



Exercise dependence and orthorexia nervosa in Crossfit: exploring the role of perfectionism

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Accepted: 29 July 2022

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Abstract

Physical exercise and healthy diet have a positive effect on health. However, the pathological dimension of both behaviors, namely exercise dependence and orthorexia nervosa, can lead to negative results. So far, literature on these behaviors in the context of high-intensity sports is limited. The present study aims for investigating exercise dependence and orthorexia nervosa in a sample of Crossfit athletes, as well as examining the mediating role of perfectionism in their manifestation. The sample consisted of 110 people who attended Crossfit programs and 131 active gym members. The Exercise Dependence Scale was used to assess exercise dependence, the ORTO-15 to assess orthorexic behavior and the Almost Perfect Scale to evaluate perfectionism. 19.8% of crossfitters and 3.8% of gym members were at risk for exercise dependence. 11.7% of participants in the Crossfit group and 10% of participants in the control group had orthorexic symptoms. An association was found between the scores on the two behaviors. In addition, the dimension of perfectionism high standards predicted obligatory exercise and orthorexia nervosa, while the dimension of discrepancy predicted only exercise dependence. The study suggests that exercise dependence is more evident in Crossfit compared to gym athletes and may be accompanied by orthorexic symptoms. Orthorexia nervosa is a noticeable phenomenon in the population of active exercisers. Perfectionism is a risk factor for obligatory exercise and orthorexia. A more demanding selection of target populations is encouraged in order to better understand exercise dependence, orthorexia nervosa and their personality background.

Keywords Exercise dependence · Orthorexia nervosa · Perfectionism · Crossfit

Exercise dependence

In modern western societies, according to the prevailing model of “healthy individual”, the maintenance of optimal levels of physical and mental health through exercise and healthy eating leads to social recognition and reward (Lee & MacDonald, 2010). The effect of moderate exercise on the prevention of physical illnesses (Moore et al., 2016) and mood improvement (Gucciardi et al., 2020) is well documented. However, exercise can become an unhealthy obsession (Veale, 1987). The theoretical model for understanding exercise dependence based on the DSM IV diagnostic criteria for substance use disorders [American

Psychiatric Association (APA), 2000] has been proposed since 2002. Exercise addiction is described as the dedication of extreme time in warming up, training and cooling down after exercise against other daily activities, which is accompanied by elevated exercise intensity and duration as well as loss of control (Hausenblas & Downs, 2002). In addition, engaging in training despite being injured and expressing psychological discomfort in the absence of exercise have been confirmed as dependence symptoms (Hausenblas et al., 2017). The above mentioned clinical presentation of exercise dependence is often studied as a symptom of eating disorders (secondary exercise addiction) (Scharmer et al., 2020). Nevertheless, in primary exercise dependence continuous training and strict diet plans aim mainly at improving physical fitness, and increasing physical performance (Hall et al., 2009).

Exercise dependence has not been officially recognized as a mental disorder; still it is considered to fall into the category of behavioral addictions, which is a new subcategory of addictive disorders in medical classifications (Nogueira et

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al., 2018). So far, only gambling disorder has been included in DSM-5 [American Psychiatric Association (APA), 2013] and in the 11th revision of the International Classification of Mental Disorders (ICD-11) [World Health Organization (WHO), 2018]. Commitment to excessive physical activity occurs in the general population at a rate of 0.3–3.3% (Meulemans et al., 2014; Monok et al., 2012), highlighting that this is a behavior with relatively low prevalence. In contrast, 17% of amateur cyclists (Mayolas-Pi et al., 2016) and 6.8% of gym members (Lichtenstein et al., 2017) were found to be at risk for exercise dependence. Uncontrollable exercise behavior has been proved harmful to physical health (Di Lodovico et al., 2018), while it has been associated with the onset of depressive symptoms (Levit et al., 2018) and impaired social functioning (Hausenblas et al., 2017).

Orthorexia nervosa

Healthy eating is considered to be an environmental protective factor for physical health (Sofi et al., 2008) and is involved in maintaining psychological well-being through stress reduction mechanisms (Lakhan & Vieira, 2008). The term “orthorexia nervosa” was introduced by American physicist Steven Bratman, who, by referring to “health food junkies”, described a condition where an individual is obsessed with healthy eating in order to avoid physical harm and disease (Bratman & Knight, 2000). Despite the lack of official recognition as a distinct mental disorder (Abdullah et al., 2020), researchers have suggested that the symptomatology of orthorexia nervosa includes mental and behavioral preoccupation with selection and preparation of meals, exaggerated concern about health issues and anxiety in case of violation of self-imposed dietary rules (Dunn & Bratman, 2016) and avoidance of social events, that include eating (Cheshire, Berry, & Fixsen, 2020). Orthorexia nervosa’s main difference from anorexia nervosa and bulimia nervosa is that the emphasis is put on the quality of food rather than quantity and the ultimate goal is physical well-being rather than weight loss (Varga et al., 2013).

Prevalence rates of orthorexia nervosa in the general population range from 1–28.3% depending on the psychometric tool (Dunn et al., 2017; Plichta & Jezewska-Zychowicz, 2019). However, 51.8% of regular exercisers (Almeida et al., 2018) and 27.7% of fitness athletes (Bona et al., 2019) have reported orthorexic symptoms. Orthorexia nervosa has been associated with increased feelings of anxiety and depression (Douma et al., 2021).

Exercise dependence and orthorexia nervosa

Literature on the relationship between exercise dependence and orthorexia nervosa is limited. Indicatively, Oberle and Lipschuetz (2018) argued that orthorexia is positively correlated with increased perceived muscle strength. At the same time, Rudolph (2018) found that 10.2% of 1,008 regular exercisers were at risk for exercise dependence and 3.4% of them also had orthorexic symptoms. Based on this finding, she assumed that these are probably comorbid behaviors. In line with these findings, White et al. (2020) revealed a strong association between dysfunctional exercise behaviors and orthorexia symptoms in men, deducing that it may be driven by social pressure to attain a healthy body. Researchers highlighted the positive relation between frequency and duration of exercise and orthorexic behaviors (Almeida et al., 2018; Oberle et al., 2018). Finally, personal trainers, who participated in the qualitative study of Haman et al. (2017), mentioned that some exercisers especially in fitness sports exhibit these behaviors concurrently and find it difficult to balance eating and exercise in a healthy way. Nevertheless, they express uncertainty about how to discern the border between healthy and unhealthy exercise and eating attitudes, given the societal health ideals.

Perfectionism

Perfectionism is a personality trait that can be described as a “double-edged sword” (Stoeber, 2014). According to the dominant model of perfectionism, it consists of two factors: (a) striving for perfectionism, namely setting high standards of performance and (b) perfectionistic concerns, which are associated with the sense of discrepancy between performance and goal, self-criticism and constant doubts about the way of acting (Stoeber et al., 2020). An individual with maladaptive perfectionism sets high goals, but when he/she fulfils them, they are replaced with even higher unrealistic ones, as the previous ones are now considered as not demanding enough. When the new goals are achieved, they are underestimated again or the individual feels that high praise is not deserved (Lo & Abbott, 2013). Therefore, negative self-evaluation increases. Perfectionistic tendencies are presented as a desirable trait of individuals in modern society, where competition is favoured. Curran and Hill (2019) found a linear increase in perfectionism in USA and Europe, while Stoeber and Stoeber (2009) argued that perfectionism is expressed in most areas of life, such as work, academic studies and other important to the individual activities such as sports. Based on these findings, researchers have focused on studying the role of perfectionism on mental health.

Perfectionism and exercise dependence

The trait of perfectionism does not appear to be involved in the development of substance use behaviors. On the contrary, it plays a key role on exercise dependence. Costa et al. (2016) found that maladaptive perfectionism was associated with symptoms of deprivation, loss of control, withdrawal and reduced time devotion to other activities in 169 Italian regular exercisers. This finding confirms the suggestion of Taranis and Meyer (2010), according to which perfectionistic concerns are the primary indicator of exercise dependence. This can be explained by the fact that rumination about perceived insufficiency leads to psychological deficit and, then, to excessive effort as a means of compensating for it (Hall, 2006). On the other hand, a recent systematic review of Cakın et al. (2021), which included 22 studies, conducted in general population and amateur athletes (mainly runners), showed that exercise dependence is moderately correlated with both dimensions of perfectionism.

Perfectionism and orthorexia nervosa

The involvement of perfectionism as a risk factor in the development of eating disorders is empirically documented (Bardone-Cone et al., 2007). The positive correlation between perfectionism and obsession with healthy eating practices in the general population has also been supported (Barnes & Caltabiano, 2017; Oberle, Samaghbeidi, & Hughes, 2017). According to Brown et al. (2012), perfectionists interpret experts' recommendations on healthy eating rigidly and adhere to strict dietary rules. In fact, it seems that high personal standards are related both to the process of eating (selection of raw materials, adherence to dietary rules) and to the achievement of physical well-being (Barnes & Caltabiano, 2017). However, Bartel et al. (2020) suggested that the strength of the relationship between perfectionism and orthorexia nervosa is weaker when compared with the one between eating disorders and perfectionism.

Crossfit

Crossfit is the second most popular fitness trend in global level (Thompson, 2019). It is defined as constantly high-intensity interval training, which aims at the acquisition of physical skills, namely speed, endurance, flexibility, agility, muscular strength, balance and coordination, so that the individual is able to face daily physical challenges to the maximum extent (Waryasz et al., 2016). It endorses muscularity ideal for both sexes (Dawson, 2017). The athlete performs aerobic and resistance exercises striving either for

the best time or the maximum number of repetitions of each exercise. Training is structured in a way that everyone can participate regardless of their fitness level and takes place in the box, where advanced athletes and beginners workout together with shared music, so that autonomy can be avoided (Fisher et al., 2016). Based on this framework, coaches aim for creating a competitive and socially supportive environment. Subsequently, exercisers go after the recognition of their progress by the team and the acquisition of a high performance-based position within it (Fisher et al., 2016). Thus, the philosophy of Crossfit training lies in the active commitment of the population to exercise and the strong sense of belonging. Indeed, crossfitters, who participated in a recent study, reported that Crossfit training not only helped them change their perceptions about their fitness, but it also influenced their commitment towards their overall health status (Simpson et al., 2017). It is worth mentioning that Crossfit coaches encourage athletes to follow a healthy diet plan, which contains high quality protein foods, as well as food rich in fat and carbohydrates, but in a more restrictive degree and especially before a workout. The criterion for dietary behaviors is considered to be the effectiveness of training (Gogojewicz et al., 2020). Literature supports that Crossfit training offers high psychological satisfaction (Heinrich et al., 2014) and improves body composition, cardiorespiratory endurance and muscular strength (Gianzina & Kassotaki, 2019). On the other hand, there are indications for increased risk of injury usually in the anatomical area of the shoulders and back (Sprey et al., 2016).

Present study

Based on the existing literature presented above, the study aims for examining exercise dependence and orthorexia nervosa symptomatology in Crossfit athletes, as well as the relationship between perfectionism and these behaviors. In line with the above it was hypothesized that (a) the Crossfit group would present more exercise addictive behaviors and orthorexic symptoms compared to a personal gym workout program group, (b) exercise dependence would be positively correlated with orthorexia nervosa and (c) perfectionism would predict exercise dependence and orthorexia.

Method

Participants and procedure

The study included 241 individuals, 130 (53.9%) of them were gym members and 111 (46.1%) were regular crossfitters. 51.5% of the participants were male and their mean

age was 26.3 years. Criteria for inclusion in the study were training at least twice a week, age (18–35 years) and training regularly for at least six months before quarantine due to Covid-19 pandemic and two months after its termination. The data collection was conducted digitally from September to November 2020 and participants were approached through social media groups about exercise and nutrition. Permission to conduct the research was obtained by the Ethics Committee of the 1st Department of Psychiatry of National and Kapodistrian University of Athens. There was no payment or other incentive to complete the questionnaires.

Measures

Exercise Dependence The Exercise Dependence Scale-Revised (EDS-R; Downs et al., 2004) was used to assess the symptoms of exercise dependence. It is comprised of 21 sentences formulated in a six-point likert scale, which are divided into 7 subscales: tolerance, withdrawal, lack of control, time, reductions in other activities, continuance and intention effect. The scale categorizes participants into at-risk for exercise dependence, nondependent-symptomatic or nondependent-asymptomatic groups. The categorization is generated by a scoring manual that consists of flowchart decision rules, in which items or combinations of items determine if an individual would be classified in each range on each of the 7 subscales. The dependent range is operationalized as indicating a score of 5 or 6 for that item. The scale has been adapted and translated in Greek showing good psychometric properties (Parastatidou et al., 2012). In the present study the internal consistency of the scale was $a=0.78$.

Orthorexia Nervosa The ORTO-15 scale (Donini et al., 2005) assesses the presence of orthorexia nervosa symptoms. It consists of 15 sentences, which focus on behaviors of selection, acquisition, preparation and consumption of food and receive a score from 1 (indication of orthorexia nervosa) to 4 (non disturbed eating behavior). The adaptation and translation of the scale was performed by Gonidakis et al. (2020) exhibiting good psychometric properties. In our sample, the reliability of the scale was $a=0.81$. According to the authors, a total score of < 30 is indicative of orthorexia nervosa symptoms in the Greek population.

Perfectionism The Almost Perfect Scale (APS; Slaney et al., 2001) evaluates perfectionistic tendencies. It is comprised of 23 sentences, which correspond to 3 subscales: High standards, Order and Discrepancy. The rating in the subscale of high standards distinguishes an individual as a perfectionist or not. The rating in the subscale of discrepancy refers

to adaptive and maladaptive perfectionism. The sentences are formulated in a five-point likert scale. It is adapted and translated in Greek showing good psychometric properties by Diamantopoulou and Platsidou (2014). In our sample, the internal consistency was $a=0.87$ for Discrepancy subscale and $a=0.75$ for High Standards subscale.

Demographics A demographic questionnaire was completed to collect information regarding the age, gender, educational and professional level and workout features; namely main type of exercise, months of continuous exercise, frequency, duration and exercise during Covid-19 quarantine.

Data analysis

T-test for independent samples was used for the comparison of quantitative variables between the two groups. Analysis of variance (ANOVA) was used to compare quantitative variables among more than two groups. The normality of the distributions was verified through Kolmogorov-Smirnov test. Due to multiple comparisons, Bonferroni correction was used to check type I error. Significance level was $0.05/k$ (k =number of comparisons). The strength and direction of the relationship between the variables were examined through Pearson correlation. Multiple linear regression analysis was used to assess which variables predict independently the outcome variables (scoring on ORTO-15 scale and exercise dependence scale). It was calculated that with the sample size of 241 patients in total, the study would have 85% power to detect a mean difference between the groups with an effect size of 0.4 or more. Significance levels are bilateral and statistical significance was set at 0.05. The SPSS (Statistical Package for Social Sciences, version 22.0) was used for data analysis.

Results

Sociodemographic characteristics of the participants

130 (53.9%) of the participants were gym members and 111 (46.1%) were regular crossfitters. 51.5% of the participants were male and the mean age was 26.3 years. The Cross-fit group ($M=28.41$, $SD=4.78$) was older compared to the gym group ($M=24.58$, $SD=4.51$). This difference in age was statistically significant ($t(241)=-6.361$, $p<0.001$, effect size=0.88). Regarding educational and professional level, 34% of the participants were high school graduates and 41.1% were unemployed/ students and these percentages

Table 1 T-test among exercise groups

Variables		Mean	SD	t	Effect size	p
Exercise dependence	Gym	61.4	16.9	1.988	0.25	<0.05
	Crossfit	66.1	19.6			
Orthorexia nervosa	Gym	34.3	4.2	0.237	0.02	ns
	Crossfit	34.4	4.1			
High standards	Gym	29.2	3.9	1.148	0.16	ns
	Crossfit	29.8	3.5			
Discrepancy	Gym	33.8	11.1	-0.043	0.0	ns
	Crossfit	33.8	12.8			

were higher in the group of individuals, who chose personal training as their main way of exercising [$(\chi^2(2)=11.34, p<0.05, \text{effect size}=0.22)$ and $(\chi^2(3)=18.29, p<0.001, \text{effect size}=0.26)$ respectively]. Cramér's V measurement was used to calculate the effect sizes. In terms of exercise features, 45.2% of participants had been exercising for more than 3 consecutive years before the imposition of lock down due to Covid-19 pandemic, while 44% of them continued to workout in parks or at home during lock down 3–4 times a week. In the last seven days, the average training duration was 75.9 min (SD = 32.1) and the average exercise frequency was 4.4 times (SD = 1.3).

Differences between exercise groups regarding exercise dependence, orthorexia nervosa and perfectionism

The investigation of possible differences between the two groups in terms of exercise dependence, orthorexia nervosa and perfectionism was conducted through t-test for independent samples (Table 1). No statistically significant results were observed, apart from the exercise dependence scale, in which crossfitters scored higher (M = 66.06, SD = 19.55) than gym members (M = 61.39, SD = 16.92) in a significant level ($t(241)=1.988, p<0.05, \text{effect size}=0.25$). In addition, 3.8% of gym members and 19.8% of crossfitters were at risk for exercise dependence. The difference between the two groups was statistically significant ($\chi^2(2)=15.50, p<0.001, \text{effect size}=0.27$). A point of interest is that, after the implementation of Bonferroni post hoc test, the symptoms of obligatory exercise were more pronounced in individuals, who used to workout more than 5 times a week compared to those, who used to exercise 1–4 times, at a significant level $F(2,238)=3.92, p<0.05, \eta^2=0.03$. At the same time, keeping in mind that a cut-off point of 30 was used in ORTO-15 scale, it was revealed that 10% of gym members and 11.7% of crossfitters had orthorexic symptoms. There was no significant difference between the two groups ($\chi^2(1)=0.93, \text{ns}$).

Table 2 Pearson r correlations among study variables

Variables	1	2	3	4
1.Exercise dependence	1	-0.20*	0.27**	0.41*
2.Orthorexia		1	-0.14*	-0.07
3.High standards			1	0.17*
4.Discrepancy				1

* $p<0.05$, ** $p<0.001$

Correlations

Pearson r correlations among variables for the total sample are presented in Table 2. Specifically, exercise dependence was found to be negatively correlated to orthorexia nervosa scoring and positively correlated to perfectionism high standards and discrepancy. Orthorexia scoring was negatively, but weakly, correlated to perfectionism high standards. No statistically significant correlation was observed between orthorexia nervosa and discrepancy. Pearson r correlations were also calculated for each group separately; however the majority of them were not statistically significant due to the reduction of the sample.

Predictive factors of exercise dependence

Consequently, multiple linear regression analysis was applied in order to examine the research hypothesis that the dimensions of perfectionism will predict exercise dependence and orthorexia nervosa symptoms. The latter variables were set as dependent variables in two distinct regression models. Demographics, type of exercise, exercise features, high standards and discrepancy were entered as independent variables. Table 3 shows the linear regression model in respect to exercise dependence variable. Specifically, the type of exercise was found to predict exercise dependence in a statistically significant level ($B=4.02, SE=2.20, p<0.05$). Similarly, exercise frequency ($B=2.93, SE=0.89, p<0.001$) and exercise duration ($B=0.12, SE=0.03, p<0.001$) appear to predict independently the outcome variable. Finally, it was found that perfectionism subscales, namely discrepancy ($B=0.64, SE=0.12, p<0.001$) and high standards ($B=0.85, SE=0.28, p<0.05$) have predictive power. The above variables explain 33% of the total variance of exercise

Table 3 Summary of multiple hierarchical regression for exercise dependence predictors

		B	SE	p
Gender	Male (control)			
	Female	0.21	2.20	0.925
Age		0.12	0.29	0.676
Education	High school (control)			
	Bachelor	-1.89	2.47	0.447
	Master/Doctorate	-1.25	3.34	0.708
Job	No (control)			
	Yes	-0.02	2.65	0.995
Exercise group	Gym (control)			
	Crossfit	4.02	2.01	0.036
Months of continuous exercise	6–12 (control)			
	12–36	0.31	2.89	0.915
	> 36	0.69	2.42	0.777
Exercise during Covid-19 quarantine (times per week)	> 5 times (control)			
	None	-1.80	4.73	0.704
	1–4 times	-2.44	2.32	0.294
Exercise frequency		2.93	0.89	0.001
Exercise duration		0.12	0.03	<0.001
Discrepancy		0.64	0.12	<0.001
High standards		0.85	0.28	0.003

Table 4 Summary of multiple hierarchical regression for orthorexia nervosa predictors

		B	SE	p
Gender	Male (control)			
	Female	1.14	0.58	0.033
Age		0.01	0.08	0.915
Education	High school (control)			
	Bachelor	0.45	0.65	0.488
	Master/Doctorate	-0.27	0.88	0.763
Job	No (control)			
	Yes	0.98	0.70	0.161
Exercise group	Gym (control)			
	Crossfit	0.18	0.59	0.759
Months of continuous exercise	6–12 (control)			
	12–36	-0.44	0.76	0.565
	> 36	-0.81	0.64	0.204
Exercise during Covid-19 quarantine (times per week)	> 5 times (control)			
	None	-0.12	1.25	0.924
	1–4 times	0.68	0.61	0.264
Exercise frequency		-0.24	0.23	0.314
Exercise duration		-0.01	0.01	0.411
Discrepancy		-0.03	0.03	0.346
High standards		-0.14	0.07	0.011

dependence variable ($R^2=0.33$, $F(15,225)=7.43$, $p<0.01$). The interaction between the APS scale and the type of exercise was examined and it was not significant; thus the effect of discrepancy and high standards subscales is the same in both exercise groups.

Predictive factors of orthorexia nervosa

Table 4 shows the linear regression model in respect to orthorexia nervosa variable. Gender was found to predict in a statistically significant level the scoring in ORTO-15 scale ($B=1.14$, $SE=0.58$, $p<0.05$). It was revealed that men were more likely to express orthorexic behaviors compared to women. In addition, high standards predict independently the outcome variable ($B=-0.14$, $SE=0.07$, $p<0.05$). Gender and high standards subscale interpret 9% of the total variance of orthorexia nervosa variable ($R^2=0.09$, $F(15,225)=1.56$, $p<0.05$).

Discussion

Recent studies have suggested the investigation of exercise dependence among athletes populations and individuals, who workout in non-competitive environments, including gym (Di Lodovico et al., 2019). At the same time, the growing literature on orthorexia nervosa highlights the need for studies in high-risk populations, such as amateur athletes, given the social promotion of the ideal of “healthy individual” (Kiss-Leizer et al., 2019). Taking into account the existing literature, the present study is the first attempt to investigate exercise dependence and orthorexia nervosa in Crossfit athletes compared to gym exercisers. We found that 19.8% of Crossfit athletes and 3.8% of individuals, who workout at the gym, were at risk for exercise addiction. The type of exercise was a strong predictor of exercise dependence symptoms. This finding is consistent with previous research, according to which symptoms of addiction are more evident in high-intensity sports (Di Lodovico et al., 2018). Furthermore, it has been suggested that the workout environment may act as a trigger for obligatory exercise symptoms (Di Lodovico et al., 2019).

In addition, we found that 10% of individuals in the gym training group and 11.7% of individuals, who follow a Crossfit workout program, had orthorexic behaviors. In the study of Gonidakis et al. (2020) the rate of orthorexia nervosa was found to be 2.5% in Greek students. A cut-off point of 30 at ORTO-15 questionnaire was used. The recognition of regular exercisers as a group vulnerable to orthorexic behaviors is empirically supported (Bona et al., 2019). Nevertheless, the present study failed to show that orthorexia nervosa is more pronounced in Crossfit, possibly due to the fact that the two groups has similar exercise parameters, such as months of training and exercise duration.

At the same time, it was found that exercise dependence symptoms were positively, but weakly, correlated with the appearance of orthorexia nervosa symptoms in the whole sample. The coexistence of these pathological behaviors has been underpinned by previous research and is attributed to

the social construction of the ideal of “health”, according to which every citizen has personal responsibility towards achieving physical well-being through healthy eating habits (increase in organic stores) and physical exercise (Oberle et al., 2018). In fact, Haman et al. (2015) introduced the term “fitness culture”, in which healthy diet is essential for maximum physical performance during workout.

Further to the findings mentioned above, we hypothesized that perfectionism would independently predict the onset of exercise dependence symptoms. The hypothesis was confirmed, as it was found that individuals, who set high personal standards and evaluate themselves in a strict way, exhibit escalating obligatory exercise behaviors. The two dimensions of perfectionism predicted exercise dependence. This finding is in line with the study of Hauck et al. (2020). In addition, the hypothesis that both dimensions of perfectionism will predict orthorexic symptoms was only narrowly verified in the case of high personal standards. This confirms the study of Barnes and Caltabiano (2017) in 220 individuals, who found that self-directed perfectionism is positively correlated with orthorexia nervosa. The weak character of the relationship has been argued in the existing literature (Bartel et al., 2020). This finding support the suggestion that the relationship between perfectionism and distorted eating is more profound in eating disorders that orthorexia nervosa (Dahlenburg et al., 2019). The knowledge of the role of individual differences in psychopathology can contribute to the improvement of prevention programs, as they will focus on vulnerable populations.

Moreover the study showed that exercise frequency and duration independently predict compulsory exercise along with the type of training and the dimensions of perfectionism. The finding that the more frequent and longer the workout, the more severe the symptoms of exercise addiction are, is empirically supported (Lichtenstein & Støvring, 2016). No gender differences were found in exercise commitment, although studies showed higher rates in men (Meulemans et al., 2014) or women (Weik & Hale, 2009). Ambiguous results are probably related to the use of different psychometric tools. With regard to orthorexia nervosa, there were significant gender differences. The present study in line with previous studies (Donini et al., 2004; Fidan et al., 2010) indicated that men had more orthorexic symptoms than women. This finding can be interpreted by bearing in mind the greater impact of social stereotypes about physical appearance in male population (Donini et al., 2004).

Limitations

The presence of anorexia or bulimia nervosa symptoms in participants was not assessed to rule the possibility of secondary exercise dependence. In addition, body image

disturbance, including concerns about weight or muscularity-oriented attitudes, was not evaluated in the participants. Another important limitation is the exclusive use of self-reported questionnaires, given the fact that individuals often create a narrative identity of themselves, which might not fully respond to reality (Zinbarg et al., 2008). The use of interview as a psychometric tool in combination with self-report questionnaires in future research could increase the reliability and validity of the present findings. The cross-sectional design of the study is also a limitation, as it does not permit the investigation of causal relationships between the variables. Finally, it should be noted that data collection took place between the two quarantines (from March to April 2020 and from October to May 2021) due to Covid-19 pandemic in Greece. The lack of available sports facilities under this social condition probably influenced individuals' exercise and eating behaviors.

Conclusion

The present study showed that exercise dependence symptoms are more pronounced in Crossfit athletes compared to active gym members and that orthorexia nervosa is a noteworthy phenomenon in the population of active exercisers. Raising the awareness of Crossfit coaches regarding the increased risk of developing exercise addictive and orthorexic behaviors can contribute to the early detection of symptoms among athletes. In addition, the knowledge of the possible comorbidity will be useful in the context of clinical evaluation by nutrition professionals. Overall, this research expands the current literature on exercise dependence and orthorexia nervosa aiming at their inclusion in diagnostic manuals of mental disorders. We strongly encourage future researchers to select specific target populations in order to gain a better understanding of these pathological behaviors and their personality background.

Data Availability The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest On behalf of all authors, the corresponding author states that there is no declaration of interest.

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