

Exercise addiction – the emergence of a new disorder

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Abstract

An optimal level of regular physical activity plays an important role in the maintenance of physical and mental health. However, excessive exercise in a minority of individuals can have adverse effects on health and lead to exercise addiction. Exercise addiction can be conceptualised as a behavioural addiction. The aim of this paper is to outline the current knowledge on the concept, epidemiology, aetiology, comorbidity, and possible interventions of exercise addiction.

The concept of exercise addiction

Exercise addiction has been conceptualised as a behavioural addiction.¹ The symptoms and consequences of exercise addiction have often been characterised by six common components of addiction: salience, mood modification, tolerance, withdrawal symptoms, personal conflict, and relapse.^{2,3} However, exercise addiction has yet to be included in official psychiatric diagnostic manuals (DSM-V⁴, ICD-10⁵).

It is also important to clarify whether exacerbated exercise is a primary problem in the person's life or emerges as a secondary problem as a consequence of other psychological dysfunctions. In the former case, the dysfunction is considered as primary exercise addiction, while in the latter case it is termed as secondary exercise addiction because it co-occurs with another dysfunction, typically with eating disorders such as anorexia nervosa or bulimia nervosa.⁶⁻⁸ The differentiating feature between the two is that in primary exercise addiction the objective is the exercise itself, whereas in secondary exercise addiction the objective is weight loss and where excessive exercise is one of the primary means in achieving the desired objective.

Recreational exercise or addictive behaviour?

The incentive or motive for fulfilling planned exercise is an important distinguishing characteristic between addicted and nonaddicted exercisers. The reason people exercise is often for an intangible reward such as feeling in shape, looking good, being with friends, staying healthy, building

muscles, losing weight, etc. The personal experience of the anticipated reward reinforces and strengthens the exercise behaviour. Committed exercisers maintain their exercise for benefiting or gaining from their activity and thus, their behaviour is motivated via positive reinforcement.⁹ However, empirical research has demonstrated that addicted exercisers have to exercise in order to avoid negative feelings or withdrawal.^{10,11} The individual's exercise may become a chore that has to be fulfilled, or otherwise an unwanted event would occur (such as the inability to cope with stress, or gaining weight, becoming moody, etc.). Everytime a person undertakes behaviour to avoid something negative, bad, and/or unpleasant, the motive behind that behaviour acts as a negative reinforcement. In these situations, the person feels they have to do it rather than wanting to do it.

In relation to drug addiction, Duncan¹² has suggested that addiction is almost identical to, and semantically just another name for, avoidance or escape behaviour when the unpleasant or painful feeling is being negatively reinforced by drug-taking. In Duncan's view, the intensity, compulsiveness, and proneness to relapse (i.e. important components of addictive behaviours) result from the negative reinforcement of the behaviour. In this regard, mood modification is a key factor among the symptoms of exercise addiction and suggests there is a self-medication aspect of exercise that facilitates the distinction between normal and abnormal exercise: addicts do not simply exercise to experience the joy of it, but rather to escape negative, unpleasant feelings and everyday difficulties. This results in 'crossing the line' into excessive exercise.

Exercise addiction often has been identified on the basis of the presence of withdrawal symptoms (e.g. anxiety, depression, feelings of guilt and discomfort, tension, and restlessness).¹³ This definition has frequently been used in the literature.¹⁴⁻¹⁶ However, withdrawal symptoms in exercise addiction are only one of the several other critical symptoms universally observable in behavioural addictions.^{2,3,17} As discussed by a number of scholars^{3,9,17-19} it is therefore incorrect to establish the presence of exercise addiction

merely on the basis of withdrawal symptoms, because negative psychological feelings are reported by almost all habitual exercisers (or hobby-makers) at times when exercise is prevented for an unexpected reason.^{19,20} It is the intensity of these symptoms that is the crucial factor in separating committed and habitual exercisers from addicted exercisers.

At this point, it is also useful to draw a conceptual distinction between the sense of loss and withdrawal symptoms. A sense of loss occurs in the case of individuals that engage in sports regularly if they miss their usual training session. However, such a feeling is not marked by the development of a negative affective state concomitant with negative biological symptoms as is the case with withdrawal symptoms. Therefore, a sense of loss is not a key feature in the development of exercise addiction, while withdrawal symptoms are clearly characteristic of it. A further option for differentiating between the at-risk, dependent, and non-dependent athletes has been outlined in the Exercise Dependence Scale (EDS)²¹ that conceptualises exercise dependence on the basis of the DSM-IV²² criteria for substance abuse or addiction.

Instruments used in the assessment of exercise addiction

The Exercise Addiction Inventory (EAI) and the Exercise Dependence Scale are the most recent and most widely used screening tools in the research area of exercise addiction – primarily because of their superior psychometric properties in contrast to antecedent instruments; secondarily because of their theoretical underpinning. Although the tools differ in length and the underlying approach for screening, their excellent concurrent validity suggests a good internal validity for both scales.^{23,24}

The EAI is a short, psychometrically validated questionnaire that comprises only six statements, each corresponding to one of the symptoms in the 'components' model of addiction.²³ Each statement is rated on a five-point Likert scale ranging from one (strongly disagree) to five (strongly agree), with a total score out of 30. The EAI cut-off score for individuals considered at-risk for exercise addiction was defined originally as 24 (i.e. most answers agree or strongly agree with the presence of the six classical symptoms), and 13 for those considered being nondependent-symptomatic exercisers. However, these cut-off points were never tested psychometrically. The EAI was developed on the basis of a sample of 200 habitual exercisers in the United Kingdom. The internal reliability of the original scale was excellent ($\alpha = 0.84$) and its concurrent validity was at least $r = 0.80$.

Hausenblas and Downs²⁵ developed the Exercise Dependence Scale using an American sample. The EDS was based on the DSM-IV criteria for substance dependence.²² The EDS yields both interval and nominal data. Specifically, a mean score (i.e. interval data) as well as categorisation (i.e. nominal data) are obtained. This latter solution is to

differentiate between at-risk, nondependent-symptomatic, and nondependent-asymptomatic individuals. The categorisation into one of the three groups are generated by a scoring manual that consists of flowchart decision rules, in which items or combination of items determine into which group the person is classified. On the EDS, 21 items are rated on a six-point frequency scale ranging from one (never) to six (always). Evaluation is made in reference to the DSM-IV criteria, screening for the presence of three or more of the following symptoms: 1) tolerance, 2) withdrawal, 3) intention effects, 4) loss of control, 5) time, 6) conflict, and 7) continuance. A total score and subscale scores can be calculated for the EDS. The higher the score, the higher is the risk for addiction. The EDS possesses good psychometric properties, including a good internal reliability ($\alpha = 0.78$ to $\alpha = 0.92$), test-retest reliability ($r = 0.92$), and concurrent validity with the EAI ($r = 0.81$).

Epidemiology

In five studies carried out among university students, Hausenblas and Downs²¹ reported that between 3.4% and 13.4% of their samples were at high risk of exercise addiction. Griffiths, Szabo, and Terry²⁶ reported that 3.0% of a British sample of sport science and psychology students were identified as at risk of exercise addiction using the EAI.²⁷ Among those who are also professionally connected to sports, the prevalence may be even higher. For example, using the EAI, Szabo and Griffiths²⁸ found that 6.9% of British sport science students were at risk of exercise addiction. However, one study that surveyed 95 'ultra-marathoners' reported only three people (3.2%) as at-risk for exercise addiction.²⁹ To date, the only nationally representative study examining exercise addiction was carried out by Mónok and colleagues.²⁴ This study surveyed a Hungarian adult population aged 18–64 years ($n=2,710$) and assessed exercise addiction using both the EAI and the EDS. Results showed that 6.2% (EDS) and 10.1% (EAI) of the population were characterised as nondependent-symptomatic exercisers (having some of the symptoms of exercise addiction, but presumably not being dependent), while the proportion of the people at risk for exercise dependence was 0.3% and 0.5%, respectively.

Differences in the estimates can perhaps be attributed to sample selection bias, small sample size, and/or the sampling method. With the exception of the study by Lejoyeux and colleagues,³⁰ that applied consecutive sampling and the one by Mónok and colleagues²⁴ on a nationally representative sample, all the studies to date have used convenience sampling. Furthermore, clear definitions of the target population are lacking in most cases. As a consequence, the estimates of these studies are in no way comparable, and to draw any general conclusions about these prevalence figures of exercise addiction is very much limited. The study of Mónok and colleagues²⁴ is the only national study ever to assess the prevalence of exercise addiction in a representative sample of participants of the target population, and therefore there are no studies to compare the findings of this study to.

Aetiologic aspects of exercise addiction

There are numerous theories that deal with both the causes of exercise addiction and the process and mechanisms of its development and maintenance. Some of these theories interpret the phenomenon with biological factors. One of these is the 'runners' high' hypothesis (in correlation with beta-endorphin activity).³¹ Another is the arousal regulating explanation by Thompson and Blanton.³² The authors argue that regular exercise, especially aerobic exercise such as running, if performed for a sustained period, results in lower basal heart rate, reflecting a training effect or the adaptation of the organism to exercise. The training effect is also accompanied by lower sympathetic activity at rest and, in parallel, lowers levels of arousal, which may be experienced as lethargic or energy-lacking states. The lower arousal initiates the individual do something about it (i.e. to increase arousal) for the sake of optimal functioning. For avid exercisers, the obvious way to increase the arousal level is via exercise. However, the effects of exercise are only temporary and, therefore, further bouts of exercise may be needed to achieve the optimal state of arousal. Moreover, not only the frequency but also the intensity of exercise may need to increase (tolerance) due to progressive training effect. The thermogenic regulation hypothesis^{33, 34} is based on the physiological fact that intense physical activity increases body temperature. Warmth in the body may trigger a relaxing state with concomitant reduction in anxiety. Consequently, physical exercise reduces anxiety and aids its relaxation as a consequence of increased body temperature. Lower levels of state anxiety and higher states of relaxation act as positive reinforcers or motivational incentives for the continuation of exercise behavior. The pleasant psychological state experienced through the relaxing and anxiety-relieving effects of exercise conditions people to turn to exercise whenever they experience anxiety. Higher levels of anxiety may be associated with greater need for exercise and more frequent and intense workouts. Therefore, in stressful situations, the frequency, duration, and the intensity of exercise may progressively increase (i.e. develop tolerance) to obtain a stronger antidote to stress and anxiety. Finally, there is the catecholamine hypothesis.³⁵ Catecholamines, among other functions, are involved in both the stress response and the sympathetic response to intense physical exercise. According to this hypothesis, brain catecholaminergic activity is altered through exercise. Knowing that central catecholamine levels are involved in regulating mood and affect, and additionally play an important role in the reward system, the changes in brain catecholamine levels following exercise is an attractive explanation for the posited addictive nature of exercise. However, there is no conclusive evidence for this conjecture. Similar to the beta-endorphin dilemma, it is unclear whether the peripheral changes in catecholamine levels have an effect on brain catecholamine levels or vice-versa. Moreover, the dynamics of changes in brain catecholamine levels during exercise in humans are unknown, because direct measurement in the human brain is not possible.

A significant number of psychological theories are based on learning theory or the cognitive psychology approach. According to the theory of functioning⁴¹, both positive reinforcers (e.g. a feeling of euphoria following exercise or muscle growth from exercise) and negative reinforcers (e.g. an end to unpleasant feelings through exercise or avoidance of the presumed negative effect of missed exercise) may lie behind the development and maintenance of exercise addiction which, according to the fundamental principles of learning theory, may contribute to the establishment of compulsive and addictive exercise that may be viewed as maladaptive.

Szabo⁹ stresses the role of cognitive appraisal mechanisms in the development of the vicious cycle that leads to excessive exercise. The process starts when the habitual exerciser uses exercise as a means of coping with stress, and the affected individual learns to depend on exercise at times of stress. The addicted exerciser is then trapped in a vicious cycle of needing increased amounts of exercise to deal with the consistently increasing life stress, part of which is caused by exercise itself.

The affect-regulation hypothesis suggests that exercise has a dual effect on mood.³⁶ First, it increases positive affect, and therefore contributes to an improved general mood state. Second, it decreases negative affect associated with missed exercise sessions. Through this relief, exercise further contributes to improved general mood state. However, the affect-regulating consequences of exercise are temporary, and the longer the interval between two exercise sessions, the experience of negative affect becomes more likely. After prolonged periods of abstention from exercise, the negative affective states develop into severe deprivation sensations and/or withdrawal symptoms that can only be relieved through further exercise. Therefore, as the cycle continues, further increasing amounts of exercise are needed to experience improvement in affect and general mood. Over time, the inter-exercise rest periods decrease as a way of preventing withdrawal symptoms surfacing.

It also appears that the issue of self-assessment represents a further significant factor among the psychological factors^{37, 38} in the sense that during exercise, the physical strength experienced through exercise in a person dissatisfied with his or her body or body image contributes to the formation of a more positive self-image and self-assessment. Tucker has demonstrated that weightlifting has a positive effect on body image and self-esteem both in men^{39, 40} and in women.⁴¹ Perfectionism, obsessive-compulsive functioning, and heightened anxiety have also been claimed to be determining factors in exercise addiction.^{21, 42-45}

Comorbidity with other addictions

Exercise addicts attempt to channel and rid their tensions, frustrations, and other unpleasant feelings with regular, intensive, and longlasting exercise periods.¹⁷ In this sense they are similar to those who use alcohol or drugs for the same purpose. At the same time, they differ significantly from such users in that, unlike alcohol and drug use, exercise is based on effort and physical strain. This difference would appear to rule out the concomitance of exercise addiction and drug and alcohol dependence. In fact, a great deal of research has unambiguously reported that exercise can play a decidedly positive role in the treatment of drug and alcohol dependence. For instance, a study by Murphy, Pagano and Marlatt⁴⁶ demonstrated that alcohol use among heavy social drinkers significantly declined with regular exercise. In a study by Ussher and colleagues⁴⁷, a brief bout of moderate-intensity exercise was shown to provide some short-term relief in those dependent on alcohol. Smith and Lynch⁴⁸ have also claimed individuals that engage in regular aerobic exercise are less likely to use and abuse illicit drugs. In their opinion, exercise serves as an alternative, non-drug reinforcer, and decreases comorbid risk factors associated with substance use.

In relation to substance use among exercise addicts, it should be noted that the disorder of muscle dysmorphia (also known as 'reverse anorexia nervosa') has been observed among bodybuilders that, in addition to exercise addiction, is often accompanied by the use of anabolic steroids. Despite their muscular build, those that suffer from muscle dysmorphia consider themselves thin and do everything to become even bigger and more muscular.⁴⁹⁻⁵³

Interventions to increase awareness concerning the risks of excessive exercise

The public promotion of healthy and appropriate exercise patterns may reduce the incidence of exercise dependence. It is important in public health programs and campaigns to 1) stress the healthy nature of regular exercise and 2) communicate the message that exercise when taken to excess can be potentially harmful. It is important to raise awareness of potential harm within the population of regular exercisers. Adams and Kirkby⁵⁴ claim that individuals with exercise dependence have a poor understanding of the negative health consequences of excessive exercising, of the mechanism of exercise adaptation, and the need for rest between exercise sessions. The use of education may be an effective step in the prevention and treatment of exercise dependence.⁵⁵

As with other addictive disorders, the environment of regular exercisers also plays a significant role in recognising this condition early. In more severe cases psychotherapeutic interventions may be needed. When treating exercise addiction, abstinence from exercise may not be a required and/or realistic goal, because exercise has many benefits for

health and no one would advocate doing no exercise. Therefore, the typical treatment goal would more likely be to return to moderate and controlled exercise. In some cases, a different form of exercise may be recommended.⁵⁶

Conclusion

Individually tailored exercise and fitness programs clearly contribute to the maintenance of health and aid in the prevention of disease. However, misconception about the required amount of exercise and exaggerated engagement in exercise—to escape from stress, for example—can (in a minority of cases) lead to dysfunction. Professionals and family members should cooperate to recognise and intervene when signs of dysfunctional exercise or eating habits are noted. For a diagnosis of exercise addiction, the requisite information needed includes information about aetiology, process, and prognosis.

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References

1. **Demetrovics Z, Griffiths MD.** Behavioral addictions: Past, present and future. *Journal of Behavioral Addictions*. 2012;1(1):1-2.
2. **Brown RIF.** Some contributions of the study of gambling to the study of other addictions. In: Eadington WR, Cornelious JA, editors. *Gambling behavior and problem gambling*. Reno: University of Nevada Press; 1993. p. 241-72.
3. **Griffiths MD.** A 'components' model of addiction within a biopsychosocial framework. *Journal of Substance Use*. 2005;10:191-7.
4. American Psychiatric Association. Diagnostic and statistical manual of mental disorders 5th ed. Washington, D.C.: American Psychiatric Association; 2013.
5. World Health Organization. International Classification of Diseases 10th ed: World Health Organization; 1994.
6. **Bamber D, Cockerill IM, Carroll D.** The pathological status of exercise dependence. *British Journal of Sports Medicine*. 2000;34(2):125-32. Epub 2000/04/29.
7. **Blaydon MJ, Lindner KJ, Kerr JH.** Metamotivational characteristics of eating-disordered and exercise dependent triathletes: An application of reversal theory. *Psychology of Sport and Exercise*. 2002;3(3):223-36.
8. **de Coverley Veale DM.** Exercise dependence. *British Journal of Addiction*. 1987;82(7):735-40.
9. **Szabo A.** The impact of exercise deprivation on well-being of habitual exercisers. *Australian Journal of Science and Medicine in Sport*. 1995;27(3):68-75. Epub 1995/09/01.
10. **Baker TB, Piper ME, McCarthy DE, Majeskie MR, Fiore MC.** Addiction motivation reformulated: an affective processing model of negative reinforcement. *Psychological Review*. 2004;111(1):33-51. Epub 2004/02/06.
11. **Bozarth MA.** *Pleasure Systems in the Brain*. In: Warburton DM, editor. *Pleasure: The politics and the reality* New York: John Wiley & Sons; 1994. p. 5-14.
12. **Duncan DF.** Letter: Drug abuse as a coping mechanism. *The American Journal of Psychiatry*. 1974;131(6):724. Epub 1974/06/01.
13. **Sachs ML.** *Running Addiction*. In: Sacks M, Sachs M, editors. *Psychology of Running*. Champaign, IL: Human Kinetics; 1981. p. 116-26.
14. **Furst DM, Germone K.** Negative addiction in male and female runners and exercisers. *Perceptual & Motor Skills*. 1993;77(1):192-4. Epub 1993/08/01.
15. **Morris M.** Running round the clock. *Running*. 1989;104:44-5.
16. **Sachs ML, Pargman D.** Running addiction. In: Sachs ML, Buffone GW, editors. *Running as therapy: An integrated approach*. Lincoln, NE: University of Nebraska Press; 1984. p. 231-52.
17. **Griffiths MD.** Exercise addiction: A case study. *Addiction Research*. 1997;5:161-8.
18. **Szabo A.** *Addiction to exercise: A symptom or a disorder?* New York, NY: Nova Science Publishers, Inc.; 2010.
19. **Szabo A, Frenkl R, Caputo A.** Deprivation feelings, anxiety, and commitment to various forms of physical activity: A cross-sectional study on the Internet. *Psychologia*. 1996;39:223-30.
20. **Szabo A, Frenkl R, Caputo A.** Relationships between addiction to running, commitment to running, and deprivation from running. *European Yearbook of Sport Psychology*. 1997;1:130-47.
21. **Hausenblas HA, Symons Downs D.** How much is too much? The development and validation of the Exercise Dependence Scale. *Psychology and Health*. 2002;17:387-404.
22. American Psychiatric Association. Diagnostic and statistical manual for mental disorders 4th ed. Washington, D.C.: American Psychiatric Association; 2000.
23. **Allegre B, Souville M, Therme P, Griffiths MD.** Definitions and measures of exercise dependence. *Addiction Research and Theory*. 2006;14:631-46.
24. **Mónok K, Berczik K, Urbán R, Szabó A, Griffiths MD, Farkas J.** Psychometric properties and concurrent validity of two exercise addiction measures: A population wide study. *Psychology of Sport and Exercise*. 2012;13(6):739-46.
25. **Hausenblas HA, Downs SD.** Exercise dependence: a systematic review. *Psychology of Sport Exercise*. 2002;3:89-123.
26. **Griffiths MD, Szabo A, Terry A.** The exercise addiction inventory: A quick and easy screening tool for health practitioners. *British Journal of Sports Medicine*. 2005;39(6):e30. Epub 2005/05/25.
27. **Terry A, Szabo A, Griffiths MD.** The exercise addiction inventory: A new brief screening tool. *Addiction Research and Theory*. 2004;12(5):489-99.
28. **Szabo A, Griffiths MD.** Exercise addiction in British sport science students. *International Journal of Mental Health and Addiction*. 2007;5(1):25-8.
29. **Allegre B, Therme P, Griffiths MD.** Individual factors and the context of physical activity in exercise dependence: A prospective study of 'ultra-marathoners'. *International Journal of Mental Health and Addiction*. 2007;5:233-43.
30. **Lejoyeux M, Avril M, Richoux C, Embouazza H, Nivoli F.** Prevalence of exercise dependence and other behavioral addictions among clients of a Parisian fitness room. *Comprehensive Psychiatry*. 2008;49:353-8.
31. **Farrell PA, Gates WK, Maksud MG, Morgan WP.** Increases in plasma beta-endorphin/beta-lipotropin immunoreactivity after treadmill running in humans. *Journal of Applied Physiology: Respiratory, Environmental and Exercise Physiology*. 1982;52(5):1245-9. Epub 1982/05/01.
32. **Thompson JK, Blanton P.** Energy conservation and exercise dependence: A sympathetic arousal hypothesis. *Medicine & Science in Sports and Exercise*. 1987;19(2):91-9. Epub 1987/04/01.
33. **De Vries HA.** Tranquilizer effect of exercise: A critical review. *The Physician and Sports Medicine*. 1981;9(11):47-53.
34. **Morgan WP, O'Connor PJ.** Exercise and mental health. In: Dishman RK, editor. *Exercise adherence: Its impact on public health* Champaign, IL: Human Kinetics; 1988. p. 99-121.
35. **Cousineau D, Ferguson RJ, de Champlain J, Gauthier P, Cote P, Bourassa M.** Catecholamines in coronary sinus during exercise in man before and after training. *Journal of Applied Physiology: Respiratory, Environmental and Exercise Physiology*. 1977;43(5):801-6. Epub 1977/11/01.
36. **Hamer M, Karageorghis CI.** Psychobiological mechanisms of exercise dependence. *Sports Medicine (Auckland, NZ)*. 2007;37(6):477-84. Epub 2007/05/17.
37. **Hausenblas HA, Giacobbi PRJ.** Relationship between exercise dependence symptoms and personality. *Personality and Individual Differences*. 2004;36:1265-73.
38. **Rudy EB, Estok PJ.** Intensity of jogging: its relationship to selected physical and psychosocial variables in women. *Western Journal of Nursing Research*. 1983;5(4):325-36. Epub 1983/01/01.
39. **Tucker LA.** Effect of a weight-training program on the self-concepts of college males. *Perceptual & Motor Skills*. 1982;54:1055-61.
40. **Tucker LA.** Weight training: A tool for the improvement of the self and body concepts of males. *Journal of Human Movement Studies*. 1983;9:31-7.
41. **Tucker LA, Maxwell K.** Effects of weight training on the emotional well-being and body image of females: predictors of greatest benefit. *American Journal of Health Promotion*. AJHP. 1992;6(5):338-44. 71. Epub 1992/04/08.
42. **Coen SP, Ogles BM.** Psychological characteristics of the obligatory runner: A critical examination of the anorexia analogue hypothesis. *Journal of Sport & Exercise Psychology*. 1993;15(3):338-54.
43. **Davis C, Brewer H, Ratusny D.** Behavioral frequency and psychological commitment: necessary concepts in the study of excessive exercising. *Journal of Behavioral Medicine*. 1993;16(6):611-28. Epub 1993/12/01.
44. **Davis C, Kennedy SH, Ralevski E, Dionne M, Brewer H, Neitzert C, et al.** Obsessive compulsiveness and physical activity in anorexia nervosa and high-level exercising. *Journal of Psychosomatic Research*. 1995;39(8):967-76. Epub 1995/11/01.
45. **Spano L.** The relationship between exercise and anxiety, obsessive-compulsiveness, and narcissism. *Personality and Individual Differences*. 2001;30:87-93.
46. **Murphy TJ, Pagano RR, Marlatt GA.** Lifestyle modification with heavy alcohol drinkers: effects of aerobic exercise and meditation. *Addictive Behaviors*. 1986;11(2):175-86. Epub 1986/01/01.
47. **Ussher M, Sampuran AK, Doshi R, West R, Drummond DC.** Acute effect of a brief bout of exercise on alcohol urges. *Addiction (Abingdon, England)*. 2004;99(12):1542-7. Epub 2004/12/09.
48. **Smith MA, Lynch WJ.** Exercise as a potential treatment for drug abuse: evidence from preclinical studies. *Frontiers in Psychiatry*. 2011;2:82. Epub 2012/02/22.
49. **Pope HG, Jr., Katz DL, Hudson JI.** Anorexia nervosa and 'reverse anorexia' among 108 male bodybuilders. *Comprehensive Psychiatry*. 1993;34(6):406-9. Epub 1993/11/01.
50. **Túry F, Kovács S, Gyenis M.** A táplálkozás magatartás zavarai: az anorexia nervosa és a bulimia nervosa. Budapest: *Medicina Könyvkiadó*. 2001.
51. **Babusa B, Túry F.** *Izomdiszmozgás*. In: **Demetrovics Z, Kun B, editors.** *Az addiktológia alapjai IV*. Budapest: ELTE Eötvös Kiadó; 2010. p. 481-99.
52. **Hurst R, Hale B, Smith D, Collins D.** Exercise dependence, social physique anxiety, and social support in experienced and inexperienced bodybuilders and weightlifters. *British Journal of Sports Medicine*. 2000;34(6):431-5. Epub 2000/12/29.
53. **Foster AC, Shorter GW, Griffiths MD.** Muscle dysmorphia: Could it be classified as an addiction to body image. *Journal of Behavioral Addictions*. 2014.
54. **Adams J, Kirby RJ.** Exercise dependence and overtraining: The physiological and psychological consequences of excessive exercise. *Sports Medicine, Training and Rehabilitation*. 2001;10:199-222.
55. **Adams J.** Understanding exercise dependence. *Journal of Contemporary Psychotherapy*. 2009;39:231-40.
56. **Freimuth M, Moniz S, Kim SR.** Clarifying exercise addiction: differential diagnosis, co-occurring disorders, and phases of addiction. *International Journal of Environmental Research and Public Health*. 2011;8(10):4069-81. Epub 2011/11/11.