Research article

SERBIAN VERSION OF EXERCISE DEPENDENCE SCALE-REVISED: PSYCHOMETRIC ANALYSIS

UDC 159:796(497.11)-053.8

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Abstract. *The aim of the study was to evaluate the factorial validity and reliability of the Serbian version of the Exercise Dependence Scale-Revised (EDS-R). The sample of participants consisted of 222 students from the Faculty of Sport and Physical Education, including 164 male participants and 58 female participants. All participants were over 18 years of age and reported engaging in exercise with a frequency ranging from 3 to 7 sessions per week. The main statistical analysis for this study was conducted using confirmatory factor analysis (CFA). The results indicate good overall reliability of the complete inventory ($\alpha > .82$), while the reliability of individual subscales ranges from .56 to .84. The results of the confirmatory factor analysis demonstrate that the model nearly aligns with the established fit indices ($\chi^2 = 600.299$; $df = 168$; $p < 0.001$; $CFI = .891$; $NFI = .935$; $RMSEA = .093$). The seven factors collectively explained 73.1% of the variance, with the first factor accounting for 16.4%, the second for 12.7%, the third for 11.1%, the fourth for 10.9%, the fifth for 8.3%, the sixth for 8.0%, and the seventh factor for 5.7% of the variance. The Serbian version of the Exercise Dependence Scale-Revised demonstrates solid psychometric properties, with acceptable fit indices that suggest its relevance for assessing exercise dependence within this population.*

Key words: *Exercise dependence, psychometric properties, validation, Serbian population.*

1. INTRODUCTION

Exercise dependence is a complex behavioral phenomenon characterized by a compulsive need to engage in physical activity, often resulting in negative physical, emotional, or social outcomes (Allegre et al., 2006). Understanding this behavior is critical, particularly for adults and especially for athletes, where the balance between healthy physical activity and maladaptive exercise patterns can become blurred. The Exercise Dependence Scale-

Revised (EDS-R) serves as a robust and widely used tool for identifying and assessing exercise dependence across various populations (Granziol et al., 2021). With its foundation in the diagnostic criteria for substance dependence, the EDS-R provides a nuanced understanding of dimensions like tolerance, withdrawal, and loss of control, making it indispensable for identifying individuals at risk of maladaptive exercise behavior (Downs, Hausenblas, & Nigg, 2004). Athletes, in particular, may be vulnerable due to the pressures associated with competitive sports, further underscoring the importance of validated measures for both research and clinical practice.

Exercise dependency, often characterized by a compulsive need to engage in physical activity, is a phenomenon increasingly observed among athletes. It is particularly prevalent in high-performance and endurance sports, where training regimens often demand consistent effort and discipline (McNamara, & McCabe, 2013). Granziol et al. (2021) highlighted the challenges associated with identifying exercise addiction in athletes, comparing assessment instruments and examining athletes' willingness to cease exercise following medical advice. The findings underscore the potential conflict between athletes' pursuit of excellence and their mental and physical health. Zandonai et al. (2020) conducted a descriptive study among Italian and Japanese runners, revealing a nuanced interplay between cultural contexts and patterns of exercise dependency. They reported that endurance sports are especially conducive to developing dependency due to their solitary nature and reliance on personal goal-setting. Furthermore, Venuti et al. (2024) explored the intersection of exercise dependency and perfectionism in sports, shedding light on how personality traits may contribute to addictive behaviors. This growing body of evidence highlights the need to monitor and manage exercise behaviors, ensuring that athletes maintain a healthy balance between performance goals and well-being.

The validation of psychometric instruments across diverse cultural and linguistic settings is crucial for ensuring their reliability, validity, and utility. Several studies have adapted and tested the EDS-R for different populations, contributing significantly to the understanding of exercise dependence globally. The EDS-R has been validated in multiple languages, including Spanish (Sicilia & González-Cutre, 2011), Italian (Costa et al., 2012), Swedish and Portuguese (Lindwall & Palmeira, 2009), German (Müller et al., 2013) and Chinese (Yang et al., 2021), each study contributing to the growing body of evidence supporting the scale's factorial validity and reliability.

Downs et al. (2004) originally established the factorial validity of the scale in English-speaking populations, providing a foundation for subsequent research. Similarly, Sicilia and González-Cutre (2011) validated the EDS-R for Spanish populations, while Costa et al. (2012) conducted psychometric examinations of the scale in Italian exercisers. Further extending the scale's reach, Yang et al. (2021) adapted and validated the Chinese version of the EDS-R, emphasizing its relevance across cultural contexts. In a systematic review, Baptista et al. (2019) highlighted the importance of cross-cultural studies, recognizing that cultural and linguistic nuances may influence responses, thus necessitating localized validations. These efforts underscore the importance of ensuring the scale's applicability in diverse settings to support accurate assessment and targeted interventions.

To the best of our knowledge, no study has yet adapted or validated the EDS-R for the Serbian-speaking population, creating a research gap in understanding exercise dependence in this cultural context. Given the prominence of sports and physical activity in Serbia's cultural and social framework, this lack of localized validation restricts insights into potential exercise-related vulnerabilities and dependencies. The current study aims to fill

this gap by evaluating the factorial validity and reliability of the Serbian version of the EDS-R, making it the first effort of its kind in Serbia. By addressing this gap, the study seeks to provide a reliable tool for future research and practical applications in Serbia.

2. METHODS

2.1. Participants

The sample of the participants consisted of 222 students from the Faculty of Sport and Physical Education, including 164 male and 58 female participants. All participants were over 18 years of age and reported engaging in exercise with a frequency ranging from 3 to 7 sessions per week. The participants represented various sporting disciplines, including team sports (n = 116), regular attendance at local gyms (n = 34), combat sports (n = 46), and individual sports (n = 26). The entire sample was categorized as highly active, with participants reporting between 3 and 7 days of exercise per week, with each session lasting at least one hour.

2.2. Procedures

Exercise Dependence Scale-Revised

Permission and translation
Before initiating the study, the primary author obtained authorization via email from Hausenblas Heather, the Exercise Dependence Scale – Revised Manual (ED-R), to conduct a validation study of the instrument. The ED-R was translated into Serbian by two researchers proficient in both English and Serbian. Subsequently, the Serbian version underwent back-translation into English, which was then compared to the original scale by independent linguists without prior exposure to the initial version. Both the research team and the linguists approved the Serbian adaptation of the scale for use in the study.

Exercise Dependence Scale-Revised Manual
The Exercise Dependence Scale-Revised (EDS-R) is a psychometric instrument designed to assess exercise dependence, characterized by maladaptive patterns of physical activity that lead to functional impairment or distress (Downs et al., 2004). The EDS-R evaluates seven dimensions: tolerance, withdrawal, intention effects, lack of control, time, reduction in other activities, and continuance. The scale consists of 21 items rated on a 6-point Likert scale, ranging from "never" (1) to "always" (6), capturing the frequency of behaviors indicative of dependence. Scores are aggregated to classify individuals into three categories: at-risk for exercise dependence, non-dependent symptomatic, or non-dependent asymptomatic.

2.3. Statistical analysis

All analyses were conducted using SPSS 24 to perform CFA and reliability evaluations. Before conducting the primary analyses, normality tests were performed on the data to ensure the appropriateness of parametric statistical methods, given that the sample size exceeded 50 participants. The Kolmogorov-Smirnov test was utilized to assess the normality of the distribution for each observed variable. The primary statistical analysis for this study was conducted using confirmatory factor analysis (CFA) to evaluate the factorial

validity of the Serbian version of the Exercise Dependence Scale-Revised (EDS-R). CFA was performed to test the fit of the theoretical model underlying the EDS-R, which assumes a multidimensional structure comprising distinct but correlated factors.

The reliability of the EDS-R subscales was assessed using Cronbach's alpha coefficients to estimate internal consistency. Cronbach's alpha values above 0.70 were considered evidence of adequate reliability.

3. RESULTS

To ensure the fulfillment of certain prerequisites for conducting confirmatory factor analysis (CFA), initial procedures were carried out to assess the reliability of the measurement instruments. Additionally, the instruments' homogeneity was evaluated, and exploratory factor analyses (EFA) were performed. These steps were undertaken to appropriately develop structural models to be utilized within the framework of CFA.

The results presented in Table 1 indicate good overall reliability of the complete inventory ($\alpha > .81$), while the reliability of individual subscales ranges from .56 to .84. Correlations between subscale total scores were examined and reported as indicators of construct overlap (Table 2). The intensity of correlations between subscales varies from low (e.g., the subscales Reduction of Other Activities and Withdrawal Effects) to moderate (e.g., Time and Tolerance).

Table 1 Reliability coefficient among Exercise Dependence Scale-Revised questionnaire subscales

	Complete scale EDS-R	Subscale Withdrawal Effects	Subscale Continuance	Subscale Tolerance	Subscale Lack of Control	Subscale Reduction	Subscale Time	Subscale Intention Effects
α	.82	.58	.70	.83	.80	.56	.77	.84

Note. α – Cronbach's Alpha

Table 2 Correlation coefficient between the questionnaire subscale and total results

	Subscale Withdrawal Effects	Subscale Continuance	Subscale Tolerance	Subscale Lack of Control	Subscale Reduction	Subscale Time	Subscale Intention Effects
Subscale Withdrawal Effects	1.00	0.35[***]	0.15[*]	0.09	0.20[**]	0.16[*]	0.02
Subscale Continuance	0.35[***]	1.00	0.09	0.32[***]	0.47[***]	0.20[**]	0.02
Subscale Tolerance	0.15[*]	0.09	1.00	0.19[**]	0.14[*]	0.60[***]	0.22[***]
Subscale Lack of Control	0.09	0.32[***]	0.19[**]	1.00	0.25[***]	0.21[**]	0.11
Subscale Reduction	0.20[**]	0.47[***]	0.14[*]	0.25[***]	1.00	0.35[***]	0.16[*]
Subscale Time	0.16[*]	0.20[**]	0.60[***]	0.21[**]	0.35[***]	1.00	0.23[***]
Subscale Intention Effects	0.02	0.02	0.22[***]	0.11	0.16[*]	0.23[***]	1.00

[***]. Correlation is significant at the 0.001 level (2-tailed); [**]. Correlation is significant at the 0.01 level (2-tailed); [*]. Correlation is significant at the 0.05 level (2-tailed).

To examine the factor structure of the Exercise Dependence Scale-Revised (EDS-R), preliminary steps were taken to ensure that the necessary conditions for factor analysis were met. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was .609, meeting the minimum requirement for conducting factor analysis (KMO ≥ 0.5). Additionally, Bartlett's test of sphericity was significant ($\chi^2(210) = 2548.79$, p < 0.01), indicating that the correlation matrix was significantly different from an identity matrix.

To assess whether the obtained data aligned with the original questionnaire's factor structure, an initial set of 21 items was subjected to exploratory factor analysis (EFA) using the principal components extraction method with orthogonal (varimax) rotation.

Given the a priori assumption of a seven-factor structure, the EFA clearly confirmed the anticipated factor structure, as indicated by the scree plot, which pointed to the presence of seven distinct factors. These seven factors collectively explained 73.1% of the variance, with the first factor accounting for 16.4%, the second for 12.7%, the third for 11.1%, the fourth for 10.9%, the fifth for 8.3%, the sixth for 8.0%, and the seventh factor for 5.7% of the variance.

The results of the confirmatory factor analysis demonstrate that the model nearly aligns with the established fit indices (χ^2 = 600.299; df = 168; p < 0.001; CFI = .891; NFI = .935; RMSEA = .093). While some fit indices are below the commonly accepted thresholds for a well-fitting model, they suggest a close approximation between the empirical data and the proposed theoretical model. The model is presented in detail in Figure 1.
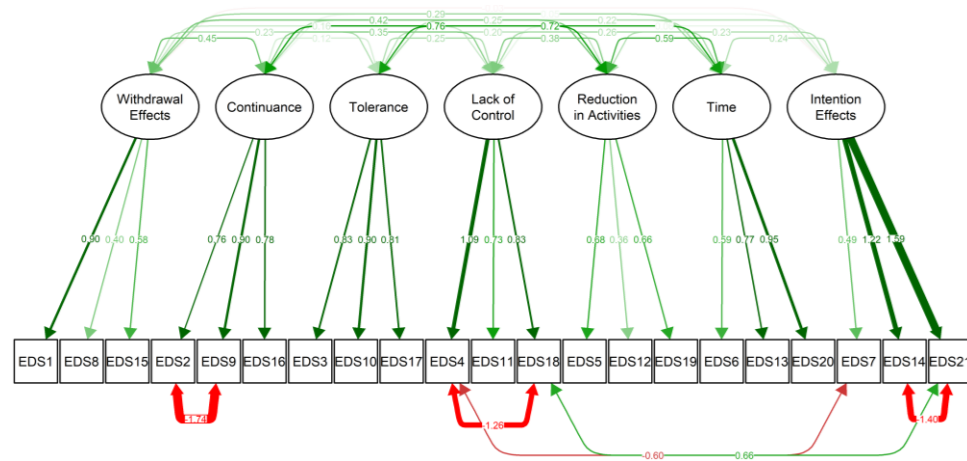

Fig. 1 Confirmatory factor analysis of Questionnaire Exercise Dependence Scale-Revised (seven-factor solution).

DISCUSSION

Based on the revised fit indices, the main outcomes of the study are as follows. The confirmatory factor analysis of the Exercise Dependence Scale-Revised (EDS-R) demonstrated a model fit that approached the established thresholds for acceptability but did not fully meet them. The Comparative Fit Index (CFI = 0.891) was slightly below the

acceptable threshold of 0.90, indicating the need for further model refinement. The Root Mean Square Error of Approximation (RMSEA = 0.093) was slightly above the acceptable range (< 0.08), suggesting moderate fit. Despite these limitations, the exploratory factor analysis supported the theoretically proposed seven-factor structure, explaining 73.1% of the total variance, providing a foundation for future research to refine the model's applicability and validity. These seven factors explained the variance as follows: the first factor accounted for 16.4%, the second for 12.7%, the third for 11.1%, the fourth for 10.9%, the fifth for 8.3%, the sixth for 8.0%, and the seventh for 5.7%.

The arrangement of items according to the obtained factors fully corresponds to previous models from other studies (Downs et al., 2004; Hausenblas & Downs, 2002). Based on the results of the exploratory factor analysis and the considerations regarding the confirmatory factor analysis, the direction was clear to proceed with a seven-factor solution. Given that there are various criteria to assess the validity of a proposed structural model (indicators of the alignment of empirical data with the theoretical model), it is customary to use multiple indicators. In our study, we utilized the relative chi-square test as well as several fit indices, namely the Comparative Fit Index (CFI), Normed Fit Index (NFI), and especially the model deviation from the population in terms of degrees of freedom, as indicated by the Root Mean Square Error of Approximation (RMSEA). Psychometricians do not fully agree on the specific values of the fit indices to determine whether the structure of socio-psychological measurement instruments is adequate, but they do agree that these values should not be lower than the following: CFI and NFI values should be greater than 0.90 (Bentler, 1992), SRMR values (Hu & Bentler, 1999) and RMSEA values (Browne & Cudeck, 1993) should be less than 0.10, GFI values should be equal to or greater than 0.85, and AGFI values should be equal to or greater than 0.80 (Cole, 1987; Nunnally & Bernstein, 1994). In other words, higher values of CFI and NFI, and lower values of SRMR and RMSEA indicate a better fit model. A relative chi-square value below 3.00 is generally accepted as indicating a good fit model, although in practice, some researchers accept a value up to 5.00 (Mueller, 1996).

Our findings show that the Serbian version of the Exercise Dependence Scale-Revised (EDS-R) exhibits acceptable psychometric properties, aligning with previous studies that validated the scale across various cultural contexts. The results suggest that the factorial structure of the scale holds up well when applied to Serbian-speaking populations, as observed in other cultural settings (Sicilia & González-Cutre, 2011; Costa et al., 2012). Specifically, our data supports the multidimensional nature of exercise dependence, confirming the relevance of key factors such as tolerance, withdrawal, and loss of control, which are central to the original EDS-R model (Downs et al., 2004). However, some discrepancies were noted between our results and those of prior studies. For instance, while Yang et al. (2021) found the scale to demonstrate good fit indices in Chinese participants, the sample's characteristics and exercise behaviors may differ considerably from those in Serbia, potentially contributing to minor variations. Similarly, despite the EDS-R's strong psychometric performance in Italy (Costa et al., 2012), variations in athletic culture, socioeconomic factors, and exercise-related expectations across countries may influence participants' responses, affecting the model fit. Another challenge faced in studies like ours and those by Opitz et al. (2020) is ensuring adequate sample size and diversity, as smaller or more homogenous samples might not fully represent the target population, ultimately impacting the goodness-of-fit indices. Furthermore, the scale's sensitivity to different exercise behaviors—whether recreational or competitive—requires

careful consideration. The heterogeneity of respondents in different studies, such as in Baptista et al. (2019), may lead to challenges in achieving an optimal model fit across populations with distinct engagement levels in exercise. These insights underline the importance of adapting tools like the EDS-R to local contexts while recognizing potential challenges such as sample diversity, response biases, and varying cultural interpretations of exercise dependence, which could hinder achieving an ideal model fit.

5. CONCLUSION

The Serbian version of the Exercise Dependence Scale-Revised demonstrates solid psychometric properties, with acceptable fit indices that suggest its relevance for assessing exercise dependence within this population. By confirming the factorial structure of the scale, this study contributes to the broader understanding of exercise dependence in adults engaged in different sports in Serbia. However, challenges remain regarding the achievement of an optimal fit model, influenced by factors such as sample size, demographic differences, and variations in sport engagement. Future research should focus on larger, more diverse samples to enhance the generalizability of findings and consider incorporating additional psychological and social factors that may influence the expression of exercise dependence. Overall, the study lays the groundwork for more effective prevention and intervention strategies to manage exercise dependence in Serbian and similar populations worldwide.

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SRPSKA VERZIJA REVIDIRANE SKALE
ZAVISNOSTI OD VEŽBANJA: PSIHOMETRIJSKA ANALIZA

Cilj ovog istraživanja bio je da se procene faktorijalna validnost i pouzdanost srpske verzije Revidirane skale zavisnosti od vežbanja (EDS-R). Uzorak ispitanika činilo je 222 studenta Fakulteta sporta i fizičkog vaspitanja, od kojih 164 muškarca i 58 žena. Svi ispitanici bili su stariji od 18 godina i prijavili su učestalost vežbanja između 3 i 7 puta nedeljno. Glavna statistička analiza u ovoj studiji sprovedena je primenom konfirmatorne faktorske analize (CFA). Rezultati ukazuju na dobru opštu pouzdanost celokupnog instrumenta (α > .82), dok se pouzdanost pojedinačnih podskala kreće od .56 do .84. Rezultati CFA pokazuju da se model približno uklapa u utvrđene indekse dobrog uklapanja (χ² = 600.299; df = 168; p < 0.001; CFI = .891; NFI = .935; RMSEA = .093). Sedam faktora ukupno objašnjava 73,1% varijanse, pri čemu prvi faktor objašnjava 16,4%, drugi 12,7%, treći 11,1%, četvrti 10,9%, peti 8,3%, šesti 8,0%, a sedmi faktor 5,7% varijanse. Srpska verzija Revidirane skale zavisnosti od vežbanja pokazuje solidna psihometrijska svojstva, sa prihvatljivim indeksima uklapanja koji ukazuju na njenu relevantnost za procenu zavisnosti od vežbanja u ovoj populaciji.

Ključne reči: *zavisnost od vežbanja, psihometrijska svojstva, validacija, srpska populacija.*