imq3qKohi2MGEvLhbJwGDHvr1BZ0ndcm8.B9fXjEHuqwg1wGbeXKIiVaFFITjyLSjmZRPUymz80V4t-D1YOledKN6VLgj8cOtuNlqJSLZACQjILtOBHXe_gQ&_sg%5B1%5D=mT8CHnM77U9AkQdQf4paO6mrEUY4TASqG0dX3St7QzKVWpTLWab5yHYGb3HGWiLGCsBn6vI.qP134PzDqtTtrbbhs3-gsQNK1hX9DJ82aKVp916fsmFjrSm4gD8vlx0lTb38xhtwJEt-4L7JWayq7NtlKej8Iw), G., & Spada, M. M. (2021). Metacognitive Therapy for Alcohol Use Disorder: Theoretical Foundations and Treatment Principles. In D. Frings and I. P. Albery (Eds.). *The Handbook of Alcohol Use and Abuse: Understandings from Synapse to Society* (pp. 201-220). Academic Press.

Mansueto, G., Martino, F., Palmieri, S., Scaini, S., Ruggiero, G., Sassaroli, S., & Caselli, G. (2019). Desire thinking across addictive behaviours: A systematic review and meta-analysis. *Addictive behaviors, 98*, 106018.

Marino, C., & Spada, M. M. (2017). Dysfunctional Cognitions in Online Gaming and Internet Gaming Disorder: a Narrative Review and New Classification. *Current Addiction Reports, 4*, 308-316. <https://doi.org/10.1007/s40429-017-0160-0>.

Marino, C., Canale, N., Vieno, A., Caselli, G., Scacchi, L., & Spada, M. M. (2020). Social anxiety and Internet gaming disorder: The role of motives and metacognitions. *Journal of Behavioral Addictions, 9*, 617-628. <https://doi.org/10.1556/2006.2020.00044>.

Milani, L., La Torre, G., Fiore, M., Grumi, S., Gentile, D. A., Ferrante, M., et al. (2018). Internet gaming addiction in adolescence: Risk factors and maladjustment correlates*. International Journal of Mental Health and Addiction, 16*, 888–904. <https://doi.org/10.1007/s11469-017-9750-2>.

Mohammad Zadeh, A., & Najafi, M. (2010). Validating of the Big Five Inventory (BFI- 10): A very brief measure of the five factor personality model. *Quarterly of Educational Measurement, 1*, 117–130.

Moudiab, S., & Spada, M. M. (2019). The relative contribution of motives and maladaptive cognitions to levels of Internet Gaming Disorder. *Addictive Behaviors Reports, 9*, 100160. https://doi.org/10.1016/j.abrep.2019.100160

Müller, K. W., Beutel, M. E., Dreier, M., & Wölfling, K. (2019). A clinical evaluation of the DSM-5 criteria for Internet Gaming Disorder and a pilot study on their applicability to further Internet-related disorders*. Journal of Behavioral Addictions, 8*, 16-24. https:// doi.org/10.1556/2006.7.2018.140.

Muñiz, J. (2009). The role of EFPA in setting standards for tests and test use. *Paper presented at the 11th European Congress of Psychology*, Oslo (2009, July). Retrieved June 3, 2012.

National poll on children's health (2020). <http://www.mottpoll.org>.

Nikčević, A. V., Alma, L., Marino, C., Kolubinski, D., Yılmaz-Samancı, A. E., Caselli, G. & Spada, M. M. (2017). Modelling the contribution of negative affect, outcome expectancies and metacognitions to cigarette use and nicotine dependence. *Addictive Behaviors, 74*, 82-89. <https://doi.org/10.1016/j.addbeh.2017.06.002>.

Rammstedt, B., & John, O. P. (2007). Measuring personality in one minute or less: A 10-item short version of the Big Five Inventory in English and German. *Journal of Research in Personality*, *41*, 203-212. <https://doi.org/10.1016/j.jrp.2006.02.001>.

Şalvarlı, Ş. I., & Griffiths, M. D. (2019). Internet gaming disorder and its associated personality traits: A systematic review using PRISMA guideline. *International Journal of Mental Health and Addiction*, 1–23. <https://doi.org/10.1007/s11469-019-00081-6>.

Samani, S., & Jokar, b. (2007). Evaluation of the validity of the short scale of depression, anxiety and stress. *Social Sciences and Humanities of Shiraz University, 26*, 65-77.

Shadloo, B., Farnam, R., Amin-Esmaeili, M., Hamzehzadeh, M., Rafiemanesh, H., Jobehdar, M. M., & Rahimi-Movaghar, A. (2017). Inclusion of gaming disorder in the diagnostic classifications and promotion of public health response: Commentary to the “Scholars’ open debate paper on the World Health Organization ICD-11 Gaming Disorder proposal”: A perspective from Iran. *Journal of Behavioral Addictions, 6*, 310-312. https:// doi.org/10.1556/2006.6.2017.048.

Spada, M. M., & Caselli, G. (2017). The metacognitions about online gaming scale: Development and psychometric properties. *Addictive Behaviors, 64*, 281-286. doi.org/10.1016/j.addbeh.2015.07.007.

Spada, M. M., Caselli, G., Nikčević, A. V., & Wells, A. (2015). Metacognition in addictive behaviors. *Addictive Behaviors, 44*, 9-15. <https://doi.org/10.1016/j.addbeh.2014.08.002>.

Spada, M. M., Langston, B., Nikčević, A. V., & Moneta, G. B. (2008). The role of metacognitions in problematic Internet use. *Computers in Human Behavior*, *24*, 2325-2335. <https://doi.org/10.1016/j.chb.2007.12.002>.

Spada, M. M., Moneta, G. B. & Wells, A. (2007). The relative contribution of metacognitive beliefs and expectancies to drinking behaviour. *Alcohol and Alcoholism, 42*, 567-574. <https://doi.org/10.1093/alcalc/agm055>.

Spada, M. M., Nikčević, A. V., Moneta, G. B., & Wells, A. (2007). Metacognition as a mediator of the relationship between emotion and smoking dependence. *Addictive Behaviors, 32*, 2120-2129. <https://doi.org/10.1016/j.addbeh.2007.01.012>.

Stavropoulos, V., Gomez, R., Steen, E., Beard, C., Liew, L., & Griffiths, M. D. (2017). The longitudinal association between anxiety and Internet addiction in adolescence: The moderating effect of classroom extraversion. *Journal of Behavioral Addictions, 6*, 237-247. <https://doi.org/10.1556/2006.6.2017.026>.

Stevens, M. W., King, D. L., Dorstyn, D., & Delfabbro, P. H. (2019). Cognitive–behavioral therapy for Internet gaming disorder: A systematic review and meta‐analysis. *Clinical Psychology & Psychotherapy, 26*, 191-203. <https://doi.org/10.1002/cpp.2341>.

Thorslund, J., McEvoy, P. M., & Anderson, R. A. (2020). Group metacognitive therapy for adolescents with anxiety and depressive disorders: A pilot study. *Journal of Clinical Psychology, 76*, 625-645. <https://doi.org/10.1002/jclp.22914>.

Throuvala, M. A., Janikian, M., Griffiths, M. D., Rennoldson, M., & Kuss, D. J. (2019). The role of family and personality traits in Internet gaming disorder: A mediation model combining cognitive and attachment perspectives. *Journal of Behavioral Addictions, 8*, 48-62. <https://doi.org/10.1556/2006.8.2019.05>.

Tonioni, F., Mazza, M., Autullo, G., Cappelluti, R., Catalano, V., Marano, G., ... & Lai, C. (2014). Is Internet addiction a psychopathological condition distinct from pathological gambling?. *Addictive Behaviors*, *39*(6), 1052-1056. <https://doi.org/10.1016/j.addbeh.2014.02.016>.

Wang, C. W., Ho, R. T., Chan, C. L., & Tse, S. (2015). Exploring personality characteristics of Chinese adolescents with internet-related addictive behaviors: Trait differences for gaming addiction and social networking addiction. *Addictive Behaviors, 42*, 32-35. <https://doi.org/10.1016/j.addbeh.2014.10.039>.

Wartberg, L., Kriston, L., & Thomasius, R. (2020). Internet gaming disorder and problematic social media use in a representative sample of German adolescents: Prevalence estimates, comorbid depressive symptoms and related psychosocial aspects. *Computers in Human Behavior, 103*, 31-36. <https://doi.org/10.1016/j.chb.2019.09.014>.

Wartberg, L., Kriston, L., Zieglmeier, M., Lincoln, T., & Kammerl, R. (2019). A longitudinal study on psychosocial causes and consequences of Internet gaming disorder in adolescence. *Psychological Medicine, 49*, 287-294. https://doi.org/10.1017/s003329171800082x.

Wells, A. (2002). *Emotional Disorders and Metacognition: Innovative Cognitive Therapy*. John Wiley & Sons.

Wells, A. (2013). Advances in Metacognitive Therapy. *International Journal of Cognitive Therapy, 6*, 186-201. <https://doi.org/10.1521/ijct.2013.6.2.186>.

Weil, L. G., Fleming, S. M., Dumontheil, I., Kilford, E. J., Weil, R. S., Rees, G., ... & Blakemore, S. J. (2013). The development of metacognitive ability in adolescence. *Consciousness and Cognition, 22*, 264-271. <https://doi.org/10.1016/j.concog.2013.01.004>.

Wu, A. M., Lai, M. H., Yu, S., Lau, J. T., & Lei, M. W. (2016). Motives for online gaming questionnaire: Its psychometric properties and correlation with Internet gaming disorder symptoms among Chinese people. *Journal of Behavioral Addictions, 6*, 11-20. <https://doi.org/10.1556/2006.6.2017.007>.

Yee, N. (2006). Motivations for play in online games. *CyberPsychology & Behavior, 9*, 772-775. https://doi.org/[10.1089/cpb.2006.9.772.](https://doi.org/10.1089/cpb.2006.9.772)