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ORIGINAL ARTICLE

Prevalence of the Risk of Exercise Addiction Based on a New Classification: A Cross-Sectional Study in 15 Countries

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Abstract
Exercise addiction is widely studied, but an official clinical diagnosis does not exist for this behavioral addiction. Earlier research using various screening instruments examined the absolute scale values while investigating the disorder. The Exercise Addiction Inventory-3 (EAI-3) was recently developed with two subscales, one denoting health-relevant exercise and the other addictive tendencies. The latter has different cutoff values for leisure exercisers and elite athletes. Therefore, the present 15-country study ($n = 3{,}760$) used the EAI-3 to classify the risk of exercise addiction (REA), but only if the participant reported having had a negative exercise-related experience. Based on this classification, the prevalence of REA was 9.5% in the sample. No sex differences, and few cross-national differences were found. However, collectivist countries reported greater REA in various exercise contexts than individualist countries. Moreover, the REA among athletes was (i) twice as high as leisure exercisers, (ii) higher in organized than self-planned exercises, irrespective of athletic status, and (iii) higher among those who exercised for skill/mastery reasons than for health and social reasons, again irrespective of athletic status. Eating disorders were more frequent among REA-affected individuals than in the rest of the sample. These results do not align with recent theoretical arguments claiming that exercise addiction is unlikely to be fostered in organized sports. The present study questions the current research framework for understanding exercise addiction and offers a new alternative to segregate self-harming exercise from passionate overindulgence in athletic life.

Keywords Athletes · Collectivist nation · Exercise addiction · Exercise Addiction Inventory · Individualist nation

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Introduction

Regular exercise and a physically active lifestyle have many physical health benefits (Lee et al., 2011) and mental health benefits (Clow & Edmunds, 2013). Individuals adopt physical activity for health reasons, such as controlling weight or coping with stress (Berczik et al., 2012; Szabo et al., 2019a, 2019b). In some instances, determined by unique personal and situational factors (Dinardi et al., 2021), exercise training might become compulsive (Stevens et al., 2013), which can induce tolerance (due to training effects) and push individuals to progressively increase their exercise to achieve the same benefits as before, or to augment the anticipated reward of exercise. On this path, the need for more and more exercise may result in a loss of control, and thereafter, the behavior becomes a health risk (Szabo, 2010; Szabo & Demetrovics, 2022).

When individuals lose control over their exercise and experience self-harm on physical, psychological, or social grounds (Juwono & Szabo, 2020), a dysfunctional behavior known as exercise addiction (EA) may be observed (Szabo, 2010; Szabo & Demetrovics, 2022; Szabo et al., 2015). However, clinically dysfunctional self-harming exercise behavior is seldom reported in the literature. For example, Szabo and Kovacsik (2019) located over 1,000 research papers on EA but found less than 20 cases reporting mental dysfunction. Echoing these findings, Juwono and Szabo (2020) located only 12 dysfunctional cases in the literature and decided to explore the internet for testimonials until they gathered 100 self-harming cases, matching the classification of EA (Griffiths, 2005; Szabo, 2010). Such clinically significant cases are unlikely to surface in cross-sectional research, representing the bulk of studies in the field.

Research on EA has primarily employed psychometric instruments, for instance, the Commitment to Exercise Scale (CES; Davis et al., 1993), Compulsive Exercise Test (CET; Taranis et al., 2011), Exercise Addiction Inventory (EAI; Terry et al., 2004), Exercise Dependence Questionnaire (EDQ; Ogden et al., 1997), Exercise Dependence Scale (EDS-21; Downs et al., 2004), and Obligatory Exercise Questionnaire (OEQ; Pasman & Thompson, 1988) (for a review of these most widely adopted scales assessing problematic exercise, see Alcaraz-Ibáñez et al., 2022b). Despite their convincing psychometric properties, most psychometric instruments assessing EA yield an absolute value through which a high or low *risk of addiction* is implied. Predictors are identified through regressions, or the score on the scale itself is compared across various groups or cutoff scores, none of which could be linked to morbidity. Szabo and Demetrovics (2022) emphasized that psychometric scales are not diagnostic tools. Even a score denoting a high risk of EA may not materialize as dysfunction. Exercise addiction is not currently listed in any psychiatric reference manual, such as the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; American Psychiatric Association, 2013), as an independent category of mental health disorder. Szabo (2010) argued that EA is more likely the symptom of another psychiatric dysfunction rather than a unique mental health disorder.

The interactional model of EA (Dinardi et al., 2021; Egorov & Szabo, 2013) posits the existence of a black box representing unique personal and situational factors interacting in the etiology of dysfunction. The model implies that various cognitive and psychophysiological events react to life situations, and this interaction makes an individual choose to exercise as a means of coping (rather than drugs, alcohol, gambling, or gaming, for example). This is the *therapeutic path* of the model, which also has a *mastery path* (Szabo et al., 2019a). The latter leads to EA when individuals are unable and/or unwilling to recognize their biological limits and want to stretch their physical limits to conquer previous personal

best exercise or athletic performances. Egorov and Szabo (2013) thought that the therapeutic path may be more common than the mastery path, and there is partial support for this contention. For example, in a study of 1,079 participants from eight Spanish-speaking countries, de la Vega et al. (2020) found that the risk of exercise addiction (REA) was 79.3% among those who exercised for health/therapeutic reasons, 13.4% among those who exercised for skill/mastery reasons, and 7.3% among those who exercised for social reasons.

The interactional model, presented over a decade ago, aimed to differentiate between the 'risk' of EA and morbidity by stressing that risk may never become dysfunctional (Egorov & Szabo, 2013). Indeed, EA research relies on *risk levels* based on psychometric scales and their cutoff points. Previously, the EAI (Terry et al., 2004) was designed to offer a short and efficient instrument for researchers and practitioners to assess the REA. Notably, it is the most concise psychometrically validated instrument to assess REA (Szabo & Demetrovics, 2022). Comprising just six items, it aligns with the six symptoms in the components model of addiction (Griffiths, 2005). Individuals rate each statement on a five-point Likert scale (strongly agree to strongly disagree), with a cutoff score of 24 identifying individuals at REA. More recently, Szabo et al., (2019b) revised the EAI (EAI-R). Here, the six items remained unchanged, but the rating scale was modified from a five-point to a six-point Likert scale, removing the neutral midpoint. The adjustment was made to address the concern that the neutral point artificially inflated total scores, compromising the accuracy of the interpretation. The EAI-R is widely used owing to its robust theoretical foundation and 'easy to administer' quality. However, the cross-cultural psychometric properties of the EAI-R were further enhanced by the addition of three further pathological indicators of EA: feelings of guilt, harm, and exercising despite injury (Granziol et al., 2023). The revised Exercise Addiction Inventory (EAI-3) (Granziol et al., 2023) was developed to incorporate these indicators.

Addictions sooner or later involve conflict and self-harm (Blasco-Fontecilla et al., 2016; Szabo et al., 2015). Unsurprisingly, Szabo and Demetrovics (2022) recently proposed that assessing negative consequences or self-harm should be part of studying EA. Consequently, Granziol et al. (2023) added an item to the EAI-3 to also include the occurrence of past exercise-related issues (physical, psychological, or social). Still, in its formulation, this item caused misspecification in the cross-cultural assessment model. Therefore, it could not be applied for validity and reliability reasons in the final version of the EAI-3. The authors speculated that this may have been due to a lack of specificity regarding the item's wording and/or cross-cultural differences in the interpretation, contributing to overall inconsistency on the scale.

While some psychometric instruments have established cutoff scores separating low and high risk of EA, most still prefer to work with continuous data and fail to ignore the scrutiny of the subgroup considered at REA based on cutoff scores. Additionally, the prevalence estimates (ranging from 3% to 77% [Szabo & Demetrovics, 2022]) are exaggerated in the literature in contrast to the few clinical or dysfunctional cases reported, supporting the warning of Egorov and Szabo (2013) that the risk of EA is a different concept relative to actual dysfunction. Determining the experience of negative consequences is also necessary to achieve more conservative prevalence estimates of REA. Moreover, eliminating items from EA screening tools that reflect health relevance (Granziol et al., 2023) would increase the risk estimate's reliability. While this approach still has no diagnostic value, a more precise screening of REA would facilitate the application of a 'pyramid approach' based on collaborative networks between researchers

and clinicians, as proposed by Szabo and Demetrovics (2022), enabling the identification, understanding, and treatment of clinical cases of exercise addiction.

The present cross-cultural study aimed to determine the prevalence of REA in a large international sample using a new classification based on items reflecting *addictive tendencies* on a recently validated psychometric instrument (Granziol et al., 2023) and the subjectively perceived negative consequences associated with exercise. Additionally, the study examined biological sex differences in REA and differences between individuals from collectivist and individualist countries. In collectivistic countries, group goals are favored over personal ambitions through a sharp focus on social harmony. In individualist countries, cultural belief favors the self and the immediate social sphere over group or mass interests, and the emphasis on everyday activities is placed on personal concerns (Hofstede, 1980a). Although EA has not been researched in collectivist and individualist countries to date, based on the authors' best knowledge, the '*we*' social conscience in the former versus the '*I*' in the latter (Gao & Liu, 2018) might involve greater group and/or team sports orientation with a comparative lesser focus on the self in collectivist countries. This presumption is substantiated by research on passion showing differences between individualist and collectivist nations (Curran et al., 2015). Since the likelihood of EA among individuals engaged in group and team-based exercises would be expected to be lower than in individual sports (Griffiths et al., 2023), the present study also tested the hypothesis that the prevalence of REA would be lower in collectivist compared to individualist countries (H_1).

Moreover, based on the position paper by Griffiths et al. (2023), it was hypothesized that REA would be lower among athletes compared to leisure exercisers (H_2), and individuals participating in team and organized sports compared to individuals participating in self-planned sports (H_3) since addiction is an individual disorder rather than a group phenomenon and is unlikely to occur among organized team sports that take place infrequently compared to individual exercise. Furthermore, given that Pálfi et al. (2021) found no differences in the prevalence of REA between aerobic and anaerobic exercisers, the present study explored whether such differences would emerge using a new classification of REA in a large international sample. This aim was exploratory but was warranted based on the literature review of Di Lodovico et al. (2019), who reported a 14.2% prevalence among those engaged in aerobic exercises compared to 6.4% among those engaged in anaerobic forms of exercise.

Finally, the present study aimed to estimate the prevalence of REA among three types of exercise motivations (i.e., those who exercised for health, those who exercised for skill, and those who exercised for social reasons) (de la Vega et al., 2020). Based on the interactional model of EA (Dinardi et al., 2021; Egorov & Szabo, 2013), it was hypothesized that REA would be highest among those exercising for health reasons, followed by skill and social reasons, respectively (H_4), and, therefore, differences might exist between collectivist and individualist countries, assuming (and testing this assumption) that the reasons of exercise differ between these societies.

Exercise addiction and eating disorders (EDs) can co-occur (Alcaraz-Ibáñez et al., 2022a; Trott et al., 2020, 2021). Since, as postulated by Szabo (2010), EA may be a symptom of another dysfunction such as an ED, the present study also examined the prevalence of EDs among those at REA. Trott et al. (2021) found that REA is approximately three and a half times more frequent among individuals with an ED. Similarly, Szabo (2023) found that an ED was three times more frequent among individuals at REA (10.0%) compared to those who were not (3.1%). Therefore, it was hypothesized that EDs would be more frequent among those at REA (H_5), but, based on recent studies (Agüera et al., 2017; Brytek-Matera et al., 2020), EDs would be lower among athletes from the collectivist than individualist countries (H_6).

Methods

Participants

The research team recruited participants from 15 countries on social media platforms targeting sports and exercise-related focus groups, including *Twitter, Facebook, Instagram*, and *LinkedIn*. The eligibility criteria for participation were: (1) exercising at least three times per week, based on the definition of regular exercise by Huang et al. (2019), (2) exercising in this manner for the past six months, and (3) being aged 18 + years. In total, 3,760 participants from 15 countries (Australia [n = 67], Brazil*,[1] [n = 70], Canada [n = 79], China* [n = 510], Denmark [n = 280], France [n = 73], Germany [n = 333], Hungary [n = 310], Italy [n = 446], Japan* [n = 511], Mexico* [n = 308], Russia* [n = 152], Spain* [n = 166], Türkiye* [n = 377], and the United Kingdom [UK, n = 78], see Appendix) were included after excluding 60 participants who did not meet the eligibility criteria. Only 24.6% of participants did not have a university education. The rest had either undergraduate (58.4%) or postgraduate (17%) degrees. More responses came from collectivist (2,094) than individualist countries (n = 1,666). The biological sex ratio of the participants was balanced (1874 [49.8%] female). While running was the most popular sport in the sample, participants listed over 150 sports they engaged in. The mean age of the sample was 29.96 years (± SD = 12.74); males = 30.39 years (± SD = 13.20), females = 29.52 years (± SD = 12.25). Approximately one-fifth of the participants were athletes (20.3%; 46.5% female; 53.5% male). The exercise-related data of the participants are presented in Table 1.

Measures

Exercise Addiction Inventory (third revised version) (EAI-3). The present study comprised participants from 15 nations (see Participants section), but the EAI-3 has only been formally validated in samples from China, Japan, Germany, Italy, and Turkey (Granziol et al., 2023). The EAI-3 is currently being formally validated for the remaining ten countries. The EAI-3 (Granziol et al., 2023) is an expanded version of the Exercise Addiction Inventory-Revised (EAI-R; Szabo et al., 2019a, 2019b). The EAI-3 has eight items and two subscales, each comprising four items rated on a 1 to 6 disagreement-agreement scale. Its internal reliability in the present study was (Cronbach's alpha [α]) 0.77, which was slightly lower than that reported for the original scale ($\alpha = 0.81$; Granziol et al., 2023). One subscale reflects addictive tendencies (ATs) and has a cut-off value of 15.5 for leisure exercisers and 19.5 (out of 24) for athletes, above which the individual is considered at REA. The internal reliability of this subscale in the present study was $\alpha = 0.69$, which was slightly lower than the value reported for the original scale ($\alpha = 0.71$; Granziol et al., 2023). The AT subscale comprises two new items added to EAI-R: guilt when exercise is not fulfilled and the tendency to exercise despite injury. The other subscale of the EAI-3 is health relevance (HR), which comprises items that could reflect a healthy commitment or devotion to exercise but could also be manifestations of problematic exercise (Granziol et al., 2023). Due to its specificity, the present study relied on the AT subscale of the EAI-3 to gauge REA in the present study.

[1] The asterisk (*) refers to a collectivist nation detailed in the Appendix.

Table 1 Exercise demographics of the participants

		Collectivist countries ($n = 2,094$)	Individualist countries ($n = 1,666$)
		n (%)	n (%)
Reason for exercise	Health	1,124 (53.8%)	1,196 (72.9%)
	Skill	851 (40.7%)	331 (20.2%)
	Social	116 (5.5%)	114 (6.9%)
$\chi^2 = 179.36$, $df = 2$, $p < .001$, effect size Cramer's $V = 0.22$			
Form of exercise	Aerobic	396 (18.9%)	400 (24.0%)
	Anaerobic	181 (8.6%)	172 (10.3%)
	Both aerobic and anaerobic	1,517 (72.4%)	1,097 (65.7%)
$\chi^2 = 20.32$, $df = 2$, $p < .001$, effect size Cramer's $V = 0.07$			
Competition status	None	619 (29.6%)	563 (33.8%)
	Amateur/leisure	961 (45.9%)	853 (51.2%)
	Athlete	514 (24.5%)	250 (15.0%)
$\chi^2 = 52.27$, $df = 2$, $p < .001$, effect size Cramer's $V = 0.12$			
Type of exercise	Individual	1,022 (48.8%)	1,013 (60.8%)
	Team	642 (30.7%)	302 (18.1%)
	Both individual and team	430 (20.5%)	351 (21.1%)
$\chi^2 = 82.84$, $df = 2$, $p < .001$, effect size Cramer's $V = 0.15$			
Exercise plan	Organized in a setting	1,021 (48.8%)	567 (34.0%)
	Self-planned	1,073 (51.2%)	1099 (64.0%)
$\chi^2 = 82.45$, $df = 1$, $p < .001$, effect size Cramer's $V = 0.15$			
	Means (± SD) Collectivist nation	Means (± SD) Individualist nation	*F, p, d*
Exercise frequency/week	4.72 (1.82)	4.49 (1.80)	14.48, < .001, 0.13
Workout duration (min)	90.56 (46.00)	79.84 (31.12)	66. 08, < .001, 0.27
Exercise history (years)	8.40 (6.92)	18.75 (13.23)	952.88, < .001, 0.98
Addictive tendencies (AT)	12.40 (4.06)	12.15 (4.36)	3.34, = .068, 0.06
Health relevance (HR)	15.72 (3.78)	14.89 (3.83)	44.14, < .001, 0.22
Total EAI-3 score	28.12 (6.82)	27.04 (7.26)	22.01, < .001, 0.15
Eating disorder (SCOFF)	1.15 (0.35)	1.13 (0.34)	2.65, = .104, 0.06

Note: Collectivist countries differed statistically significantly in most exercise measures from individualist countries as based on chi-square tests for frequency data and analysis of variance (ANOVA) for mean differences (χ^2 = Pearson's chi-square; F = ANOVA test result; p = significance level; d = effect size (Cohen's d). SCOFF = Eating Disorders Questionnaire; EAI-3 = Exercise Addiction Inventory 3rd revised version

SCOFF Questionnaire (Sick, Control, One stone, Fat, Food). The SCOFF Questionnaire (Morgan et al., 1999) has been widely used to assess eating disorders. The SCOFF comprises five dichotomously rated items. A sample item is *"Do you worry that you have lost control over how much you eat?"* The SCOFF is a brief and easy-to-administer scale with total scores ranging from 0 to 5, obtained by summing the items' scores (reliability indices in the present study were: $\alpha = 0.65$; $\omega = 0.78$). A score equal to or higher than 2 suggests a potential risk of an eating disorder. The SCOFF has shown excellent sensitivity and specificity among clinically diagnosed eating disorder patients (Hill et al., 2010).

Procedure

Ethical clearance for the study was approved by the corresponding author's university's Ethics Committee (Certificate: 18F7D86802A124B1E783A3074ED8064). This study was part of an ongoing research that started in 2021 with the aim to cross-validate the EAI-3 in 16 languages (Granziol et al., 2021). The *Qualtrics* platform (Qualtrics, 2023) was used for anonymous data collection in 15 countries between the summer of 2021 and the spring of 2023. After informed consent, participants completed demographic questions primarily concerning their exercise habits and education, country of residence, age, and biological sex. Participants received no compensation for taking part in the study and completed the survey in their home-country language. Data from respondents who did not fully complete the survey and those who completed it in under five minutes were deleted because attentive responding was unlikely under this time threshold, as based on pilot trials by several authors. The research protocol followed the Helsinki Declaration (World Medical Association, 2013).

Data Analyses

Data analyses were performed with the Statistical Package for Social Sciences (SPSS, v. 28) software (IBM Corp., 2021). After calculating the prevalence of REA for the whole sample and the participating countries using the two different cutoff values for leisure exercisers and athletes (Granziol et al., 2023) on the AT subscale of the EAI-3, REA prevalences were calculated for collectivist and individualist cultures, biological sex, athletic status (leisure exercisers vs. athletes), various exercise characteristics, such as team-based exercise vs. individual exercise, organized exercise versus self-planned exercise, and aerobic versus anaerobic exercise. The prevalence of REA in the context of reason for exercise and its association with eating disorders were also calculated in the whole sample and layered by collectivist and individualist countries. Cases of REA in contingency tables were examined with chi-square tests and followed up with adjusted standardized residuals (z-values) using the Bonferroni correction for the p-values.

Results

Prevalence of the Risk of Exercise Addiction Across 15 Countries

Based on the cutoff score (15.5 for leisure exercisers and 19.5 for athletes) reported for the EAI-3 subscale of 'addictive tendencies' (AT; Granziol et al., 2023), the samples were grouped into two categories: (i) 'at REA' (above the cutoff score) and (ii) 'at no risk' (under the cutoff score). Based on this classification, REA prevalence estimates were high in the sample: 19.9% for leisure exercisers, 32.7% for athletes, and 22.5% for the whole sample.

Results of Risk Prevalence Based on a Novel Classification

The classification resulted in lower prevalence estimates: 7.8% for leisure exercisers, 16.1% for athletes, and 9.5% for the overall sample. The REA correlated positively ($r = 0.123$, $p < 0.001$) with exercise volume, calculated from the reported weekly

Table 2 Prevalence of the risk of exercise (REA) addiction and eating disorders (ED) in 15 countries (mixed exercises) among individuals who train at least three times a week

Nation	Not at REA	At REA	Eating disorder
1. Italy	94.4%	5.6%	18.4%
2. Japan	93.9%	6.1%	7.4%
3. Brazil	92.9%	7.1%	17.1%
4. Hungary	92.9%	7.1%	12.3%
5. Australia	92.5%	7.5%	9.0%
6. France	91.8%	8.2%	15.1%
7. Spain	91.6%	8.4%	10.8%
8. Germany	91.3%	8.7%	11.1%
9. China	91.2%	8.8%	16.9%
10. Canada	91.1%	8.9%	8.9%
11. Denmark	89.6%	10.4%	8.2%
12. Russia	88.8%	11.2%	31.6%**
13. Mexico	88.0%	12.0%	14.9%
14. Türkiye	82.0%	18.0%*	16.2%
15. United Kingdom	78.2%	21.8%	14.1%
Total	90.5%	9.5%	13.9%

Note: *, ** These countries had higher proportion of REA (*) or ED (**) than expected

exercise frequency and training session duration, but the shared variance was almost negligible ($r^2 = 0.015$; 1.5%).

Cross-Cultural Differences in Prevalence for the Risk of Exercise Addiction

The next analysis tested whether the prevalence of REA differed across the 15 countries. A 2×15 Pearson's chi-square (χ^2) test of the contingency table was statistically significant (χ^2 [14] = 67.35, $p < 0.001$, effect size [Cramer's V] = 0.13). The highest prevalence was observed among participants from the United Kingdom and lowest among participants from Italy (Table 2). However, after conducting an adjusted residuals-based post-hoc test (Sharpe, 2015), contrasting the cells within a contingency table, only participants from Türkiye differed from the other 14 countries ($z = 5.97$, $p = 0.0012$ [Bonferroni adjusted $p = 0.0017$]). Therefore, despite the absolute differences, cross-national differences in the prevalence of REA (apart from Turkish participants), were not demonstrated.

The prevalence of REA in collectivist and individualist countries also differed statistically significantly based on a 2×2 chi-square test (χ^2 [1] = 4.15, $p = 0.04$, Cramer's $V = 0.03$). The participants in collectivist countries had a slightly greater REA (10.4%) than the participants in individualistic countries (8.4%). However, after using the adjusted residuals' post hoc test, the cells were statistically no different from each other ($z = 2.04$, $p = 0.046$ vs. corrected $p = 0.0125$).

Biological Sex Differences in the Prevalence of the Risk of Exercise Addiction

Males exercised 4.74 times per week (SD = 1.84), while females exercised 4.49 times per week (SD = 1.79). A 2×2 chi-square test showed no statistically significant differences between males and females in the prevalence of REA (χ^2 [1] = 1.02, $p = 0.310$, Cramer's

$V=0.02$). Similar non-statistically significant results were found when the test was layered by collectivist vs. individualist countries, leisure exercise vs. athletes, reason for exercise (health, skill, social), self-planned vs. organized exercise forms, type of exercise (aerobic, anaerobic, mixed), and team vs. individual forms of exercise. Therefore, no sex differences could be seen in the prevalence of REA in this multinational sample.

Differences in Risk of Exercise Addiction Based on Exercise Characteristics

Athletic Status

A 2×2 chi-square test of REA frequency among leisure exercisers was statistically significant (χ^2 [1]=48.68, $p<0.001$, Cramer's $V=0.11$). Adjusted residuals-based post-hoc tests showed that the cells' observed and expected frequencies differed significantly ($z=6.98$, $p<0.001$). Significant results were also found when the test was layered for collectivist countries (8.4% vs. 16.3%; χ^2 [1]=26.21, $p<0.001$, Cramer's $V=0.11$) and individualist countries (7.1% vs. 15.6%; χ^2 [1]=19.79, $p<0.001$, Cramer's $V=0.11$). The adjusted residuals-based post-hoc tests showed that all cells' observed frequencies were significantly different from the expected values: collectivist countries ($z=5.12$, $p<0.001$) and individualist countries ($z=4.45$, $p<0.001$).

Mixed, Team- and Individual-Based Exercises

A 2×3 chi-square comparing the prevalence estimates of REA among individual, team-based, and mixed exercisers was statistically not significant (χ^2 [2]=5.62, $p=0.060$, Cramer's $V=0.04$). Significant findings were also found when the test was layered for collectivist countries (χ^2 [2]=5.17, $p=0.075$, Cramer's $V=0.05$) and individualist countries (χ^2 [2]=0.97, $p=0.617$, Cramer's $V=0.02$).

Organized vs. Self-Planned Exercise

A 2×2 chi-square comparing REA prevalence estimates among individuals participating in organized (11.71%) and self-planned (7.87%) sports/exercise was statistically significant (χ^2 [1]=15.74, $p<0.001$, Cramer's $V=0.06$). The results were similar when the test was layered for collectivist countries (12.3% vs. 8.5%; χ^2 [1]=8.39, $p=0.004$, Cramer's $V=0.06$) and individualist countries (10.6% vs. 7.3%; χ^2 [1]=5.30, $p=0.025$, Cramer's $V=0.11$). However, the adjusted residuals-based post-hoc tests suggested that the differences in REA frequencies were only statistically significant in collectivist countries ($z=2.90$, $p=0.004$ vs. adjusted $p=0.0125$) and not in individualist countries ($z=2.30$, $p=0.021$ vs. adjusted $p=0.0125$).

The Main Reason for Exercise

A 2×3 chi-square test comparing the prevalence estimates of REA among those who exercised for health (7.32%), skill (13.95%), or social reasons (7.83%) was statistically significant (χ^2 [2]=40.98, $p<0.001$, Cramer's $V=0.10$). Most individuals at REA exercised for mastery (skill development) reasons. Adjusted residuals-based post-hoc tests showed that the observed and expected cell frequencies of REA differed statistically

significantly among those who exercised for health reasons ($z = -5.70$, $p < 0.001$ vs. adjusted $p = 0.008$) and skill or mastery reasons ($z = 6.40$, $p < 0.001$ vs. adjusted $p = 0.008$), but not among those who exercised for social reasons ($z = -0.87$, $p = 0.384$ vs. adjusted $p = 0.008$). These results were significant when the test was layered for collectivist countries (χ^2 [2] = 24.30, $p < 0.001$, Cramer's $V = 0.11$) and individualist countries (χ^2 [2] = 12.07, $p = 0.002$, Cramer's $V = 0.08$). Similarly, post hoc tests were statistically significant for health reasons ($z = -4.55$, $p < 0.001$ vs. adjusted $p = 0.008$) and skill reasons ($z = 4.92$, $p < 0.001$ vs. adjusted $p = 0.008$) but not for social reasons ($z = -0.64$, $p = 0.815$ vs. adjusted $p = 0.008$) in collectivist countries. However, in individualist countries, the post hoc test was only statistically significant for the skill reasons ($z = 3.47$, p 0.002 vs. adjusted $p = 0.008$) and not for health reasons ($z = -2.84$, $p = 0.018$ vs. adjusted $p = 0.008$) or social reasons ($z = -0.51$, $p = 0.878$ vs. adjusted $p = 0.008$).

Form of Exercise

Finally, a 2×3 chi-square test comparing the prevalence estimates of REA among those who performed aerobic (6.65%), anaerobic (8.50%), and mixed (9.49%) forms of exercises was statistically significant (χ^2 [2] = 10.90, $p = 0.004$, Cramer's $V = 0.05$). The post-hoc tests showed that the observed and expected cell frequencies only differed significantly for those who performed mixed aerobic and anaerobic ($Z = 3.15$, $p = 0.007$ vs. adjusted $p = 0.008$), but not for those performing aerobic ($Z = -3.07$, $p = 0.009$ vs. adjusted $p = 0.008$) or anaerobic exercises ($Z = -0.67$, $p = 0.799$ vs. adjusted $p = 0.008$). When the test was layered for collectivist and individualist countries, no statistically significant results were noted for participants from individualist countries. However, there were significant differences for the participants from collectivist countries (χ^2 [2] = 15.77, $p < 0.001$, Cramer's $V = 0.09$). Post-hoc tests, based on adjusted residuals, showed that the observed and expected frequencies significantly differed in aerobic ($z = -3.67$, $p = 0.001$ vs. adjusted $p = 0.008$) and mixed exercisers ($z = 3.82$, $p < 0.001$ vs. adjusted $p = 0.008$), but not anaerobic exercisers ($z = -0.96$, $p = 0.631$ vs. adjusted $p = 0.008$).

The Risk of Exercise Addiction and Eating Disorders

The next analysis examined the percentages of eating disorders among exercisers from collectivist and individualist countries. There was no significant difference (χ^2 [1] = 2.65, $p = 0.103$, Cramer's $V = 0.02$). However, a 2 (eating disorder) $\times$ 15 (countries) contingency table test was significant (χ^2 [14] = 85.96, $p < 0.001$, Cramer's $V = 0.15$). The prevalence of ED was 13.9% among the total sample, with the lowest prevalence among participants in Japan (7.4%) and the highest among participants in Russia (31.6%). Adjusted residuals-based post hoc tests showed that only participants from Russia (Table 2) had a greater-than-expected prevalence of ED ($Z = 6.41$, $p < 0.0001$ vs. adjusted $p = 0.0017$),

Subsequently, to test the prevalence of ED among those at REA, a 2×2 chi-square test was conducted. This was statistically significant (i.e., eating disorders were more prevalent among those with EA) (χ^2 [1] = 48.26, $p < 0.001$, Cramer's $V = 0.11$). The test layered for collectivist and individualist countries was also statistically significant for both participants from collectivist countries (χ^2 [1] = 16.31, $p < 0.001$, Cramer's $V = 0.09$) and participants

from individualist countries (χ^2 [1] = 38.49, $p < 0.001$, Cramer's $V = 0.15$). Post-hoc tests based on adjusted standardized residuals showed that the prevalence of EDs was higher among participants in the REA group in all instances: whole sample 26.1% vs. 12.7% ($Z = 6.94$, $p = 0.001$), collectivist countries 24.0% vs. 13.4% ($Z = 4.04$, $p = 0.001$), and individualist countries 29.3% vs. 11.4% ($Z = 6.04$, $p = 0.001$).

Discussion

The present study had six hypotheses. H_1, that the prevalence of REA would be lower in collectivist than individualist countries, was not supported. Similarly, H_2 and H_3, that the prevalence of REA among athletes and those in team/organized sports would be comparatively lower were also not supported. H_4 was also not supported (the prevalence of REA was higher among those training for mastery than health reasons). H_5, that the prevalence of EDs would be greater among those at REA was supported. Finally, H_6, that the prevalence of EDs would be lower among athletes from collectivist than individualist countries was not supported.

Other findings emerging at an exploratory level were: (i) the prevalence of REA among 3,760 participants from 15 countries based on a new classification that included both REA absolute score above the cutoff value *and* participants' experiences of exercise-related negative consequences was lower than 10% based on cutoff scores; (ii) at a national level, participants from Türkiye had a higher than expected prevalence estimate; (iii) there were no significant differences in the prevalence estimate of REA among participants based on biological sex; (iv) in collectivist countries only, aerobic exercisers had a significantly lower prevalence of REA compared to mixed (both aerobic and anaerobic) exercisers; and (v) Russians had a significantly higher prevalence of EDs compared to other countries.

High Prevalence Estimates

This classification resulted in very high prevalence estimates compared to the only population-based study previously reported in the literature (Mónok et al., 2012) that found a range of 1.9% to 3.2% among participants who exercised at least once a week. However, Mónok et al. had less than 500 exercisers among their 2,710 participants. Moreover, studying EA among individuals who exercise weekly is likely to yield results of limited utility in the same manner as would studying alcoholism among social drinkers. Indeed, Huang et al. (2019) define regular exercise as being performed *at least three times per week*, the criterion adopted in the present study. Consequently, the 9.5% prevalence of REA found in the present study aligns more realistically with the findings in Di Lodovico et al.'s (2019) review, ranging from 6.4% to 14.2% among various types of exercisers.

While a scale score exceeding the cutoff value in isolation may not justify clinical follow-up, the additional cumulative experience of exercise-related negative consequences, warrants further attention. Demetrovics and Szabo (2022) described a *pyramid model* at the bottom of which screening based on specific criteria is followed up by clinicians to filter out problematic cases in the middle of the model. The personal attention given to dysfunctional cases is at the top of the three-layer pyramid. The present study's results, which despite assessing perceived negative experiences in addition to high REA scores, yielded a high prevalence (9.5%).

Due to the scale items' possible ambiguity through semantic overlap with passion and high commitment (Szabo & Demetrovics, 2022), the high percentages could be far from implying health risk (Szabo et al., 2015) and are disproportionate to the small number of clinically dysfunctional cases (i.e., < 20) reported in the literature over two decades in over 1,000 peer-reviewed papers (Szabo & Kovacsik, 2019). Therefore, the definition of EA was revisited (i.e., Griffiths et al., 2023; Szabo et al., 2015), which emphasizes the occurrence of adverse effects in relation to ill-patterned exercise manifesting in *psychological*, *physical*, or *social* harm (Juwono & Szabo, 2020), and asked participants if they experienced such consequences. Then, among those considered at *possible* risk (based merely on the cutoff point), the REA was reclassified to only include individuals who reported having adverse effects due to their exercise pattern *and* scored above the cutoff point on the EAI-3. Therefore, screening should also assess other factors that could narrow further the estimated REA because a figure near 10% is too large to follow-up considering time and resource availability of health professionals. For example, questions concerning negative experiences could be followed up with the severity and consequences of such experiences. Furthermore, whether these individuals consider their exercise regimen problematic should also be assessed because REA was twice as high among athletes (based on the present study's results) compared to leisure exercisers. However, accepting the reasoning of Juwono et al. (2021) that athletes are passionate rather than addicted, it is speculated that most athletes do not see their training habits as detrimental.

Cultural Differences in Risk of Exercise Addiction

From a country perspective, despite low exercise participation reported in previous studies (see Subak (2021) for a review), Türkiye had a higher-than-expected prevalence estimate of REA. While no research exists to compare this finding, it might be possible that those engaging in exercise in Türkiye must overcome social or other barriers that mirror commitment and translate into high REA scores. Indeed, despite low exercise participation in this nation, sports are the most popular subjects on Turkish social media (Çetinkaya et al., 2014).

Szabo et al. (2022) proposed that "…*from a cross-cultural perspective, future research should look at the differences* [in REA] *between individualist and collectivist societies*…" (p. 7, parenthesis added). The present study addressed this issue, but the hypothesis that participants from collectivist countries would have a lower prevalence of REA than individualist countries was not supported. On the contrary, participants from collectivist countries showed a 2.0% higher prevalence of REA than participants from individualist countries, though this difference was found to be non-significant after the post-hoc test. Participants from collectivist countries also reported significantly higher total EAI-3 scores than participants from individualist countries, which on the AT subscale only approached (but did not reach) statistical significance (see Table 1). In sum, REA tended to be higher among participants in collectivist rather than individualist countries.

Due to the lack of previous research in this area, these findings are somewhat difficult to interpret. One interpretation extrapolated from a meta-analysis on media addiction (Cheng et al., 2021) is that there may be a heightened pressure to conform to group norms and cultivate a harmonious relationship with the group in collectivist countries. Based on the theory of cultural tightness-looseness (Gelfand et al., 2017), collectivistic countries are 'tight' societies with strong group norms. Group members are expected to conform to the norms

and values of the group that, apart from intrinsic pressure (i.e., exercise for health or skill), also generates extrinsic pressure (i.e., not letting others down). In contrast, individualist countries are 'loose' societies in which the pressure is primarily internal (i.e., individuals must exercise to get rid of stress or must exercise to beat their personal best times/scores) with little need to conform to group norms unless the person is a team player. However, whether the tendency of higher REA in collectivist countries is a sign of potential dysfunction or a reflection of high commitment, respect for group norms, passion, or social dedication remains the subject for future EA research.

Sex Differences in the Risk of Exercise Addiction

The present study found no biological sex differences in REA. These findings agree with a recent study showing that when a minimal exercise volume (i.e., 3 h/week) is set as the criterion for participation, no sex differences were found in REA among a relatively large sample ($n = 1{,}448$; Szabo et al., 2022). The findings also concur with other recent studies that imposed a participation criterion for exercise (i.e., three times/week) (Gori et al., 2021; Pálfi et al., 2021). Nevertheless, the findings contrast with a review of 27 studies concluding that males are more prone to REA than females (Dumitru et al., 2018). However, the studies in that review had different exercise volumes, unlike the criterion-based recent studies showing no sex differences. Indeed, Dumitru et al. (2018) stressed that among leisure exercisers, females tend to exercise less than men, which could have biased the results of the review. Since studying EA among individuals who exercise less than three times or three hours per week may be futile, it is recommended that studies on the REA impose participation criteria on exercise frequency and/or volume.

Risk of Exercise Addiction Among Athletes

The prevalence estimate of REA among athletes was 16.1% in the present study's international sample. This figure fits within the range (2.7% to > 42.0%) reported in a literature review of 17 studies over a 17-year period (Juwono et al., 2021). Using specific examples, Szabo et al. (2015) argued that leisure exercisers and elite athletes might interpret the EA screening tools' items differently, yielding conceptual confusion between ill-patterned and highly dedicated, passionate training. However, no empirical research exists on how athletes and leisure exercisers may differentiate in relation to their interpretation of scale items when rating various REA screening items.

There is strong opposition in the literature to studying EA among athletes and participants only engaged in team-based exercise due to theoretical incompatibility between the concept of addiction, being a personal phenomenon, and athletic and team-based training that is *scheduled* for athletes (Griffiths et al., 2023; Juwono et al., 2021; Szabo & Demetrovics, 2022). Addictions cannot exist on a schedule since urges and cravings characterizing an addiction cannot be delayed within a pre-set schedule. This is why a typical symptom of exercise, and all other addictions, is the loss of control (Szabo et al., 2015). According to Griffiths et al. (2023), EA in team-based/scheduled exercise could exist only if the affected person satisfies the addictive urges beyond the regularly scheduled training, likely leading to physical exhaustion, injury, and performance loss.

It is reasonable to assume that 16.1% of athletes classified at REA in the present study are predisposed to psychopathology. Therefore, researchers must understand how athletes interpret statements associated with items on EA screening tools. The mediators and

moderators of their responses should also be investigated because factors such as commitment and passion (Kovacsik et al., 2020) could significantly influence the REA scores. The high scores of REA may primarily reflect an interaction between athletic commitment, passion, and firm determination to achieve the best personal performance without necessarily experiencing pathological risk.

Risk of Exercise Addiction in the Context of Exercise Characteristics

In addition to athletic status, the present study examined REA prevalence estimates in (i) team vs. individual exercises, (ii) organized vs. self-planned exercises, and (iii) aerobic vs. anaerobic exercises. The prevalence estimates of REA were similar among participants engaged in team and individual exercises in the whole sample and also when examined separately for collectivist and individualist countries. These findings (using a new classification) concur with the conclusion of a recent review (Griffiths et al., 2023), showing that most research comparing these forms of sports cannot disclose differences in REA despite using different assessment tools. However, theoretically, these findings make little sense since most addicts are "*lone wolves*" (Griffiths et al., 2023). Consequently, team exercisers can only experience EA if they exercise beyond and above their usual team training events. This conceptual controversy illustrates the extent to which REA is unlikely to mirror dysfunctional EA, which is in accord with Egorov and Szabo (2013), who, in their interactional model, claim that from a clinical perspective, EA is revolutionary (surfacing suddenly) rather than evolutionary (progressive).

Using a similar theoretical rationale to the above, it was hypothesized that the REA would be lower among participants engaged in organized exercise settings than in self-planned exercise because, in EA, the control vanishes over the training, while the addiction controls the individual, which is highly unlikely to happen in a scheduled, organized exercise settings. Indeed, studies have shown that participation in organized forms or exercises is associated with protection against addiction to illicit drug use among young people (Terry-McElrath & O'Malley, 2011; Terry-McElrath et al., 2011). In contrast, the present study's results yielded a greater REA prevalence among those engaged in organized exercises than in self-planned training in the whole sample. After separate analyses, this was also found among those in collectivist but not individualist countries. It is worth noting that athletes participate in organized sports/exercise. However, a separate analysis of this was performed because leisure exercise can also occur in organized forms.

A possible explanation for the higher REA among those engaged in organized exercises (and among athletes) might relate to the specific items of the AT subscale on EAI-3 assessing *conflict, withdrawal effects, guilt,* and *training despite injury*. All these items could have different meanings (Szabo et al., 2015) among those engaged in organized and self-planned exercises. An organized exercise training session (initiated by others) might interfere with other life activities and create conflict between family and friends. Missing such training might relate to an inner void caused by not being part of group activity or missing learning a new skill. These feelings are closely related to guilt that can be internal but also result from feelings of letting down others. Finally, training despite injury may be associated with self- and social pressure, guilt, and conflict (with organizers) avoidance. Therefore, as suggested earlier, researchers must understand what athletes and those who are part of organized sports think and what they mean when they complete EA screening items. Consequently, qualitative studies to specifically examine this are needed in this area.

It was also found that aerobic exercisers had a lower-than-expected prevalence of EAI, and the opposite occurred among mixed aerobic and anaerobic exercisers. This finding was also found among those in collectivist countries. The findings are in contrast to those in a literature review, showing that REA was greatest in endurance (aerobic) exercises (14.2%) and lowest in strength (anaerobic) exercises (6.4%) (Di Lodovico et al., 2019). Moreover, the results appear to disagree with a study comparing the prevalence estimate of REA among those engaged in aerobic and anaerobic activities (Pálfi et al., 2021), but the study did not have a mixed aerobic-anaerobic group. Finally, the non-significant findings among those in individualist countries concur with those of Pálfi et al. (2021), who conducted their study in an individualist culture (Hungary). Overall, the findings warrant the examination of the social context in which aerobic and mixed exercises are performed in collectivist countries to delineate the differences in the REA prevalence.

Reasons for Exercise

The prevalence of REA was less than hypothesized among those who exercised for health reasons, while the opposite was found among those who exercised for skill/mastery reasons. The same finding was observed among participants in both collectivist and individualist countries. However, lower-than-expected hypothesized REA prevalence among those who exercised for health reasons was only found in collectivist countries. In the present study, the prevalence of REA among those who engaged in exercise for health (7.32%), skill (13.95%), and social reasons (7.83%) were lower than in the study by de la Vega et al. (2020) who reported a prevalence of REA of 14.7% among those who exercised for health, 17.5% among those who exercised for mastery, and 16.9% among those who exercised for social reasons. Despite the apparent difference in these prevalence estimates, most likely due to the more stringent classification of REA in the present study through the inclusion of negative experiences related to exercise, the order of REA prevalence estimates is similar (i.e., skill/mastery reasons, followed by social motives, followed by health reasons).

These findings contrast with the interactional model of EA (Dinardi et al., 2021; Egorov & Szabo, 2013) because they favored an evolutionary mastery path to EA, whereas the clinical model purports a revolutionary therapeutic (health-oriented) path. Therefore, this raises the issue of whether the findings mirror a strong athletic commitment or passion, or (based on Szabo [2018]), possibly both. Individuals training for mastery (skill improvement) reasons are dedicated and passionate about their training, and they make sacrifices (with negative consequences) that could surface in their REA but are unlikely to indicate dysfunctional exercise (Szabo, 2018; Szabo & Demetrovics, 2022).

Prevalence of Eating Disorders Among Individuals at Risk of Exercise Addiction

Russian participants had the highest prevalence of EDs than all other countries, irrespective of the REA. There is no obvious explanation for this finding, as there are no relevant Russian or comparative studies in the literature. The results showed that the prevalence of EDs was twice as high among individuals at REA in the whole sample. The results were similar among participants in individualist countries but slightly less than twice as high in collectivist countries. These findings concur with the results of a meta-analysis (Trott et al., 2021), which found that individuals who score above the agreed cut-offs for EDs are three

times more likely to be at REA. The dilemma is whether these individuals are primarily rewarded by exercise in which ED is instrumental, or their reward is a body or weight-related outcome in which exercise is only instrumental (Szabo & Demetrovics, 2022). The dilemma exists because, in the latter case, EA cannot be talked about, and is 'instrumental exercise' (as Szabo and Demetrovics termed it). Therefore, future research should attempt to delineate EA from 'instrumental exercise' because the latter likely inflates EA prevalence estimates.

Limitations

Despite the sizeable international sample size, the study has several limitations. First, its cross-sectional design prevents any determination of causation between the studied variables. Second, volunteer (self-selected) participants are not representative of individuals in the 15 countries sampled. Third, data were self-reported and subject to various methods biases. Fourth, some of the sample sizes in each country were very small. This could have affected some of the results. Fifth, apart from its presence, the severity of negative consequences was unknown among the surveyed participants. Sixth, social attitudes and personal strivings in individualist and collectivist nations were not assessed, but assumed that respondents from these countries displayed (in the majority) these characteristics. Finally, when data were collected, the EAI-3 had only been formally validated in five of the 15 nations. Therefore, the psychometric properties require confirmation in the other 10 countries.

Conclusion

The main conclusion of the present study is that exercise patterns and REA prevalence estimates differ between collectivist and individualist countries but are minimal based on effect sizes. Athletes and those engaged in organized exercises reported higher prevalence estimates of REA than leisure exercisers and those engaged in individual exercises, which theoretically does not align with addiction, notable primarily in 'lone wolves' (Griffiths et al., 2023; Juwono et al., 2021; Szabo & Demetrovics, 2022). Screening for REA with the AT subscale of the EAI-3 and gauging the experience of negative consequences yielded lower REA prevalence estimates than the cutoff point assessment. However, those at REA may not be dysfunctional and may not develop morbidity. The evaluation of dysfunctionality requires the REA screening scores to be followed by clinicians as described in the 'pyramid model' (Szabo & Demetrovics, 2022). Based on the current classification of the REA, those exercising for skill/mastery reasons reported higher prevalence estimates than those exercising for health reasons. In contrast, the opposite is expected based on the interactional model of EA. Consequently, mediators, moderators, and subjective meanings of the responses given on REA assessment tools call for further investigations to avoid labeling a committed and passionate exercise behavior as pathological (Szabo, 2018). It is hoped that the present international study will stimulate a rethinking of the conceptualization of EA in terms of the significant difference between REA (screening) and EA (clinical issues), given that there have been over 1,000 academic publications on EA but with fewer than 20 identified clinical cases (Szabo & Kovacsik, 2019). This disparity calls for re-evaluating research directions in the field of EA.

Appendix

Classification of individualist and collectivist nations based on extant literature.

Individualistic Cultures	Collectivistic Cultures
1. Germany (Kühnen et al., 2001)	1. Mexico (Mackinnon et al., 2017; Shkodriani & Gibbons, 1995)
2. Canada (Mackinnon et al., 2017; Nelson & Shavitt, 2002)	2. Turkey (Caffaro et al., 2014)
3. Australia (Feather, 1998; Nelson & Shavitt, 2002)	3. China (Tynan et al., 2010)
4. Hungary (Mackinnon et al., 2017)	4. Russia (Kühnen et al., 2001)
5. Italy (Caffaro et al., 2014)	5. Brazil (Gouveia et al., 2002; Mackinnon et al., 2017)
6. United Kingdom (UK) (Mackinnon et al., 2017; Tynan et al., 2010)	6. Spain (Gouveia et al., 2002; Mackinnon et al., 2017)
7. France (Janssens et al., 1995)	7. Japan (Yamawaki, 2012)
8. Denmark (Hofstede, 1980b; Nelson & Shavitt, 2002)	

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Data Availability Data are available upon reasonable request from the first author.

Declarations

Ethical Approval All procedures performed in this study involving human participants were obtained ethical permission from the University of Padova, Certificate number 4460.

Informed Consent All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5). Informed consent was obtained from all patients for being included in the study.

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

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