

## Exercise Addiction: A Narrative Review

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## ABSTRACT

This narrative review includes current research on the prevalence of exercise addiction as well as the positive and negative effects, the comorbidities, the risk factors/predictor variables for experiencing exercise addiction, potential underlying biological mechanisms for exercise addiction and interventions. The prevalence has varied from 2% to 18%. The positive effects of exercise have included reduction of cell phone addiction and drug addiction. Excessive exercise, in contrast, has negative effects including poor mental health and physical injuries. The comorbidities of exercise addiction include OCD, depression, and ADHD. The risks /predictors for exercise addiction that have been addressed in this literature include individual sports, restrained eating, perfectionism, body dissatisfaction, childhood trauma, and death anxiety. A few potential underlying biological mechanisms include elevated cortisol, brain alterations and genetic predispositions. The only interventions that appeared in this literature included treadmill training and rational emotive behavior therapy.

The prevalence of exercise addiction has ranged from 2% to 18% in studies in this current literature (see table 1). In a study entitled “Benefits, common risks, and gender differences in sport and exercise dependence” (N= 396, mean age =20) the Exercise Dependence Scale was administered [1]. In this sample, **2% of women and 3% of men** were considered at risk for exercise dependence whereas 31% of women and 48% of men were labeled non-dependent symptomatic. Alexithymia was a risk factor for exercise dependence, but only in men.

**Table 1: Prevalence of exercise addiction (and first authors).**

Prevalence	First Authors
2% for females, 3% for males	Manfredi
5%	Uriegus
6%	Zandonai
9%	Kalayasiri
17% for females, 11% for males	Garison
18%	Raikan
12%-18%	Thuany

In a study that addressed the association between exercise dependence and eating disorder risk in college student athletes, **5%** were at risk for exercise dependence (N= 1885) [2]. Those

who were at risk for exercise dependence had a greater risk for eating disorder. In this sample, 26% of the females were at risk for eating disorder while 16% of the males were at risk. These data were not surprising as exercise addiction and eating disorder have frequently been comorbid. As the authors suggested, exercise can be a compensatory behavior to achieve weight loss. However, excessive exercise can lead to eating disorders like anorexia nervosa.

In a study entitled “Predictive modeling links exercise dependence to associated psychological and behavioral risk factors”, **6%** were considered at risk for exercise dependence while 51% were labeled non— dependent symptomatic (N= 1099) [3]. Perfectionism was the greatest predictor followed by drive for thinness and muscularity. These results highlight the importance of including several risk factors in addiction studies and conducting regression analysis or structural equations analysis to determine their relative importance which in turn would suggest specific targets for intervention.

In research on a sample of adults from a sports center in Bangkok (N= 386, mean age = 28), **9%** had “full symptoms” of exercise addiction while 83% had “partial symptoms” [4]. Full and partial were not operationally defined. Males were at greater risk for exercise addiction, and the most negative effect was knee injuries.

Males often engage in more high intensity training related to motivations for muscularity and physique enhancement.

In a paper entitled “Compulsive exercise among college students”, the prevalence varied by gender with **11% being noted for males and 17% for females** (N= 8251 college students) [5]. In this sample, greater odds were noted for mental health issues and illicit drug use for both males and females and greater odds for alcohol use for females. In younger samples like this alcohol use is increasing faster among women.

In research on a sample of physical medicine and rehabilitation physicians, exercise addiction was a significant risk (N= 143, mean age= 37, 72% females) [6]. As many as **18%** were addicted based on the Exercise Addiction Scale and 64% were considered at risk for exercise addiction. These data are not surprising given that education for physical medicine and rehabilitation physicians emphasizes the importance of exercise for health.

The prevalence of exercise addiction was significant in a review of 11 studies (N= 3670) [7]. In this review, **12% to 18%** of the participants had exercise addiction. Several comorbidities were noted including that as many as 32% to 63% of the participants had eating disorders, 19% were depressed and 25% experienced sleep disturbances. In addition, significant correlations were noted between exercise addiction and performing exercise in an unstructured space as well as age and BMI (body mass index). An unstructured space likely refers to the paths of individual runners. Age was inversely related as might be expected given that exercise addiction is more prevalent in adolescents and young adults. The correlation between exercise addiction and BMI was not surprising as weight reduction has frequently been the motive for exercise.

**Effects of Exercise Addiction**

Exercise has been noted to have positive effects in several addiction studies, for example, in literature on cell phone addiction and research on drug addiction (see table 2). In a systematic review and meta-analysis, for example, aerobics exercise was the best form of **exercise to reduce mobile phone addiction** in adolescents [8].

**Table 2: Effects of exercise and exercise addiction (and first authors).**

Exercise Effects	First Authors
Decreases mobile phone addiction	Li
Decreases drug addiction	Abdullah
Exercise Addiction Effects	
Anxiety and insomnia	Wyszomirska
Physical injuries	Tomic
Knee injuries	Kalayasiri

In a paper entitled “Dopaminergic and glutamatergic biomarkers disruption in addiction and regulation by exercise”, **exercise reversed the damage of drug addiction** [9]. In the absence of longitudinal follow-up studies, it is unknown if exercise then became addictive for those individuals recovering from other addictions.

Despite the reduction in several addictions by exercise, excessive exercise can become addictive. Exercise addiction, in turn, can lead to mental health problems and physical injuries.

In a study entitled “Exercise addiction symptoms and mental health”, exercise addiction symptoms were noted following deprivation of exercise during COVID-19 in Poland [10]. In this sample (N= 391, age range= 18–68), the Exercise Dependence Scale was given following restricted routine physical training. Exercise addiction explained as much as 27 to 45% of the variance in mental health symptoms. The mental health symptoms included **anxiety and insomnia**.

Physical injuries were noted in a study on running addiction in Croatia (N=644, age range =18 to 75, mean age =42) [11]. In this sample, five was the mean number of years the participants had been running. The risk of running addiction was positively associated with the use of dietary supplements and the frequency of injuries. Runners might be expected to have knee injuries. Knee injuries were also noted in the sample from the Sports Center in Bangkok already described [4].

**Comorbidities of Exercise Addiction**

Several comorbidities have been noted for exercise addiction (see table 3). They include OCD, depression, ADHD, multiple comorbidities and mental health in general.

**Table 3: Comorbidities of exercise addiction (and first authors).**

Comorbidities	First Authors
OCD, Major deression	Meyer
Eating disorders	Cosh, Remilly
ADHD	Ramji
OCD, depression, stress	Wang

In a current study on the stability of exercise addiction symptoms and co-occurring mental disorders, the most prevalent comorbidity was **OCD (obsessive compulsive disorder)** [12]. The relationship between exercise addiction and OCD was not surprising as exercise addiction is a type of obsessive-compulsive disorder. **Major depression disorder** also appeared as a comorbidity of exercise addiction which was also not surprising as major depression and OCD are frequently comorbid. However, these data are not definitive as this was a small sample (N=19).

In a much larger sample (N=281 adults with mental health symptoms), compulsive exercise was not related to OCD after adjusting for eating disorder symptoms [13]. However, these data are also tenuous given that the sample was limited to adults with mental health symptoms, suggesting that the data may not generalize to samples of healthy individuals. Depression, as has already been noted, was a comorbidity along with OCD in the stability of exercise addiction symptoms study [12].

**ADHD (attention deficit hyperactivity disorder)** has also been comorbid with exercise dependence in a sample of adults with ADHD (N=114). [14]. The comorbidity of ADHD and exercise dependence is not surprising as exercise would be considered an

attempt to cope with hyperactivity and may become excessive depending on the severity of ADHD. In this study, 39% were labeled symptomatic non-dependent exercisers. This research group also addressed overuse injuries in this sample.

Several comorbidities were noted in a systematic review and meta-analysis of 79 studies (N= 40,329) [15]. In this meta-analysis, exercise addiction was moderately associated with **OCD, depression and stress**. Smaller associations were noted with body image disturbance, anxiety, and emotional dysregulation. As might be expected, greater exercise levels increased the association between exercise addiction and anxiety, depression and OCD.

**Eating disorders and neuroticism** have also been associated with exercise dependence in ultra endurance athletes (N= 507) [16]. Not surprisingly, as many as 72% of this sample were considered symptomatic for exercise dependence.

### Risk Factors/Predictors of Exercise Addiction

Several risk factors/predictors have been noted for exercise addiction in this current literature (see table 3). They include engaging in individual sports, restrained eating, perfectionism, body dissatisfaction, childhood trauma, and death anxiety.

**Engaging in individual sports** versus collective and two person sports has been a greater risk factor for exercise addiction [17]. Individuals would have more opportunities for engaging in individual sports both with respect to frequency and duration and thereby would be more vulnerable to exercise addiction. In this sample (N=1986), engaging in collective sports was a risk factor for alcohol use disorder. This relationship may derive from collective sports groups often engaging in celebratory drinking following a win or depressive drinking following a loss.

**Restrained eating** has been a risk factor for exercise addiction in a sample of Chinese university students (N=1575) [18]. Restrained eating and exercise are often simultaneously motivated by the desire for weight loss. This relationship was mediated by both a positive factor labeled grit and social anxiety as a negative factor. Those mediators are plausible although mediators are more frequently in the same direction rather than in opposite directions as in positive and negative.

**Perfectionism** has been a predictor variable in at least two studies in this current literature. In research already summarized, perfectionism was the primary predictor of exercise dependence followed by a drive for thinness and muscularity [3]. This is an excellent example of how regression results can inform the relative importance of risk factors and specific targets for intervention.

In another sample (N=149 females with anorexia nervosa), perfectionism predicted compulsive exercise which in turn predicted eating disorder pathology [19]. This sequence is plausible although it is retrospective as this was not a longitudinal study, and the sample already had an eating disorder.

In another study on compulsive exercise and eating disorder symptoms (N=591 university students), the Compulsive Exercise Test was administered along with the Eating Pathology

Symptoms Inventory [20]. Females were noted to engage in more weight control exercise, to lack exercise enjoyment, to experience body dissatisfaction, and to engage in purging behavior. These problems were associated with their eating pathology symptoms. The greater prevalence of these symptoms in females was not surprising as eating disorders are more prevalent in females.

In a systematic review and meta-analysis entitled “Body image risk of exercise addiction in adults”, the results are in the title [21]. In this meta-analysis of 38 studies, **body image** was a primary risk factor for exercise addiction. The exercise that was intended to improve body type and thereby body image became excessive and likely resulted in psychological and physical problems in many of these studies.

In a study entitled “How early family experiences shape exercise addiction” (N= 960 college students in China), **early childhood trauma** was the primary self-reported “cause” [22]. The early childhood trauma was said to lead to emotional dysregulation and distorted body image which in turn led to exercise addiction. Again, these data are based on retrospective, self-report data. Although “faking good” has frequently been attributed to positive self-reports, a similar phenomenon of remembering negative events from early childhood has not been described. Having a negative condition like exercise addiction has not surprisingly been attributed to early negative events.

Multiple risk factors/predictors were cited in a couple papers. In one study entitled, “Passion, perfectionism, and sports commitment as predictors of exercise addiction”, the results are given in the title [23]. In this study (N=1003 regular exercisers, mean age =32), the authors elaborated on those predictors as **exercise volume and intensity**, harmonious and obsessive passion, rigid perfectionism, and constrained commitment, which together explained 43% of the variance in exercise addiction. Although exercise volume and intensity could be easily operationalized, they have typically not been measured. The other descriptors (harmonious, rigid and constrained) would be difficult to operationalize.

In a review of 15 studies on exercise addiction, several predictable risk factors were consistently noted [24]. Exercise addiction was related to perfectionism, **body dissatisfaction, depression and OCD**, consistent with the previously described, more recently published individual studies.

**Death anxiety** has also been a predictor variable of exercise addiction. In a paper entitled “Exercise addiction in older adults: health preservation or fear of death? ”, older adults completed a survey about exercise addiction (N=254 adults 65+ years) [25]. Death anxiety was greater in the exercise addicted group. The addicted group also had less health anxiety and greater health – protective behavior which was counter-intuitive relative to their greater death anxiety as more health anxiety instead of less health anxiety and less health-protective behavior would be expected to lead to more death anxiety.

### Potential Underlying Biological Mechanisms for Exercise Addiction

Surprisingly, given the severity of exercise addiction, only

two papers in this current literature were focused on potential underlying biological mechanisms for exercise addiction (see table 4). They included studies on brain alterations and genetics.

**Table 4: Risk Factors/Predictors (and first authors).**

Risk Factors/Predictors	First Authors
Individual sports	Vansteene
Restrained eating	Pan, White
Perfectionism	Zandonai, Cresswell, Chabbra
Body image	Guo, Minutillo
Early childhood trauma	Zhang
Sports commitment	Chabbra
Depression and OCD	Minutillo
Death anxiety	Surenkok

The brain alterations data were based on a multimodal neuroimaging investigation [26]. The authors noted **greater connectivity from the right inferior frontal gyrus to the right superior parietal lobule**. They referred to these as alterations in cognition-related brain structures and functional changes that may drive compulsive habitual behavior. These conclusions may be considered tenuous given that fMRIs typically identify regions that are currently activated, but without repeated fMRIs longitudinally, alterations in structures and functional changes cannot be concluded.

Genetic analyses were conducted by another research group on oral swab samples provided by athletes and non-athletes (N= 469) [27]. The results of the analyses are given in the title of their paper “Association of DRD2 and BDNF genetic polymorphisms with exercise addiction”. The **DRD2 gene** is involved in regulating dopamine, an activating neurotransmitter, and **BDNF (brain-derived neurotrophic factor)** promotes the growth of neurons involved in learning and memory. Although these complex polymorphism data are based on current oral swab samples, the genetic analyses imply that the genetic makeup of athletes and non-athletes is different.

**Interventions for Exercise Addiction**

Only two interventions appeared in this literature on exercise addiction (see table 5). They included a study on rational emotive behavior therapy and a study that involved physical training.

**Table 5: Potential underlying biological mechanisms (and first authors).**

Mechanisms	First Authors
>connectivity right frontal gyrus to right parietal lobule	Schaub
DRD2 and BDNF genes	Moreira da Silva

In the study on **rational emotive behavior therapy** (that focuses on identifying and replacing self-defeating thoughts with healthier, rational beliefs), the therapy decreased exercise addiction symptoms [28]. These data would imply a “mind over matter’ effect.

The other intervention involved two months of **treadmill**

**exercise training**, 20 minutes per day for three days per week (N= 90) [29]. By the 24th session, those who received the treadmill exercise program showed a decrease in cortisol levels and an increase in beta – endorphin levels. The underlying mechanism is not clear for these surprising physiological effects of treadmill exercise training reducing an exercise addiction. A possible interpretation is that lower levels of cortisol and higher levels of beta-endorphins are associated with treadmill exercise rather than with the addictive exercise. It’s also possible that the treadmill exercising then became addictive.

**Methodological Limitations of this Literature**

Several methodological limitations can be noted for this current literature on exercise addiction. They include sampling problems, self-report measures, different types of exercise, and limited data analyses.

Exercise is most frequently noted as having positive effects on physical and mental health including the reduction of various addictions. Ironically, when exercise becomes excessive, it itself can become an addiction and then is viewed as having the negative effects that have been reviewed here.

Exercise addiction has been labeled different terms including addictive, dependent, excessive, and compulsive. The definitions of exercise addiction or exercise dependence have varied based on different scales, not the frequency and intensity of exercise based on more objective measures like actigraphy. Several different scales have been used including the Negative Addiction Scale, the Exercise Dependence Scale, the Compulsive Exercise Test, and the Exercise Addiction Scale. These scales yield different kinds of samples that then cannot be compared.

Based on these scales the participants have been labeled addictive, symptomatic non-dependent or non-addictive. Minimal demographic data appear on the participants except gender data which has been mixed with some studies reporting greater exercise addiction in women and others suggesting it occurs more often in men

This current literature has focused primarily on prevalence and risk data. The prevalence rates have been highly variable, ranging from 2% to 18%. The risk factors related to exercise addiction have also been highly variable. Some have seemingly been theoretically and empirically based like body dissatisfaction and perfectionism, but others seem to be arbitrarily selected like death anxiety in an old people sample. Only a few researchers focused on multiple risk factors, but then their relative significance was not determined, for example by regression analysis or structural equation modeling

Different types of exercise have appeared in this literature. They vary from treadmill to running to aerobics to engaging in sports. These forms of exercise have not been compared in this literature. The different forms of exercise seemingly would have different degrees of risk for exercise addiction. For example, individual forms of exercise like running have been more vulnerable to addiction than team sports that occur less often and have time and intensity limits.

Surprisingly, only two negative effects of exercise addiction were the focus of studies in this current literature, including mental health and physical effects. Most of the studies focused on one versus multiple effects, so the relative severity of different effects could not be determined.

Several mental health comorbidities and disorders were noted which likely confounded the negative effects of exercise addiction. In one meta-analysis, for example, the comorbidities were more related to exercise addiction than body image disturbances or concerns about weight reduction.

Only two potential underlying biological mechanisms studies were conducted including one fMRI and one genetics study. And only two intervention studies were found, including one on psychotherapy and one on treadmill training. Surprisingly, treadmill training reduced exercise addiction, reduced cortisol and increased beta endorphins by no apparent underlying mechanism.

Despite these methodological limitations, this literature has been informative. Future research directions are suggested including more objective measurement of exercise addiction, for example by actigraphy, comparisons of different exercise forms for their risk for exercise addiction, and more mechanism and intervention research to understand and to reduce the risks for exercise addiction and its negative effects.

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