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ORIGINAL ARTICLE

A Screening Tool for Exercise Addiction: The Psychometric Properties of the Italian Exercise Addiction Inventory

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Abstract

Exercise addiction is characterized by morbid pattern of behavior which may have negative psychological consequences, seriously compromising the lives of those affected. The Exercise Addiction Inventory (EAI) is one of the most used psychometric instruments for assessing the risk of exercise addiction and has been translated into a number of languages. However, it has never been psychometrically validated in Italian. Therefore, the purpose of the present study was to test the psychometric properties of the EAI among Italian-speaking exercisers. The back-translation process was utilized to develop an Italian version of the EAI. A cross-sectional online survey was used to recruit a sample of 331 Italian regular exercisers (M_{age} = 30.64 years, SD = 12.10). The participants completed the Italian EAI, alongside a battery of other self-report psychometric scales used to assess some aspects of the concurrent validity of the EAI. The one-factor structure of the EAI was confirmed, which also showed good internal consistency and a satisfactory construct validity in the Italian version. No gender differences were found for the risk of exercise addiction. The data obtained in this study provide some evidence suggesting that Italian Exercise Addiction Inventory (EAI) is a valid and reliable self-report scale that can be used to assess the risk of exercise addiction among Italian-speaking individuals. The scale showed some psychometrically robust features, and is a quick and easy-to-use scale that can be used in different cultures and countries, including Italy.

Keywords: Exercise Addiction Inventory; EAI; exercise addiction; problematic exercise; behavioral addiction

Introduction

The fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; American Psychiatric Association, 2013) includes a chapter on "Substance-Related and Addictive

Disorders", in which both disorders related to substance use and behavioral addictions fall within. Although in the latter category there is only one behavioral addiction (i.e., gambling disorder), its inclusion is evidence of the need to consider addictions that do not include the ingestion of a psychoactive substance, especially given evidence demonstrating significant overlaps in several etiological (e.g., onset, natural course), phenomenological (e.g., craving, pre-occupations), and clinical presentations (e.g., treatment strategies, comorbidities) (Grant et al., 2010; Griffiths, 2017). Within this behavioral addiction framework, some research has focused on exercise addiction (Berczik et al., 2012; Egorov & Szabo, 2013), and has been described as "*a morbid pattern of behavior in which the habitually exercising individual loses control over his or her exercise habits and acts compulsively, exhibits dependence, and experiences negative consequences to health as well as in his or her social and professional life*" (Szabo et al., 2015, p. 303).

Although exercise has shown significant association with better physical and mental health (Szabo, Griffiths & Demetrovics, 2019), and higher quality of life (Ekelund et al., 2016), a small minority of individuals may adopt a dysregulated exercise practice resulting in symptoms of addiction (Weinstein & Weinstein, 2014), which compromises the individual's personal, social and/or professional life (Bircher et al., 2017). Furthermore, exercise addiction has also been related to injuries and musculoskeletal problems, as well as psychological disorders (Simon-Grima, Estrada-Marcen, & Montero-Marin, 2019), with higher levels of anxiety, depression and eating issues (Lichtenstein et al., 2018). In this regard, the dysregulated physical activity may be a primary or secondary addiction. In the former, exercise has the function of moderating psychological distress, while, in the latter, exercise addiction becomes a consequence of another dysfunction, typically an eating disorder (Sussman, Lisha & Griffiths, 2011; Szabo, 2010). However, research has shown that symptoms and consequences of exercise addiction are similar whether the disorder is primary or secondary (Szabo, Griffiths, & Demetrovics, 2019).

Since physical exercise is a positive and socially accepted activity, and given the relevant clinical implications due to its dysfunctional drift, the accurate definition of the features which

characterize the condition of exercise addiction, as well as the development of effective screening tools appears of great importance. Building on the previous theorization of Brown (1993), Griffiths (1996, 1997, 2002) popularized the components model of addiction (Griffiths, 2005), applicable to any kind of addiction, including that related to physical activity. The components comprise: *salience*, indicating a condition in which the activity becomes the most important one in the individual's life, dominating thinking, feelings, and behavior; *mood modification*, indicating the subjective mood-modifying experience reported as consequences of engaging in a particular activity; *tolerance*, indicating the need of increasing amounts of the activity to achieve the initial mood-modifying effects; *withdrawal symptoms*; indicating the unpleasant effects that occur when activity is stopped or suddenly reduced; *conflict*, indicating the interpersonal and intrapsychic conflicts with other activities or individuals due to the activity; and *relapse*, indicating the tendency to repeat earlier patterns of the activity, even after months or years of abstinence or control. Consequently, the Exercise Addiction Inventory (EAI; Griffiths, Szabo, & Terry, 2005; Terry, Szabo, & Griffiths, 2004) was developed to screen for the risk of developing exercise addiction utilizing the six aforementioned components in the model (Griffiths, 2005). The EAI is a theoretically guided six-item self-report instrument which has consistently demonstrated very good psychometric properties, and has proved effective in identifying individuals at high risk of being addicted to exercise in different sports settings (Griffiths et al., 2015) and in the general population (Mónok et al., 2012), as well as in different cultures (Griffiths et al., 2015; Lichtenstein et al., 2014).

The unifactorial structure of the scale has been reported in physical activities of a different nature, such as CrossFit, football (soccer), and fitness (Lichtenstein et al., 2014; Lichtenstein & Jensen, 2016), and in several countries, both eastern (Li et al., 2016) and western (e.g., Griffiths et al., 2015). Furthermore, the cross-cultural evaluations of the EAI have shown evidence of configural and metric invariance across six samples from five different countries (Spain, United Kingdom, United States, Denmark, and Hungary) and for males and females, but scalar invariance was not supported (Griffiths et al., 2015). In Italy, some translations of the EAI have been used (e.g., Gori,

Topino, & Griffiths, 2021; Granziol et al., 2021) but many of these have reported its psychometric properties (e.g., Venturella et al., 2015; Bruno et al., 2014; di Nicola et al., 2010).

Therefore, the present study provides a novel contribution to the Italian literature, by translating and validating of the Exercise Addiction Inventory among a sample of regular exercises, which will facilitate research on exercise addiction among Italian-speaking populations. Given that the original instrument is brief (i.e., six items), quick to administer, psychometrically robust, and a valid measure in many different cultures (Griffiths, Szabo, & Terry, 2005; Terry, Szabo, & Griffiths, 2004; Griffiths et al., 2015; Lichtenstein et al., 2014), it was hypothesized that the Italian version would have (i) high construct and concurrent validity, (ii) good reliability, and (iii) a unidimensional factor structure.

Method

Participants

A total of 415 participants completed the survey used for this study. However, the data of 84 respondents were discarded because they declared that they did no exercise at all. Therefore, the final sample comprised 331 Italian participants who reported that they engaged in regular exercise, at least three times per week for a minimum of 30 minutes each time. They were aged from 18 to 75 years (M_{age} = 30.64 years, SD = 12.10), and were predominantly female (72%), single (69%), students (34%), and had a high school diploma (45%).

Table 1 about here

Procedure and ethics

International translation protocols were followed in the validation process (Beaton, Bombardier & Guillemin, 2000). Items in the original version of the EAI were translated into Italian and then back-translated by two professional independent translators. The outcome was discussed until all the translators agreed on the reached a consensus on cross-language equivalence. The present study comprised a cross-sectional online survey. All the participants of the study were Italian and were administered the Italian version of the EAI, together with other self-report psychometric scales

(see below) and a short demographic questionnaire (e.g., sex, age, occupation, etc.). The participants were recruited online by advertising the study on various social networks utilizing a snowball sampling method (i.e., convenience sampling), with a recruitment message that included a link to the open survey (which was previously pre-tested by the authors to ensure good usability and technical functionality of the online survey). The data collection was anonymous and utilized the *Google Forms* platform.

No incentives were offered for involvement in the study, which was voluntary for each participant. Privacy and anonymity were guaranteed and participants were free to leave the study at any time. Before starting the survey, participants provided informed consent (electronically) after they had been provided with information about the general aim of the study, the length of time to complete the survey (about 40 minutes), as well as the treatment and storage of data in anonymous form, used exclusively for the study itself in compliance with all the confidentiality criteria provided for by current legislation (Consiglio Nazionale Ordine Psicologi, 1998; European Commission, 2016). The study was approved by the research team's institutional Ethical Committee.

Measures

Exercise Addiction Inventory (EAI; Griffiths, Szabo, & Terry, 2005; Terry, Szabo, & Griffiths, 2004). The six-item EAI was used to assess the risk of exercise addiction based on a modified version of the components of behavioral addiction. Items (e.g., "*Exercise is the most important thing in my life*") are rated on a five-point scale from 1 ("strongly disagree") to 5 ("strongly agree"). The total scores range from 6 to 30 with higher scores indicating greater risk of exercise addiction. The original version of the scale showed a good internal consistency (α = .84; Terry, Szabo, & Griffiths, 2004). The psychometric properties of the Italian EAI are presented in the Results section.

Eating Disorder Inventory-3-Referral Form (EDI-3-RF; Garner, 2004; Italian version: Giannini & Conti, 2008). The 25-item version of the EDI-3-RF was used to assess risk of eating disorders and comprises three subscales: drive for thinness (nine items), bulimia (eight items), and body dissatisfaction (eight items). Items (e.g., "*I eat sweets and carbohydrates without feeling nervous*",

"*I stuff myself with food*", and "*I think that my stomach is too big*") are rated on a six-point scale from A ("*always"*) to F ("*never*") with a 0-4 scoring system (two responses in the non-symptomatic direction are not counted as contributing to the total score reflecting the psychopathology and both scoring 0; Giannini & Conti, 2008). The ratings provide a score of drive for thinness (ranging from 0 to 36), bulimia (ranging from 0 to 32), and body dissatisfaction (ranging from 0 to 32). The higher the scores on each subscale, the higher the problem on the specific dimension. The measure has demonstrated good internal consistency with values above .80 (Cumella, 2006; Nyman–Carlsson & Garner, 2016). In the Italian version, Cronbach's alphas for the EDI-3-RF subscales were .88, .73 and .84, respectively (Giannini & Conti, 2008). The scale demonstrated very good internal consistency in the present study: total scale (α = .93), drive for thinness (α = .91), bulimia (α = .84), and body dissatisfaction (α = .88).

Body Image Concern Inventory (BICI; Littleton, Axsom, & Pury, 2005; Italian version: Luca et al., 2011). The 19-item BICI was used to assess dysmorphic concerns and comprises two subscales: dysmorphic symptoms (15 items) and symptom interference (four items). Items (e.g., "*I am dissatisfied with some aspect of my appearance*" and "*I have missed social activities because of my appearance*") are rated on a five-point scale from 1 ("*never*") to 5 ("*always*"). The ratings provide a total score of dysmorphic concerns (ranging from 19 to 95), dysmorphic symptoms (ranging from 15 to 75), and interference (ranging from 4 to 20). The higher the scores, the greater the dysmorphic problem on the scale and subscales. In the original version of the BICI, the Cronbach's alphas for the total score and the two subscales were .93, .92, and .76, respectively (Littleton, Axsom, & Pury, 2005). In the Italian version, the scale demonstrated very good internal consistency (.91, .90, and .79, respectively; Luca et al., 2011). The scale demonstrated very good internal consistency in the present study: total scale (α = .94), dysmorphic symptoms (α = .93), and symptom interference (α = .78).

Rosenberg Self-Esteem Scale (RSES: Rosenberg, 1965; Italian version: Prezza, Trombaccia, & Armento, 1997). The 10-item RSES was used to assess global self-esteem. Items (e.g., "*I feel that I have a number of good qualities*") are rated on a four-point scale from 0 ("*strongly disagree*") to 3

("*strongly agree*"). The ratings provide a total score of global self-esteem ranging from 0 to 30. The greater the score the higher the self-esteem. Rosenberg (1986) reported satisfactory internal consistency for the RSES (Cronbach's alpha of .77). In the Italian version (e.g., Mannarini, 2010), the scale the scale demonstrated good reliability (e.g., .84). The scale demonstrated very good internal consistency in the present study (α = .91).

General Self-Efficacy Scale (GSE; Schwarzer & Jerusalem, 1995; Italian version: Sibilia, Schwarzer, & Jerusalem, 1995). The 10-item GSE was used to assess general self-efficacy. Items (e.g., "*I can solve most problems if I invest the necessary effort.*") are rated on a four-point scale from 1 ("*not at all true for me*") to 4 ("*very true for me*"). The ratings provide a total score of general self-efficacy ranging from 10 to 40. The higher the score, the greater the self-efficacy. Schwarzer and Jerusalem, (1995) reported very good reliability (with alphas ranging from .82 to .93) in five different studied samples. In the Italian version (Scholz et al., 2002) the scale demonstrated acceptable internal consistency (α = .70). The scale demonstrated very good internal consistency in the present study (α = .91).

Insight Orientation Scale (IOS: originally developed in Italian by Gori et al., 2015). The seven-item IOS was used to assess insight, exploring behaviors, feelings, and opinions about this construct. Items (e.g., "*I can change my behavior when I realize that things are not going well*") are rated on a five-point scale, from 1 ("*not at all*") to 5 ("*a great deal*"). The ratings provide a total score of insight orientation ranging from 7 to 35. The higher the score, the greater the insight orientation. Gori and colleagues (2015) reported a satisfactory level of internal consistency (α = .77). The scale demonstrated very good internal consistency in the present study (α = .86).

Toronto Alexithymia Scale-20 (TAS-20; Bagby, Parker, & Taylor, 1994; Bagby, Taylor, & Parker, 1994; Italian version: Bressi et al., 1996). The 20-item TAS-20 was used to assess the level of alexithymia and comprises three subscales: difficulty describing feelings (five items), difficulty identifying feelings (seven items), and externally oriented thinking (eight items). Items (e.g., "*It is difficult for me to find the right words for my feelings*", "*I am often confused about what emotion I*

am feeling", and "*I prefer to analyze problems rather than just describe them*") are rated on a five-point scale from 1 ("*strongly disagree*") to 5 ("*strongly agree*"). The ratings provide a total score of alexithymia (ranging from 20 to 100), difficulty describing feelings (ranging from 5 to 20), difficulty identifying feelings (ranging from 7 to 35), and externally oriented thinking (ranging from 8 to 40). The higher the score, the greater the level of alexithymia. The original TAS-20 total scale and subscales demonstrated acceptable reliability, with Cronbach's alpha of 81, .78, .75 and .66, respectively (Bagby, Parker, & Taylor, 1994). In the Italian version (Bressi et al., 1996), the scale demonstrated internal consistency ranging from α = .52 to α = .82. The scale demonstrated generally good internal consistency in the present study: total scale (α = .85), difficulty describing feelings (α = .79), difficulty identifying feelings (α = .87), and externally oriented thinking (α = .63).

Data analysis

The data were analyzed using SPSS 21.0, AMOS 24.0, and JAMOVI 2.0 for Windows. Descriptive statistics were calculated. The multivariate normality assumption was evaluated by calculating Mardia's coefficient, which is a multivariate measure of kurtosis (Mardia, 1970): skewness lower than 5 (Byrne, 2010; Bentler, 2005) and an absolute critical ratio smaller than 1.96 (Kim, 2013) may be interpreted as indicative of multivariate normality. The factor structure of the EAI was tested utilizing confirmatory factor analyses (CFAs) using the maximum likelihood (ML) estimation method and considering the following fit indices: the chi-square (χ^2) model, suggesting a good model fit when the probability value is nonsignificant (p > .05) (Hooper, Coughlan, & Mullen, 2008); the Non-Normed Fit Index (NNFI), suggesting a reasonable fit when the value is above .90 (Kline, 2005); the Comparative Fit Index (CFI), suggesting a good fit for values > .95, although those between .90 and .95 are recognized as a reasonable fit (Kline, 2005); the Root Mean Square Error of Approximation (RMSEA), suggesting a good fit for values less than .05, although values up to 0.08 represent reasonable errors of approximation (Marsh et al., 2004); and the Standardized Root Mean

Square Residual (SRMR), suggesting a reasonable fit for values less than .08 (Hooper, Coughlan, & Mullen, 2008).

To assess the reliability of the scale, the estimation of item-total correlation indices, Cronbach's alpha (Cronbach, 1951), and McDonald's omega (McDonald, 2013) were calculated. Although the α coefficient is a widely used procedure for estimating reliability (Sijtsma, 2012), it has some limitations (Cortina, 1993; Lord & Novick, 1968; Yang, & Green, 2011). Therefore, a second reliability coefficient, the McDonald's ω, was also calculated as an index of internal consistency (Dunn, Baguley, & Brunsden, 2014). Measurement invariance across gender was assessed, by testing a series of multigroup CFAs with increasing constraints. The criteria for support evidence of noninvariance were adequate goodness-of-fit indices for the configural invariance, and a unsignificant χ^2-difference for the metric and scalar ones (Bollen, 1989). Pearson's *r* correlation was used to investigate the association between the variables, and to assess some aspects of concurrent validity. Discriminant validity was further investigated utilizing the Heterotrait-Monotrait ratio of correlations (HTMT; Henseler, Ringle, & Sarstedt, 2015) by using an AMOS plugin (Gaskin & James, 2019). The HTMT scores should be below the recommended 0.85 thresholds to be acceptable (Henseler et al., 2015). Finally, an independent samples *t*-test was used to evaluate the gender difference in the risk of exercise addiction.

Results

The descriptive statistics of the sample were shown in Table 1. The mean values of the EAI items (see Table 2) ranged from 1.79 (Item 2) to 3.63 (Item 3).

Table 2 about here

The assumption of multivariate normality was fulfilled because both the kurtosis (2.10) and critical ratio (1.95) values were below the thresholds. The unidimensional factor structure of the Italian EAI was confirmed using CFA. Model testing indicated a significant chi-square ($p < .05$), but the other indices supported a good fit of the one-factor model to the data (NNFI = .942, CFI = .965, RMSEA = .060, SRMR = .037; see Table 3 and Figure 1a) for the first model assessed (Model 1). Although

the fit could be considered adequate, modification indices indicated that strong correlations existed between the error-terms of Item 2 (*conflict*) and Item 5 (*withdrawal symptoms*). Because these items showed comparable content, a second model (Model 2) was tested in which these error-terms were allowed to correlate (see Table 3 and Figure 1b). Model 2 showed a non-significant chi-square (p = .192), and good fit estimates (NNFI = .980, CFI = .990, RMSEA = .035, SRMR = .027).

Table 3 and Figure 1 about here

In relation to the reliability of the scale, the Cronbach alpha (α = .71) and McDonald's omega (ω = .72) indices of EAI were good and the item total correlations (see Table 2) ranged from .254 (Item 2) to .542 (Item 5). In relation to the measurement invariance across gender, the unconstrained model suggested configural invariance, with good indices of fit, for both Model 1 ($\chi^2(18) = 29.714$; NNFI = .938; CFI= .963; SRMR= .047; RMSEA= .044) and Model 2 ($\chi^2(16) = 19.036$; NNFI = .982; CFI= .990; SRMR= .024; RMSEA= .024). However, metric and scalar invariances were not supported because degree of fit (χ^2) decreased significantly across gender (see Table 3).

Pearson's r analysis (see Table 4) indicated significant and positive correlations between the scores of EAI and those of the scales used to assess concurrent validity. More specifically, the EAI was significantly and positively associated with drive for thinness (r = .260, p < .01), bulimia (r = .133, p < .05), body dissatisfaction (r = .144, p < .01), body image concerns (r = .310, p < .01), dysmorphic symptoms (r = .299, p < .01), symptom interference (r = .284, p < .01), alexithymia (r = .184, p < .01), difficulty describing feelings (r = .156, p < .01), difficulty identifying feeling (r = .199, p < .01).

Table 4 about here

In relation to discriminant validity, the EAI showed a significant and negative association with self-esteem (r = -.186, p < .01), as well as non-significant associations with general self-efficacy (r = -.034, p > .05) and insight orientation (r = .036, p > .05). As shown in Table 5, the HTMT inference did not indicate discriminant validity problems because all the scores were below the expected

threshold value of .85. Finally, the independent samples *t*-test showed no significant gender difference in relation to scores on the EAI (t_{329} = .010, p = .992).

Table 5 about here

Discussion

Since regular exercise is an accepted and recommended activity for the maintenance and improvement of physical and mental health (World Health Organization, 2020; Shipway & Holloway, 2010; Mayolas-Pi et al., 2017), it may be difficult to recognize when this includes the characteristics of an addiction with consequent negative effects in individuals' psychological well-being. In light of this, the development of validated tools such as the Exercise Addiction Inventory (EAI) is helpful in assessing the specific symptoms of exercise addiction across different countries and cultures.

The EAI derives from the operationalization of the components of behavioral addictions, and is a theory-driven measure with a solid conceptual foundation (Griffiths, Szabo, & Terry, 2005; Terry, Szabo, & Griffiths, 2004). It is also one of the most widely used tools for assessing the risk of exercise addiction in several countries. Therefore, its brevity, ease of evaluation and administration, and intercultural dissemination have allowed its use in a substantial number of publications across different sports disciplines (Di Lodovico et al., 2019). Therefore, the present study developed and evaluated the psychometric properties of an Italian translation of the EAI among a sample of regular exercisers.

Results indicated that the Italian EAI showed good psychometric properties, providing evidence supporting its factorial validity, reliability, and construct validity. In one of the two unifactorial models tested with confirmatory factor analysis (CFA), the correlation of the error terms of the items concerning *conflict* and *withdrawal symptoms* resulted in excellent fit indices. However, the model's fit statistics without these correlations were already good, supporting the single-factor structure, in line with the versions validated in different countries (Griffiths et al., 2015). Therefore, the EAI is based on a relevant and solid theoretical guide, comprising six items related to the different components (i.e., salience, mood modification, tolerance, withdrawal symptoms, conflict, and

relapse), all effectively converging in the description of behavioral addiction as defined by Griffiths (2005).

Furthermore, testing the factorial structure in the multigroup analysis across gender, the configural invariance was supported. Therefore, the one-factor solution is acceptable for both males and females, in line with previous research (Griffiths et al., 2015; Granziol et al., 2020). However, no evidence was provided in favor of metric and scalar invariance. This indicates possible inequalities in factor loadings and intercepts, which signals the need for prudence in the comparison of scores. It also suggests the possibility of creating and considering different cut-offs for males and females. However, it should be noted that these invariance measures across gender should be interpreted with caution, given the numerical imbalance between the proportion of males and females in the present sample. Moreover, in the present study, the item-total correlation indices, as well as the Cronbach's *alpha* and the McDonald's *omega* coefficients supported the good internal consistency and reliability of the Italian EAI.

The EAI has also demonstrated satisfactory results concerning the evaluation of some aspects of concurrent validity. Indeed, the correlational analyses showed significant and positive associations between the EAI and drive for thinness, bulimia, body dissatisfaction, and body image concerns. These relationships were also consistent with previous research and further support the possibility of associations between exercise addiction, eating disorders, and dysmorphic concerns (Corazza et al., 2019; Gori, Topino & Griffiths, 2021; Sussman et al., 2011). In other words, distortions or concerns about body image and disordered eating behaviors appear be risk factors for problematic exercise and/or vice versa (Shroff, 2006; Sicilia et al., 2020).

Another relevant finding in the present study was the positive association between exercise addiction and alexithymia, in line with recent research highlighting the central role of affect dysregulation in the etiopathogenesis of behavioral addictions (e.g., Caretti et al., 2018; Gori et al., 2021; Mahapatra & Sharma, 2018), and, more generally on mental health (Crapraro et al., 2018; Pellerone et al., 2017). In relation to discriminant validity, exercise addiction was negatively

associated with self-esteem and was non-significantly associated with self-efficacy and insight. Moreover, the HTMT analysis confirmed the ability of the EAI to distinguish exercise addiction from these separate constructs. These associations indicate that exercise addiction was not associated with a lack of perception of personal efficacy, or of awareness of oneself and one's psychophysical processes. The findings here also confirmed the inverse relationship between exercise addiction and self-esteem previously identified in the literature (Corazza et al., 2019). Moreover, although this result should be interpreted with caution due to the different distribution of females and males in the sample, no gender differences were found in the EAI scores, in line with the results obtained in the original validation study (Terry, Szabo & Griffiths, 2004).

The present study has some limitations that need to be considered when interpreting the results. First, a standardized back-translation procedure was followed in developing the Italian version of the EAI used in the present study. A few authors have raised concerns about the adequacy of this technique in terms of ensuring content validity and cultural equivalence (e.g., Epstein, Santo, & Guillemin, 2015; Swami & Barron, 2019). However, this method has been used in thousands of studies, including many of the other EAI translation and validation studies (e.g., Lichtenstein et al., 2014). Another limitation is that the data were collected utilizing convenience sampling and snowball sampling online. This affects generalizability of the findings. Online recruitment may have excluded regular exercisers who did not have online access. Moreover, the sample was imbalanced in relation to the sex of the participants (72% women, 28% men). These results may therefore be more representative of the female population and should be applied with caution to the male sample. Furthermore, all the data were self-report which are subject to well established methods biases (e.g., memory recall, social desirability, etc.). Future research could overcome these limits through the integration of both offline and online recruitment with a more equally distributed proportion of males and females, and the use of a multimethod approach including the utilization of clinical interviews. Moreover, a cross-sectional design was used in the study, and test-retest reliability was not calculated. The implementation of study designs that allow the evaluation of stability over time for the EAI, as

well as the assessment of convergent validity through the use of other exercise addiction screening measurements, could be implemented in future research. In this regard, the comparison of this version with the recently revised EAI (Szabo et al., 2019) and the use of more in-depth statistical methods (e.g., IRT) could provide further novel contribution. Finally, no distinctions were made with respect to the type of exercise (e.g., individual exercise vs. team sports; swimming vs. running, etc.), and the total frequency of weekly exercise was not recorded (i.e., the only measure of exercise was that all participants had to engage in exercise for at least three times a week with a minimum of 30 minutes for each exercise session). An interesting challenge for future research would therefore be to explore differences in exercise addiction based on different kinds of physical activity, as well collecting data concerning the actual amount of weekly exercise. In this regard, previous studies have highlighted athletes with harmonious passion tend to increase exercise time without decreasing the time spent on other important life activities, unlike athletes with obsessive passion (Paradis et al., 2013). The latter appear to be more prevalent in individual sports (Kovacsik et al., 2020), and have a higher association with exercise addiction (Parastatidou et al., 2014). Overall, despite the limitations, the present study proposed the Italian EAI may provide further value to the field of exercise addiction, if integrated with the extant literature and with future research.

5. Conclusions

The Exercise Addiction Inventory (EAI) is a theoretically guided, short, quick to administer self-report measure that assesses an individual's risk of exercise addiction. The results of the present study provide some evidence suggesting the good psychometric properties of the Italian EAI, supporting its use also in this context. For the majority of individuals, exercise is positive and widely promoted. However, understanding the boundary between excessive and addictive use of exercise can be complex, and the use of the EAI can be a useful for practitioners to rapidly assess the risk of exercise addiction symptoms and its correlates associated to this condition.

Declarations

Conflict of Interest: All the authors declare that they have no conflict of interest.

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

Ethics approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the research team's institutional ethics committee.

Consent to participate: Informed consent was obtained from all individual participants included in the study.

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

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Appendix A

The Exercise Addiction Inventory - Italian Version

Per favore, legga attentamente le seguenti affermazioni ed indichi il suo grado di accordo con esse, considerando la seguente scala:

Fortemente in disaccordo		*Né d'accordo né in disaccordo*		*Fortemente d'accordo*
1	**2**	**3**	**4**	**5**

L'esercizio fisico è la cosa più importante nella mia vita.	1	2	3	4	5
Sono sorti conflitti tra me ed i miei familiari e/o il/la mio/a partner riguardo la quantità di esercizio fisico che faccio.	1	2	3	4	5
Uso l'esercizio fisico per cambiare il mio stato d'animo (ad esempio per sentirmi euforico, evadere ecc…).	1	2	3	4	5
Nel corso del tempo ho aumentato la quantità di esercizio fisico che faccio nell'arco di una giornata.	1	2	3	4	5
Se sono costretto a saltare una sessione di esercizi mi sento di malumore ed irritabile.	1	2	3	4	5
Se riduco la quantità di esercizio fisico che faccio e successivamente ricomincio di nuovo, finisco sempre per tornare alla quantità di esercizio fisico che facevo prima.	1	2	3	4	5

Tables and Figures

Table 1. Demographic and professional characteristics of the sample

	Total sample (N = 331)	Males (N = 91)	Females (N = 240)
Age (M ± SD)	30.64 ± 12.02	32.63 ± 12.96	29.88 ± 11.60
Marital Status			
Single	228 (68.9%)	65 (71.4 %)	163 (67.9 %)
Married	44 (13.3%)	14 (15.4%)	30 (12.5 %)
Cohabiting	45 (13.6%)	7 (7.7%)	9 (10.7 %)
Separated	7 (2.1%)	3 (3.3 %)	4 (1.7 %)
Divorced	6 (1.8%)	2 (2.2%)	4 (1.7 %)
Widowed	1 (.3 %)	0 (0 %)	1 (0.4 %)
Education			
Middle school diploma	14 (4.2%)	3 (3.3 %)	11 (4.6 %)
High school diploma	150 (45.3%)	37 (40.7 %)	113 (47.1 %)
University degree	93 (28.1%)	27 (29.7 %)	66 (27.5 %)
Master's degree	47 (14.2%)	18 (19.8 %)	29 (12.1 %)
Post-lauream specialization	27 (8.2%)	6 (6.6 %)	21 (8.8 %)
Occupation			
Student	112 (33.8%)	23 (25.3 %)	90 (37.5 %)
Working student	59 (17.8%)	16 (17.6 %)	43 (17.9 %)
Employee	89 (26.9%)	33 (36.3 %)	55 (22.9 %)
Freelance	19 (5.7%)	2 (2.2 %)	17 (7.1 %)
Entrepreneur	16 (4.8%)	7 (7.7 %)	9 (3.8 %)
Trader	8 (2.4%)	2 (2.2 %)	6 (2.5 %)
Artisan	5 (1.5%)	1 (1.1 %)	4 (1.7 %)
Armed forces	1 (.3%)	1 (1.1 %)	0 (0 %)
Unemployed	13 (3.9%)	2 (2.2 %)	11 (4.6 %)
Retired	9 (2.7%)	4 (4.4 %)	5 (2.1 %)

Table 2. Descriptive statistics and item-total correlations of each EAI item

Items	Minimum	Maximum	Mean	Standard deviation	Skewness	Kurtosis	Item-total correlation
1	1.0	5.0	3.148	1.044	-.348	-.222	.468
2	1.0	5.0	1.789	1.122	1.228	.355	.254
3	1.0	5.0	3.628	1.169	-.707	-.180	.502
4	1.0	5.0	3.121	1.269	-.166	-.966	.440
5	1.0	5.0	2.541	1.284	.423	-.855	.542
6	1.0	5.0	2.976	1.175	-.111	-.710	.473

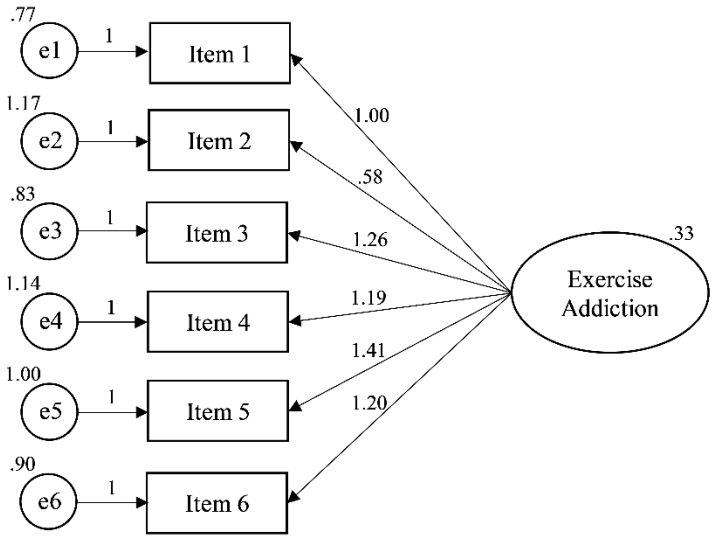
Table 3. Fit statistics of the EAI for two unifactorial model and tests of measurement invariance

	χ^2	*df*	*p*	*NNFI*	*CFI*	*RMSEA*	*SRMR*	$\Delta\chi^2$	*Δdf*	*p*
Confirmatory factor analysis										
Model 1	19.613	9	.020	.942	.965	.060	.037			
Model 2	11.167	8	.192	.980	.990	.035	.027			
Multigroup analyses to test the measurement invariance in Model 1										
Configural invariance	29.714	18	.040	.938	.963	.044	.047			
Configural vs. metric invariance								12.512	5	.028
Metric invariance	42,225	23	.009	.920	.939	.050	.069			
Metric vs. scalar invariance								13.487	6	.036
Scalar invariance	43.201	24	.009	.924	.939	.049	.077			
Multigroup analyses to test the measurement invariance in Model 2										
Configural invariance	19.036	16	.267	.982	.990	.024	.024			
Configural vs. metric invariance								13.864	5	.016
Metric invariance	32.900	21	.047	.946	.962	.042	.058			
Metric vs. scalar invariance								14.886	6	.021
Scalar invariance	33.922	22	.050	.948	.962	.041	.067			

χ^2 = Chi-square value of model fit; *df* = degree of freedom; RMSEA = root mean squared error of approximation; NNFI = Non-Normed-Fit Index; CFI = comparative fit index, RMSEA = the Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual; $\Delta\chi^2$ = Difference in χ^2 values between the compared models; *Δdf* = Difference in number of degrees of freedom between the compared models.

Figure 1. CFAs results for Model 1 and Model 2: Path diagram and estimated parameters for the Italian version of the EAI

Model 1



Model 2

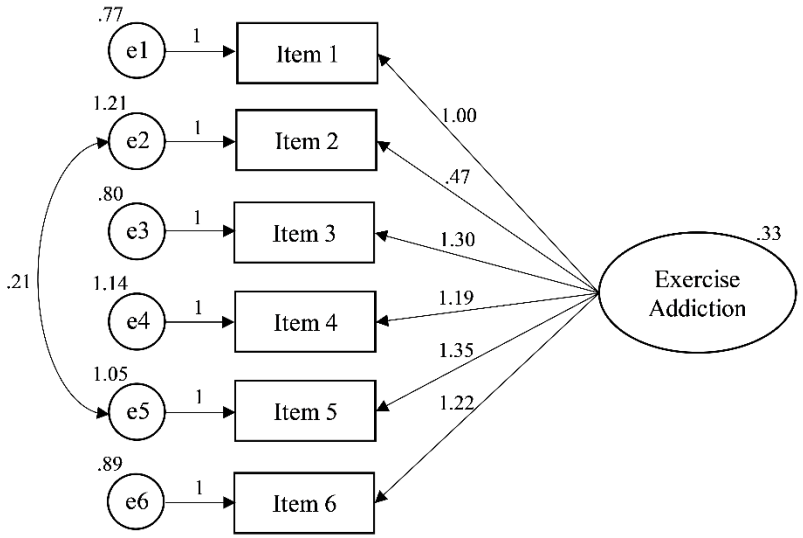


Table 4. Pearson's correlation, means and standard deviations of the variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. EAI	1													
2. EDI (DT)	**.260****	1												
3. EDI (B)	**.133***	**.620****	1											
4. EDI (BD)	**.144****	**.599****	**.415****	1										
5. BICI	**.310****	**.569****	**.274****	**.552****	1									
6. BICI (DS)	**.299****	**.551****	**.255****	**.541****	**.990****	1								
7. BICI (SI)	**.284****	**.517****	**.286****	**.474****	**.818****	**.727****	1							
8. RSES	**-.186****	**-.404****	**-.230****	**-.464****	**-.627****	**-.615****	**-.536****	1						
9. GSE	-.034	**-.228****	**-.121***	**-.340****	**-.335****	**-.338****	**-.250****	**.573****	1					
10. IOS	.036	**-.164****	**-.173****	**-.203****	**-.213****	**-.201****	**-.213****	**.401****	**.483****	1				
11. TAS20	**.184****	**.317****	**.274****	**.365****	**.457****	**.452****	**.374****	**-.524****	**-.375****	**-.396****	1			
12. TAS20 (DDF)	**.156****	**.195****	**.192****	**.283****	**.338****	**.343****	**.240****	**-.413****	**-.269****	**-.291****	**.815****	1		
13. TAS20 (DIF)	**.199****	**.368****	**.249****	**.364****	**.542****	**.537****	**.440****	**-.571****	**-.400****	**-.264****	**.850****	**.582****	1	
13. TAS20 (EOT)	.048	**.125***	**.183****	**.168****	.102	.090	**.128***	**-.161****	**-.156****	**-.384****	**.624****	**.311****	**.250****	1
M	17.20	12.79	6.50	10.29	46.55	39.84	6.71	20.80	29.72	25.68	47.33	13.63	16.50	17.20
SD	4.54	10.21	7.58	7.01	16.51	13.84	3.44	6.86	5.79	5.14	12.97	5.09	6.87	4.79

**. Correlation is significant at the .01 level (2-tailed). *. Correlation is significant at the .05 level (2-tailed). EAI: Exercise Addiction Inventory; EDI (DT) = Drive for Thinness (Eating Disorder Inventory 3 - Referral Form); EDI (B) = Bulimia (Eating Disorder Inventory 3 - Referral Form); EDI (BD) = Body Dissatisfaction (Eating Disorder Inventory 3 - Referral Form); BICI = Body Image Concern Inventory; BICI (DS)= Dysmorphic Symptoms (Body Image Concern Inventory); BICI (SI) = Symptom Interference (Body Image Concern Inventory); RSES = Rosenberg Self Esteem scale; GSE = General Self-Efficacy scale; IOS = Insight Orientation Scale; TAS20 = Toronto Alexithymia Scale – 20; TAS20 (DDF) = Difficulty Describing Feelings (Toronto Alexithymia Scale – 20); TAS20 (DIF) = Difficulty Identifying Feeling (Toronto Alexithymia Scale – 20); TAS20 (EOT) = Externally Oriented Thinking (Toronto Alexithymia Scale – 20).

Table 5: Heterotrait-Monotrait (HTMT) correlation ratio for discriminant validity

	EAI	RSES	GSES	IOS
EAI				
RSES	0.225			
GSES	0,040	0,628		
IOS	0.043	0.479	0.555	

The thresholds value for discriminant validity is of 0.85. EAI: Exercise Addiction Inventory; RSES = Rosenberg Self-Esteem scale; GSES = General Self-Efficacy Scale; IOS = Insight Orientation Scale.