Addictive Behaviors Reports 14 (2021) 100369

Contents lists available at ScienceDirect

Addictive Behaviors Reports

journal homepage: www.elsevier.com/locate/abrep

Symptoms of exercise addiction in aerobic and anaerobic exercises: Beyond the components model of addiction

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A R T I C L E I N F O

Keywords:
Disordered eating
Exercise dependence
Injury
Physical activity
Staleness

A B S T R A C T

Background: Above the six symptoms in the components model of exercise addiction, other symptoms may also reflect the risk of exercise addiction (REA). Based on past research, these additional symptoms (AS) include training when injured, missing social engagements, disordered eating, staleness, and distorted perception of the exercise volume. The manifestation of these AS, along with the REA, may vary in different exercise forms. Since research shows that aerobic exercise is associated with greater well-being and stress reduction than anaerobic exercise, based on the interactional model of exercise addiction, the prevalence of the REA may be higher in aerobic than anaerobic exercisers.
Methods: This cross-sectional investigation examined the REA and AS in regular exercisers performing *aerobic* and *anaerobic* activities. Adults (n = 176), exercising at least three times per week for at least one year, were tested. The between-groups and gender differences, along with the connection between AS and REA in the two exercise forms, were studied.
Results: Aerobic and anaerobic exercisers did not differ in the dependent measures. Women in the anaerobic group reported eating more disorderly than men. The REA groups (*asymptomatic*, *symptomatic*, and *at-risk*) differed in all AS. A consistent but weak connection was disclosed between the RAE and AS.
Conclusions: The REA and the studied AS do not differ between aerobic and anaerobic groups, but women in the latter group reported eating more disorderly when exercise is not possible. Expanding the components model with other pertinent symptoms could yield a more thorough picture about the REA.

1. Introduction

The physical work for survival activities and energy expenditure has decreased in the contemporary technology-driven society; the human lifestyle has changed significantly. This change makes modern living increasingly sedentary (Freese et al., 2018). A sedentary lifestyle, characterized by physical inactivity, is associated with numerous health risks (Blair, 2007). Therefore, scholars suggest that, in addition to household chores and active commuting, regular exercise should be incorporated into people's daily lives to compensate for the lost physical activity (Malm et al., 2019; Thompson et al., 2020). This academic standpoint is shared in the mass media, which influences individuals' thoughts about and attitudes toward regular exercise (Berry et al. 2020).

Consequently, all over the world, increasingly more people become active by adopting some form of exercise. Regular workouts and domestic and occupational activities make three out of four individuals meet the World Health Organization's recommendations for physical activity (World Health Organization, 2020). Indeed, in 2017 in 11 European Union nations, more than 10% of the people have engaged in regular sports or exercise *five or more* times a week (Medve, 2020). For some of these people, exercise may be a means of coping with stress, compensating for perceived constraints, or challenging their physical limits. When exercise becomes a means to achieve an end, people may lose control over the behavior and manifest symptoms leading to a dysfunction. Among millions of exercising people, a small percent (0.3–0.5%; Mónok et al., 2012) could be at risk of exercise addiction (REA). However, this 'small' percent of the millions involved in some form of regular exercise worldwide represents a large number when

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https://doi.org/10.1016/j.abrep.2021.100369
Received 19 April 2021; Received in revised form 25 June 2021; Accepted 25 July 2021
Available online 28 July 2021

considering the total of those at REA (Juwono & Szabo, 2020). Further, this percentage is much more significant when considering specific forms of exercises. Based on a recent literature review, including 48 studies from around the world (Di Lodovico et al., 2019), the prevalence of the REA was estimated to be 14.2% in endurance exercises, 10.4% in diverse disciplines and team sports, 8.2% in health and fitness activities, 6.4% in power disciplines, and 3.0% in the general population.

The difference in the prevalence of the REA in different forms of exercise are in accord with the interactional model of exercise addiction (Egorov & Szabo, 2013), which predicts that ongoing stress or trauma is the main antecedent of the REA. It is known for a while that aerobic exercise may be superior to anaerobic exercise in managing stress and improving well-being (Berger & Owen, 1988; Norris et al., 1990). Perhaps more people gravitate towards a therapeutic aerobic exercise, such as running (Robbins & Joseph, 1985), than towards anaerobic exercise, which might explain why the recent literature review (Di Lodovico et al., 2019) found that more than twice of the aerobic exercisers were at REA than anaerobic exercisers.

1.1. Exercise addiction

Exercising to a point where the exerciser loses control over the exercise behavior, which becomes salient, compulsory, and leads to physical or mental damage, is referred to as exercise addiction (Szabo, 2010). The term ‘exercise dependence’ is also widely used in the literature to denote this condition, but dependence is only one of the two components of ‘addiction,’ the other being compulsion (Goodman, 1990). Based on the *components model*, exercise addiction has six typical symptoms, which are: 1) salience, 2) mood modifications, 3) conflict, 4) withdrawal symptoms, 5) tolerance, and 6) relapse (Griffiths, 2005). However, as discussed later, research reveals that there are other symptoms or components of exercise addiction. The interest in studying exercise addiction is immense. A relatively recent article reported that there are over 1000 papers published in the field (Szabo & Kovacsik, 2019), but only about a dozen of clinical cases among them. This number, however, might be greater as based on a work that collected 100 personal stories of exercise addiction from the Internet (Juwono & Szabo, 2020).

1.2. Exercise addiction or risk of addiction?

Clinical diagnosis cannot be made for exercise addiction because, despite its associated dysfunctional symptoms, the disorder is currently not listed in the Diagnostic and Statistical Manual for Mental Disorders (DSM-5; American Psychiatric Association, 2013). The lack of inclusion in DSM-5 stems from insufficient evidence for a distinct dysfunction category, which is not surprising if one considers the few established cases (Juwono & Szabo, 2020). Further, even among the known cases, exercise addiction might surface as a co-morbidity besides another psychiatric dysfunction (Griffiths, 1997; Kotbagi et al., 2014). Therefore, the voluminous publications in this research field (Szabo & Kovacsik, 2019) contain studies that merely assess the *risk* of exercise addiction and have no diagnostic value. This risk reflects a *potential for developing exercise addiction* when several predisposing factors are present. Nevertheless, identifying the REA could have significant value in preventing dysfunctional exercise behavior in those predisposed to it.

1.3. Characteristics of exercise

Although the REA may vary with the type of exercise activity, the bulk of research has overlooked this critical issue, possibly resulting in unreliable conclusions. Indeed, studies show that team and individual exercisers differ in the REA. For example, Szabo and colleagues (2013) showed that team sports athletes report a greater REA than athletes in individual sports. Studies with leisure exercisers found no difference between team and individual exercisers in the score of the REA, but its predictors were different (Kovacsik et al., 2018; Lichtenstein, Larsen, et al., 2014).

Further, exercise frequency and exercise history are crucial in *selecting* participants for research examining the REA. For example, a lower frequency than three-four workouts per week accompanied by an exercise history shorter than one year is trivial in rationalizing the examination of the REA. Yet, many studies do not pay attention to these parameters when selecting their participants (i.e., Alcaraz-Ibáñez et al., 2018; Fernández-Martínez et al., 2020; Maraz et al., 2015). Moreover, numerous reports do not specify these parameters (i.e., Ertl et al., 2017; Corazza et al., 2019) or only report one of them (i.e., Duyan, 2021; Lukács et al., 2019). Huang and colleagues (2019) define the regular exercise frequency as *at least three times per week* and activity history as *at least one year*.

1.4. Additional symptoms of exercise addiction

Apart from the six symptoms comprised in the components model of addiction (Griffiths, 2005), other symptoms (AS) might also be associated with the REA. One of them is exercising against medical advice or when one feels ill, unwell, or injured (Berczik et al., 2012; Lichtenstein & Jensen, 2016). Group differences between those at REA and controls (not at risk), in their experience of past injuries, were already reported in the literature (Lichtenstein, Christiansen, et al., 2014). Further, those at REA score higher on the tendency to exercise when injured than those who are not at risk (Lichtenstein & Jensen, 2016; Lichtenstein et al., 2017). However, it is unknown to what extent this AS is connected to the REA in different exercise forms.

Another AS in the context of the REA is the reduction or refusal of social commitments because of higher priority given to exercise (Downs et al., 2004). Juwono and Szabo (2020) list several cases of exercise addiction in which the missing of social engagements due to exercise is evident. However, to date, studies did not investigate the relationship between the tendency to miss important social obligations and the REA. Even though this AS forms part of the symptoms of dependence on the Exercise Dependence Scale (Downs et al., 2004), it is not part of the components model, or the Exercise Addiction Inventory (EAI), which measures the REA based on the six symptoms in the components model of addictions.

Disordered eating, including dieting, fasting, and binge-eating, is another AS of the REA. However, disordered eating in exercise addiction is different from the voluminous exercise observed in eating disorders, known as secondary exercise addiction (Szabo et al., 2015; Veale, 1995). Indeed, research shows that exercise addiction is distinct from eating disorders (Lichtenstein, Christiansen, et al., 2014; Ogden et al., 1997), but disordered eating may be a symptom of the REA (Zeulner et al., 2016). Those sports and exercises that emphasize body appearance, such as bodybuilding (Goldfield, 2009; Goldfield et al., 2006), have been consistently associated with disordered eating. Further, some exercisers work out to lose calories via energy expenditure (Freimuth et al., 2011). However, the opposite relationship between disordered eating habits and the REA, manifested in dieting, fasting, or binge-eating when exercise is not possible (to compensate for the unused energy), has received little attention in the literature.

Individuals at REA tend to train excessively (Szabo, 2010). The exaggerated volume of exercise may result in overtraining and related feelings of staleness, characterized by burnout and chronic fatigue; it is often accompanied by negative emotional states similar to clinical depression (Veale, 1991). The main reasons beyond overtraining and staleness in exercise addiction include tolerance (the previous dose of exercise is no longer effective), the inability to accept one’s physical limits, or the setting of unrealistically difficult goals (Egorov & Szabo, 2013). Despite the long-ago formulated theoretical connection to the REA (Veale, 1991), the subjective experience of staleness has not received research attention.

Finally, the REA is also associated with the distorted perception of the 'adequate' amount of exercise. Individuals affected by the REA tend to *underestimate* their necessary amount of training, primarily due to tolerance (Condello et al., 2016; Szabo, 2010). Thus, the discord between the perceived and expected exercise volume could also be an AS of the REA, but there is no research on this issue.

1.5. Gender differences

Research results on gender differences in the REA are equivocal, but a literature review suggests that men are more affected than women (Dumitru et al., 2018). Indeed, the REA in anaerobic exercises, such as body conditioning (Giardino & Procidano, 2012) and CrossFit (Lichtenstein & Jensen, 2016), appears to be greater in men than in women. However, in aerobic forms of exercises, such as running (Pierce et al., 1997) and triathlon (Youngman & Simpson, 2014), the opposite findings were also reported. Therefore, the further examination of gender differences between aerobic and anaerobic exercisers seems to be warranted.

1.6. Objectives of the current study

Following up on Di Lodovico and colleagues' (2019) report of the different prevalence of REA in regular *aerobic* and *anaerobic* exercisers, first we wished to replicate this finding by addressing this question directly and by also examining gender differences and the AS in addition to the symptoms in the components model of addiction. A second aim was to determine whether REA groups (i.e., *asymptomatic, symptomatic,* and *at-risk*) differ in the AS.

2. Materials and methods

2.1. Participants

We posted a call for participants on recreational fitness-oriented social media groups on Facebook. Although the call for participants only solicited responses from adults aged 18 years and over who exercise regularly for *at least one year*, *at least three times every week* (Huang et al., 2019), and perform either *aerobic* or *anaerobic* activities, we also received responses not conforming to these criteria. (Indeed, the criteria were stringent, which resulted in a lower than anticipated number of responses). A total of 221 responses were obtained over the planned three-month data collection period between December 2020 and January 2021. Of these responses, 176 (80%) met the criteria for inclusion in this study. Nearly one-third (29.5%) of the respondents were from the capital area, 58% from towns/cities, and 12% from rural areas. Like in most online research (Saleh & Bista, 2017), there was a notably uneven representation of men (n = 34, 19.3%) and women (n = 142, 80.7%). The characteristics of the respondents are presented in Tables 1 and 3.

Of the 176 respondents, 68 were involved in anaerobic activities (weight training and bodybuilding), and the rest (n = 108) performed aerobic exercises (running, swimming, and triathlon). The two groups only differed on the average length of their exercise bouts. Those in the anaerobic groups scored slightly higher than individuals in the aerobic group. All the characteristics of the respondents in the two groups are presented in Table 1.

2.2. Ethics

Although the study was anonymous, the Research Ethics Board (REB) of the Faculty of Education and Psychology at ELTE Eötvös Loránd University in Budapest examined the research proposal and granted ethical clearance (No. 2020/477). The REB ensured that the work is performed according to the ethical principles of research with human participants guided by the British Psychological Society Code of Human Research Ethics (British Psychological Society, 2014) and the Helsinki Declaration (World Medical Association, 2013). All participants read and agreed to an informed consent form before completing the online survey questions.

Table 1
Characteristics of the respondents in the anaerobic (n = 68) and aerobic (n = 108) exercise groups.

Measure	Form of Exercise	Mean	Standard Deviation	*p*
Age	Anaerobic	37.43	11.22	NS
	Aerobic	38.50	10.88	
History of exercise (years)	Anaerobic	8.24	8.08	NS
	Aerobic	8.75	7.40	
Times per week (days)	Anaerobic	4.34	1.13	NS
	Aerobic	4.52	1.31	
Duration of workouts (h)	Anaerobic	1.42	0.40	0.001
	Aerobic	1.27	0.59	
Exercises when injured (1–5)	Anaerobic	2.69	1.56	NS
	Aerobic	2.70	1.52	
Misses social engagements (1–5)	Anaerobic	2.32	1.43	NS
	Aerobic	2.06	1.34	
Eats disorderly when misses exercise (1–5)	Anaerobic	2.54	1.26	NS
	Aerobic	2.41	1.35	
Experiences staleness (1–5)	Anaerobic	2.38	1.37	NS
	Aerobic	2.28	1.39	
Perceives doing the right amount of exercise (1–5)	Anaerobic	3.16	0.70	NS
	Aerobic	2.95	0.63	
REA (6–30)	Anaerobic	17.49	5.45	NS
	Aerobic	16.74	4.62	

Note: NS in the table denotes no statistical difference between aerobic and anaerobic groups.

2.3. Measures

A demographic questionnaire was used to determine the participants' gender, age, the form of regular exercise, living area (capital area, city/town, rural area), weekly frequency of exercise, duration of the workouts, and history of exercise. The Exercise Addiction Inventory (EAI; Terry et al., 2004) assessed the REA. This tool is a six-item scale. Sample items include 1) "*Exercise is the most important thing in my life*." or 2) " *If I have to miss an exercise session, I feel moody and irritable*." These statements are rated on a 5-point Likert scale ranging from *"strongly disagree"* to *"strongly agree"*. The scale's psychometric properties are good (Granziol et al., 2021; Griffiths et al., 2015; Mónok et al., 2012; Terry et al., 2004). In the current study, the validated Hungarian version of the scale was used (Mónok et al., 2012). The EAI's internal reliability (Cronbach alpha [α]) ranges between 0.68 and 0.80 across several international studies (Griffiths et al., 2015). In the present sample, this value was 0.74, which is in the middle of the reported range.

Following the method used by Lichtenstein and Jensen (2016), we adopted five other single-item statements that were rated on an identical 5-point scale like the EAI, to assess 1) the level of disagreement-agreement with exercising during a time of injury or illness, 2) missing critical social engagements because of exercise, 3) eating disorderly (dieting/fasting, binge eating.) when unable to exercise, 4) experiencing staleness (symptoms of burnout or overtraining), and 5) perceiving doing the right amount of exercise in light of one's personal goals and abilities.

2.4. Procedure

The duration of the data collection was planned *a priori* to last for three months. This period was chosen because online calls for participation in surveys receive most of the responses during the first days of the call and then progressively vanish over time despite the call's repetition. Indeed, 80% of the responses may be expected to come in within the *first week* of the study (Zheng, 2011). Therefore, even by repeating the call, our study interval was enough to maximize the obtainable responses.

Following the giving of consent to participation, respondents completed the online survey. Data were collected in spreadsheets using the *Google Forms* Interned-based platform (Lardinois, 2017). The downloaded data were exported into an SPSS (Statistical Package for Social Sciences) file and subjected to statistical analyses with the same software (Version 26; IBM Corp., 2019).

2.5. Statistical analyses

Both the Kolmogorov-Smirnov and Shapiro-Wilk tests indicated that the assumption of normality was violated in the dependent measures (REA and AS)[1]. Further, the sample size was insufficient for obtaining enough power for multivariate parametric tests. Therefore, we analyzed the ordinal data on group differences with nonparametric tests that are less sensitive to sample size differences. It was proposed that these tests are the most useful in smaller studies (Fagerland, 2012). Further, in contrast to the models on which parametric tests are based, they are less restrictive and permit more general inferences (Siegel, 1957). Furthermore, Jamieson (2004) presented a convincing argument for testing Likert scale data with nonparametric tests.

First, we compared the aerobic and anaerobic groups on demographic and dependent measures. To test the possible gender differences, we then compared the REA and AS scores between men and women and then examined the prevalence of the REA in the two sexes. Then, we categorized the REA scores according to Terry and colleagues (2004); *asymptomatic* (scores 6–12), *symptomatic* (scores 13–23), and *at-risk* (scores 24 and above). Subsequently, we performed a chi-square test to determine whether the proportion of various exercise addiction categories is different between those in the aerobic and anaerobic groups.

To examine the relationship between AS and the REA we used Spearman's *rho* (ρ) correlations. We also determined the internal reliability of the AS alone and combined with the EAI.

3. Results

3.1. Aerobic vs. Anaerobic group

As shown in Table 1, the comparison of the aerobic and anaerobic groups revealed that the two did not differ from each other in any other measures than the average duration of their regular exercise session (Mann-Whitney U test; $Z = -3.75$, effect size [Cohen's r] = 0.28).

A chi-square test comparing three REA categories between the aerobic and anaerobic groups was statistically not significant (Table 2).

Mann-Whitney independent samples U test revealed that the aerobic group only differed from the anaerobic group in the workouts' duration. The latter group reported more prolonged bouts of exercise than the former (Table 1).

3.2. Gender differences

The prevalence of the REA did not differ between men and women

Table 2
Pearson Chi square (χ^2) tests of the distribution aerobic and anaerobic exercisers in three exercise addiction risk groups.

	Asymptomatic	Symptomatic	At-risk	$\chi^2_{(df)}$	p
Aerobic	23	73	12	1.05 (2)	0.59
Anaerobic	15	42	11		

[1] The normality of the REA data was only violated on the basis of Shapiro-Wilk test.

($\chi^2_{(2)} = 1.857$, $p = .395$). It was 13.1% (n = 23; 14.7% men and 12.7% women) in the whole sample. Most, 65.3% (n = 115; 55.9% men and 67.6% women) of the sample could be classified as *symptomatic*, and 21.6% (n = 36; 29.4% men and 19.7% women) as *asymptomatic* based on Terry and colleagues' criteria (2004). Men and women also did not differ in the total REA scores either in the whole group (Table 3) or when compared separately for the aerobic and anaerobic exercisers (Table 4). However, a statistically significant difference was observed in the duration of their workouts (Mann-Whitney U test, $Z = 2.46$; effect size [Cohen's r] = 0.19) with men scoring higher than women, and in eating disorderly when an exercise bout is missed ($Z = 3.20$; $r = 0.24$), with women scoring higher than men in the whole sample (Table 3). However, when this measure was analyzed separately for the aerobic and anaerobic groups, the differences between men and women in eating disorderly when missing workouts were apparent only in the anaerobic group (Table 4).

3.3. Presence of the associated symptoms in three risk categories

We tested whether the AS (exercising when injured, missing important engagements, eating disorderly when exercise is not possible) differ in the three exercise addiction risk groups (asymptomatic, symptomatic, and at-risk). Independent samples Kruskal-Wallis tests revealed that the three risk groups differed statistically significantly in all dependent measures except perceived adequacy of the amount of exercise. Because scores in eating disorderly differed between men and women (see Table 2), we analyzed this variable separately for the two genders. These tests' results revealed that only *asymptomatic* and *at-risk* women differed statistically significantly from each other ($Z = -2.67$, $p = .02$, $r = 0.23$; means = 2.15 and 3.28, SDs = 1.29 and 1.18, respectively). The results of these tests are summarized in Table 5.

Table 3
Characteristics men (n = 34) and women (n = 142) in the studied sample.

Measure	Form of Exercise	Mean	Standard Deviation	P
Age	Men	37.44	13.08	NS
	Women	38.24	10.48	
	Full sample	**38.09**	**10.99**	
History of exercise (years)	Men	10.59	10.23	NS
	Women	8.06	6.85	
	Full sample	**8.55**	**7.66**	
Times per week (days)	Men	4.56	1.11	NS
	Women	4.42	1.27	
	Full sample	**4.45**	**1.24**	
Duration of workouts (h)	Men	1.49	0.60	0.014
	Women	1.29	0.51	
	Full sample	**1.33**	**0.53**	
Exercises when injured (1–5)	Men	2.59	1.50	NS
	Women	2.73	1.54	
	Full sample	**2.70**	**1.53**	
Misses social engagements (1–5)	Men	2.09	1.31	NS
	Women	2.18	1.40	
	Full sample	**2.16**	**1.38**	
Eats disorderly when misses exercise (1–5)	Men	1.85		0.001
	Women	2.61	1.29	
	Full sample	**2.46**	**1.31**	
Experiences staleness (1–5)	Men		1.16	NS
	Women	2.36	1.43	
	Full sample	**2.32**	**1.38**	
Perceives doing the right amount of exercise (1–5)	Men	3.09	0.67	NS
	Women	3.02	0.67	
	Full sample	**3.03**	**0.67**	
REA (6–30)	Men	15.82	5.16	
	Women	17.32	4.88	
	Full sample	**17.03**	**4.96**	

Note: NS in the table denotes no statistical difference between men and women. The groups differed in.

Table 4
Additional symptoms (AS) to the six symptoms in the components model of addiction assessing the risk of exercise addiction (REA) in men and women in the aerobic and anaerobic groups. No statistically significant differences have emerged.

		Men Mean (SD)	Women Mean (SD)	*Z*	*p*
Exercises when injured (1–5)	Aerobic	2.08 (1.32)	2.80 (1.54)	−1.55	0.12
	Anaerobic	2.91 (1.55)	2.57 (1.57)	−0.85	0.40
Misses social engagements (1–5)	Aerobic	1.77 (1.24)	2.10 (1.35)	−0.92	0.36
	Anaerobic	2.29 (1.35)	2.34 (1.48)	−0.06	0.96
Eats disorderly when misses exercise (1–5)	Aerobic	2.15 (1.57)	2.44 (1.32)	−0.95	0.34
	Anaerobic	1.67 (0.97)	2.94 (1.19)	−3.87	0.001
Experiences staleness (1–5)	Aerobic	2.46 (1.27)	2.25 (1.41)	−0.74	0.46
	Anaerobic	1.95 (1.07)	2.57 (1.46)	−1.58	0.11
Perceives doing the right amount of exercise (1–5)	Aerobic	2.77 (0.44)	2.98 (0.65)	−1.39	0.17
	Anaerobic	3.29 (0.72)	3.11 (0.70)	−1.04	0.30
Risk of exercise addiction (6–30)	Aerobic	15.31 (3.97)	16.94 (4.69)	−1.34	0.17
	Anaerobic	16.14 (5.84)	18.09 (5.22)	−1.19	0.23

3.4. Connection between associated symptoms and risk of exercise addiction

Spearman's *rho (ρ)* correlation coefficients were calculated to examine the relationships between the exercise addiction risk scores and dysfunctional behaviors (exercising when ill or injured, missing important engagements, eating disorderly when exercise is not possible), staleness, and perceived adequacy of the amount of exercise for the whole sample, and then separately for the aerobic and anaerobic groups (Table 6). Finally, we calculated the internal consistency of the five AS studied in this work, which reached the lower limit of the acceptable value (Cronbach's α = 0.61). When added to the EAI items the EAI's internal reliability changed only slightly from 0.74 to 0.77.

4. Discussion

4.1. Prevalence of the REA

The prevalence of the REA was 11.1% in the aerobic group and 16.2% in the anaerobic group. The 5.1% difference was statistically not significant. In both groups, this proportion is within the range (0.5–21.7%) reported in 27 studies, comprising over 20,000 participants from the USA, Mexico, Denmark, Spain, Germany, UK, and Korea (Dumitru et al., 2018). Nevertheless, these rates are relatively high compared to a more recent review (Trott et al., 2020). We have two plausible explanations for this high prevalence in both groups. The first is that we examined a self-selected sample of adults that might have comprised individuals with greater interest in, closer connection, and more preoccupation with exercise than those in a heterogeneous population study. Intense involvement in exercise affects the scoring of the measures (Szabo et al., 2015). The second is that unlike in several other works, we tested participants with a minimum exercise frequency of three times per week (the mean was >4.0 h; refer to Table 1 and 3) and a minimum exercise history of one year (the mean was >8.0 years; Table 1), which again might have attracted highly committed respondents. Earlier research often confounded high commitment with the risk of addiction (Szabo, 2010) because there is a fine line between the two (Landolfi, 2012). Although plausible, this second explanation remains tentative because we did not assess commitment to exercise in the current work.

4.2. Gender differences

In this study, the only gender difference was found in eating disorderly when missing exercise, but only in the anaerobic group. Women in this group scored higher than men (Table 4), similar to the findings reported in a recent study (Efthymiou et al., 2021). Although eating disorders are closely related to muscle dysmorphia, which is frequently reported in anaerobic forms of exercise (Longobardi et al., 2017), we did not assess an eating disorder *per se*, but rather *eating disorderly* when missing exercise, which might be a compensatory behavior for the missed workout in women who perform anaerobic exercises. To the best of our knowledge, this finding is novel and deserves future attention in the literature, especially in women because, in general, they are more prone to eating disorders than men (Galmiche et al., 2019).

Table 5
Differences between exercise addiction risk groups (Group) in five measures (Measures) based on Kruskal-Wallis H tests.

Measures	Group	Mean (SD)	Mean Rank	$\chi^2(2)$	*p*	Effect size (Cohen's *d*)
Exercises when injured	Asymptomatic	1.74 (1.03)	57,80 [a,b]	19.02	< 0.001	0.66
	Symptomatic	2.92 (1.54)	95,77 [a]			
	At-risk	3.17 (1.59)	102,85[b]			
Misses social engagements	Asymptomatic	1.45 (0.80)	63,72 [a,b]	13.40	= 0.001	0.53
	Symptomatic	2.30 (1.40)	94,00 [a]			
	At-risk	2.61 (1.61)	101,93[b]			
Eats disorderly when misses exercise	Asymptomatic	2.08 (1.30)	73,38 [a]	8.71	= 0.013*	0.40
	Symptomatic	2.46 (1.28)	88,83			
	At-risk	3.09 (1.31)	111,80 [a]			
Experiences staleness	Asymptomatic	1.76 (1.26)	69,09 [a]	11.10	=0.004	0.47
	Symptomatic	2.37 (1.35)	90,43			
	At-risk	3.00 (1.57)	110,89 [a]			
Perceives doing the right amount of exercise	Asymptomatic	3.11 (0.61)	91,68	3.31	=0.191	0.18
	Symptomatic	2.97 (0.68)	84,83			
	At-risk	3.21 (0.67)	101,61			

Note: The Table shows group means, standard deviations (SD), the Kruskal-Wallis H statistic (χ^2; degrees of freedom in the parenthesis), p-value, and effect sizes. Two *identical* superscript letters in the 'Mean Rank' column indicates that those groups differ statistically significantly (at least $p < .05$) from each nether. For example, in the first row (exercises when injured), the asymptomatic group differs from both the symptomatic group and the at-risk group too, but the symptomatic group does not differ from the at-risk group.* = The statistically significant overall (total sample) difference emerged because of differences between asymptomatic and at-risk women.

Table 6
Spearman's rho (ρ) correlations between the REA (REA) scores, tendency to exercise during injury (EDI), missing important engagements because of exercise, (MIE) eating disorderly when exercise is not possible (EAD), staleness (STA), and considering doing the right amount of exercise (AME). The results are presented for the full sample and then separately for the aerobic and anaerobic groups.

Full sample (n = 176)	REA	EDI	MIE	EAD	STA	AME
REA	–	0.37 **	0.32 **	0.26 **	0.30 **	0.06
EDI		–	0.41 **	0.22 **	0.41 **	0.18 *
MIE			–	0.09	0.26 **	0.16 *
EAD				–	0.28 **	-0.01
STA					–	0.23 **
Aerobic group (n = 108)						
REA	–	0.35 **	0.22 **	0.27 **	0.31 **	0.06
EDI		–	0.37 **	0.31 **	0.41 **	0.20 *
MIE			–	0.07	0.19*	0.18
EAD				–	0.31 **	-0.03
STA					–	0.20 *
Anaerobic group (n = 68)						
REA	–	0.42 **	0.46 **	0.26 *	0.28 *	0.04
EDI		–	0.49 **	0.08	0.41 **	0.16
MIE			–	0.10	0.38 **	0.11
EAD				–	0.22	0.03
STA					–	0.25 *

Note: * $p < .05$; ** $p < .001$.

4.3. Comparison of the aerobic and anaerobic exercises

As illustrated in Table 1, the aerobic and anaerobic group did not differ from each other in the demographic and dependent measures of the study, except in the reported duration of their workouts. Anaerobic exercisers reported an average of 10.3% longer exercise bouts than anaerobic exercisers. This slight difference can be attributed to the exercise characteristics. In aerobic exercise, the workout is continuous with little or no break between various exercise components, while in anaerobic exercise, rest periods separate the different exercise routines.

In contrast to our results, a greater proportion of aerobic than anaerobic exercisers was found to be at REA in a recent review (Di Lodovico et al., 2019). The different results may be due to a larger number of studies (n = 7) with aerobic exercisers reviewed, compared to anaerobic exercisers (n = 2). Further, the two studies (Lejoyeux et al., 2012; Lichtenstein & Jensen, 2016), which examined anaerobic exercisers in Di Lodovico and colleagues' review (2019), did not set a minimum exercise frequency and history as we did in the current work; in fact, these two studies had no exclusion criteria. It was shown that exercise frequency might play a role in the REA (Alcaraz-Ibáñez et al., 2018) akin to exercise experience (Egorov & Szabo, 2013).

4.4. Associated symptoms in three exercise addiction risk groups

It is important to stress that we did not observe the studied associated symptoms, including exercising when unwell or injured, missing important social engagements because of exercise, eating disorderly when exercise is not possible, overtraining-related staleness, and perceived adequacy of exercise volume, but simply assessed their *tendency* in the sample. The results reveal that these AS are higher among the exercisers who are *at-risk* than in those who are not (refer to Table 5). Asymptomatic individuals, regardless of the form of exercise, scored lower than those at risk in all instances, and they also scored lower than the symptomatic group in the tendency to exercise injured and to miss social engagements. The symptomatic exercisers, however, did not differ in any AS from those at risk. Finally, none of the groups differed from each other in the perceived adequacy of their exercise volume. Therefore, this item may not be an associated symptom of the REA.

The finding that the REA is associated with a greater tendency to exercise when injured corroborates earlier findings reported in the literature (Lichtenstein & Jensen, 2016; Lichtenstein et al., 2017). The results also expand these findings by providing support for the greater tendency of missing important social engagements due to exercise and eating disorderly when exercise is not possible in the *at-risk* for addiction risk. Further, another possibly novel finding in this work is that in accord with the early theories (Veale, 1991), high REA is connected to greater scores of staleness in the at-risk group compared to the asymptomatic group. These feeling states, closely related to burnout and overtraining, are known characteristics of exercise addiction (Szabo, 2010).

4.5. Relationship between the associated symptoms and the risk of exercise addiction

As shown in Table 5, the risk for exercise addiction was positively correlated with all AS but not with the perceived adequacy of the habitual exercise volume, further supporting that this item may be unrelated to the REA. The correlations were relatively small, nevertheless consistent as they could be demonstrated separately for both the aerobic and anaerobic groups too. However, the correlation between the REA and missing important engagements was stronger in the anaerobic group than in the aerobic group, as revealed by a greater proportion of the shared variance (21.2%) in the former compared to the latter (4.7%). This finding suggests that at least some predictors of the REA may be different in the two exercise forms.

4.6. Suggestions for future research

We suggest that future studies investigating exercise addiction set minimum criteria for the exercise history, exercise volume, and take into consideration the forms of exercise, including recreational and competitive (Szabo et al., 2013), team and individual (Kovacsik et al., 2018), and as observed in the current work (examining recreational and individual exercisers), aerobic and anaerobic. Further, given that it is often difficult to recruit a sufficient number of participants for obtaining adequate statistical power in online studies, we suggest using personal recruitment at gyms or fitness centers (i.e., bodybuilding) and public street races (i.e., running) by employing systematic randomization. Studying eating behaviors during missed exercise sessions is also warranted based on the current results. Finally, control for the 'purity' of the form (i.e., aerobic or anaerobic) of the exercise is also recommended.

4.7. Limitations

The present study has certain limitations. The first is the reliance on a voluntary sample from the Internet, including responders who provided anonymous responses for which, here and in general, the experimenters have no control. The second is the large imbalance between male and female respondents, which is a general problem in online inquiries (Saleh & Bista, 2017). The third is the imbalance in sample size between aerobic and anaerobic exercisers, that along with the gender inequality yielded too small cell sizes for adopting multivariate data analyses. The fourth is the relatively low sample size (despite > 10 participants per observation) that we attribute to the inclusion criteria being strict on exercise frequency and exercise history. Last, the lack of control over the participants' exercise form, because aerobic exercisers may perform anaerobic exercises too and vice versa, also calls for the careful interpretation of the results.

5. Conclusions

The current study suggests that the prevalence of the REA is not different in aerobic and anaerobic exercisers. These groups do not differ in the tendency of five symptoms above those contained within the components model of addiction, such as exercising when ill, missing social engagements because of exercise, eating disorderly when exercise is not possible, staleness and perceived adequacy of exercise volume. While no gender differences were observed in the risk of exercise addiction, women in the anaerobic group reported eating more disorderly when they miss their exercise than men in the same group. These gender differences did not emerge in the aerobic group. The relationship of the studied symptoms with the risk of exercise addiction was small but consistent in both aerobic and anaerobic groups, and, therefore they can be considered, as associated symptoms that could possibly expand the components model of exercise addiction.

6. Funding statement

No financial support was received for this study.

7. Data availability

The data on which this report is based is available at the Mendeley data repository: https://doi.org/10.17632/tj2gnv2ygy.1.

8. Ethical clearance

Ethical permission for the study was obtained from the Research Ethics Committee of the Faculty of Education and Psychology at ELTE Eötvös Loránd University (Permission number: 2020/477).

Author contribution

VP set up the study, took a leading role in the design of the study, and collected the data; RK searched the literature and performed a part of the data analyses; AS carried out most of the data analyses and wrote up the report.

CRediT authorship contribution statement

Viktória Pálfi: Conceptualization, Methodology, Software. **Rita Kovacsik:** Data curation, Investigation, Software. **Attila Szabo:** Data curation, Writing - original draft, Supervision.

Declaration of Competing Interest

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

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