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ORIGINAL ARTICLE

Exercise Addiction: Symptoms, Diagnosis, Epidemiology, and Etiology

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Regular physical activity plays a crucial role in health maintenance and disease prevention. However, excessive exercise has the potential to have adverse effects on both physical and mental health. The scholastic and empirical discussion of excessive physical activity focuses on obsessive and compulsive exercising, and uses several labels. However, in this review, we argue that the most appropriate term for this phenomenon is *exercise addiction*, emphasizing that excessive physical exercise fits the typical and most common characteristics of behavioral addictions. The aim of this review is to synthesize the current knowledge on symptomology, diagnosis, epidemiology, and etiology of exercise addiction.

Keywords exercise addiction, behavioral addiction, epidemiology, etiology, obsessive-compulsive behavior, positive addiction

INTRODUCTION

Regular exercise could be conceptualized as a set of planned, structured, and repetitive complex movement activities carried with sufficient frequency, intensity, and duration to be effective in health promotion, while also playing a significant role in disease prevention (Caspersen, Powell, & Christenson, 1985; Waddington, 2000). After taking into account a person's individual's gender, age, and fitness level, empirical research has demonstrated that regular physical exercise contributes to the maintenance of health (Blair et al., 1989; Paffenbarger, Hyde, Wing, & Hsieh, 1986; Royal College of Physicians, 1991; Stephens, 1988; United States Department of Health and Human Services, 1996). There is consensus in the research literature that the optimal level of habitual physical exercise has favorable effects on both physical and mental well-being of the adult population (Folsom et al., 1985; Lamb, Roberts, & Brodie, 1990; Lotan, Merrick, & Carmeli, 2005; Warburton, Nicol, & Bredin, 2006), as well as on children's and teenagers' general well-being (Biddle, Gorely, & Stensel, 2004; Lotan et al., 2005; Piko, 2000; Piko & Keresztes, 2006).

DEFINITION AND SYMPTOMOLOGY

Glasser (1976) first introduced the concept of "positive addiction"[1] into the psychological literature by trying to pinpoint the beneficial effects of physical exercise and the positive dose–response relationship between exercise and health, in contrast to substance use and other addictions that bear a negative dose–response relationship in terms of behavioral outcomes. These new "positive addictions" included activities such as exercise and transcendental meditation. However, Morgan (1979) questioned Glasser's conceptualization, because psychiatric case studies had shown that exaggerated exercise could lead not only to physical injury but also to the negligence of the most paramount everyday responsibilities such as work and family life. In these extreme clinical cases, the overuse of exercise has surfaced as a new form of addiction (Morgan, 1979). In a more recent review of behavioral

[1]The reader is reminded that "addiction" is a definition, a process, an outcome, and a code, among its other dimensions, that has been and continues to be used as well as misused by a range of stakeholders, each with their own objectives. Editor's note.

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addiction, Griffiths (1996) questioned the criteria for positive addiction and argued that Glasser's (1976) criteria bore little resemblance to the accepted signs or components of addictions.

On the basis of his observations, Morgan (1979) presented arguments that the most typical symptoms of addiction could also be applied to excessive exercise behavior, primarily through the presence of withdrawal symptoms, detrimental social consequences, and several other negative effects such as disturbed psychological functioning, exercising despite medical contraindications, or interference with relationships or work. Consequently, he viewed exercise addiction as a behavioral dysfunction, and in contrast to Glasser's concept of positive addiction, argued that it was a negative addiction. Although this connotation is still occasionally used in the literature, more uniform terminologies such as "exercise addiction" have started to be used (e.g., Griffiths, 1997; Szabo, 2010; Thaxton, 1982).

In spite of the increased usage of the term "exercise addiction," because it is a multidisciplinary concern, various branches of science with different research orientations still tend to use several incongruent terminologies in the discussion of the excessive exercise syndrome (Allegre, Souville, Therme, & Griffiths, 2006). Therefore, in addition to exercise addiction, several other terms have been adopted by researchers. The most popular perhaps is *exercise dependence* (Cockerill & Riddington, 1996; Hausenblas & Downs, 2002a). Nevertheless, some scholars refer to the condition as *obligatory exercising* (Pasman & Thompson, 1988) and *exercise abuse* (Davis, 2000), while in the media, the condition is often described as *compulsive exercise* (Dalle Grave, Calugi, & Marchesini, 2008).

In this review, the term *addiction* is considered to be the most appropriate because it incorporates both dependence and compulsion. Subsequently, addiction is defined as the behavioral process that can provide either pleasure or relief from internal discomfort (stress, anxiety, etc.) and it is characterized by repeated failure to control the behavior (state of powerlessness) and maintenance of the behavior in spite of negative consequences (Goodman, 1990). This definition is then further complemented by six common symptoms of addiction as criteria for identifying the condition: salience, mood modification, tolerance, withdrawal symptoms, personal conflict, and relapse (Brown, 1993; Griffiths, 2005; Szabo, 2010). However, while the authors' acknowledge that excessive exercise might lead to addiction and related health problems, those in the exercise addiction field need to be careful concerning the possible medicalization of the phenomenon. As discussed in this review, identification of exacerbated exercise and its potentially harmful consequences is important, although stigmatization of the phenomenon should be avoided as well as taking an exclusively medical approach.

In connection with this, it is important to clarify whether exaggerated exercise behavior is a primary problem in the affected person's life or whether it emerges as a secondary problem in consequence of another psychological dysfunction.[2] In the former case, the dysfunction is classified as *primary exercise addiction* because it manifests itself as a form of behavioral addiction. 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 (Bamber, Cockerill, & Carroll, 2000; Blaydon, Lindner, & Kerr, 2002; de Coverley Veale, 1987). In the former, the motive for overexercising is typically geared toward avoiding something negative (Szabo, 2010), although the affected individual may be totally unaware of their motivation. It is a form of escape response to a source of disturbing, persistent, and uncontrollable stress. However, in the latter, excessive exercise is used as a means of weight loss (in addition to very strict dieting). Thus, secondary exercise addiction has a different etiology than primary exercise addiction. Nevertheless, it should be highlighted that many symptoms and consequences of exercise addiction are similar whether it is a primary or a secondary exercise addiction. The distinguishing feature between the two is that in primary exercise addiction, the *exercise is the objective*, whereas in secondary exercise addiction, *weight loss is the objective*, while exaggerated exercise is one of the primary means in achieving the objective.

Bamber, Cockerill, Rodgers, and Carroll (2003) interviewed 56 regularly exercising adult women. On the basis of the qualitative analysis of the results, the authors identified three factors in the diagnostic criteria of secondary exercise addiction. Among these factors, only the presence of eating disorder symptoms could differentiate secondary from primary exercise addiction. The other two factors (i.e., dysfunctional psychological, physical, or social behavior, and the presence of withdrawal symptoms) were nonspecific to secondary exercise addiction. However, Blaydon, Lindner, and Kerr (2004) attempted to further subclassify secondary exercise addiction based on the primary source of the problem, which in their view was related to either a form of eating disorder or to an exaggerated preoccupation with body image. Although this appears to have face validity, to date, there is no empirical evidence for such speculation. Furthermore, on the basis of qualitative research, Bamber, Cockerill, Rodgers, and Carroll (2000) found no evidence for primary exercise addiction. In fact, they believe that all problematic exercise behaviors are linked to eating disorders. However, this view remains critically challenged in the literature (Szabo, 2000, 2010) and there are documented case studies (e.g., Griffiths, 1997) where no eating disorders were present at all.

Exercise addiction often has been identified on the basis of the presence of withdrawal symptoms. For example, Sachs defined addiction to running as "addiction of a psychological and/or physiological nature, upon a regular

[2]The reader is referred to Hill's (1965) criteria which were developed in order to help assist researchers and clinicians determine if *risk factors* were causes of a particular disease or outcomes or were merely associated. Editor's note.

regimen of running, characterized by withdrawal symptoms after 24 to 36 hours without participation" (1981, p. 118). This definition has frequently been used in the literature (e.g., Furst & Germone, 1993; Morris, 1989; Sachs & Pargman, 1984). However, withdrawal symptoms in exercise addiction are only one of the several other critical co-symptoms universally observable in behavioral addictions (Brown, 1993; Griffiths, 1997, 2005).

Therefore, as discussed in numerous reports (Szabo, 1995, 2010; Szabo, Frenkl, & Caputo, 1997), it is incorrect to establish the presence of exercise addiction merely on the basis of withdrawal symptoms. Rather, the type, frequency, and the intensity of withdrawal symptoms need to be examined, because negative psychological feelings are reported by almost all habitual exercisers (or hobbymakers) for the times when exercise or a hobby activity is prevented for an unexpected reason (Szabo, Frenkl, & Caputo, 1996; Szabo et al., 1997). Indeed, Szabo et al. (1996) noted that even participants in physically "light effort" types of exercises, such as bowling, report withdrawal symptoms when bowling is prevented for unforeseen reasons. However, the intensity of the symptoms reported by these individuals was less than that reported by aerobic dancers, weight-trainers, cross-trainers, and fencers (Szabo et al., 1996). Consequently, it is essential to understand that the presence of withdrawal symptoms alone is insufficient in the screening or diagnosis of exercise addiction. It is the *intensity* of these symptoms that is the crucial factor in separating committed exercisers from addicted exercisers.

CLASSIFICATION OF EXERCISE ADDICTION

Currently, exercise addiction is not cited within any officially recognized medical or psychological diagnostic frameworks. However, it is important on the basis of the known and shared symptoms with related morbidities that the dysfunction receives attention in a miscellaneous category of other or unclassified disorders. On the basis of symptoms with diagnostic values, exercise addiction could potentially be classified within the category of behavioral addictions (Albrecht, Kirschner, & Grüsser, 2007; Grant, Potenza, Weinstein, & Gorelick, 2010; Griffiths, 1996). Some disorders, on the basis of experts' consensus, classified into different categories within certain diagnostic frameworks (American Psychiatric Association, 2000) resemble each other in several ways (Hollander, 1993). The resemblance is evidenced not only in several common symptoms but also in demographic characteristics, the prognosis of the disorder, comorbidity, response to treatment, prevalence in the family, and etiology (Bartz & Hollander, 2006; Castle & Phillips, 2006; Hollander & Wong, 1995).

Hollander (1993) highlighted the obsessive, repetitive, and compulsive elements in the shared symptoms. Although, Hollander did not emphasize the addictive nature of the disorders with several common characteristics, it is evident that most of the cited disorders fit into the spectrum of addictions, and more specifically, behavioral addictions. Exercise addiction could also be potentially classified into this group of disorders, because a common feature of all behavioral (and chemical) addictions is the preoccupation with the behavior when that is prevented or delayed. This is the *obsessive* facet of the dysfunction, which is accompanied by increased levels of anxiety before carrying out the behavior and decreasing anxiety, sense of relief, and satisfaction after the fulfilment of the behavior. The anxiolytic effect of the addictive behavior is often followed by feelings of guilt in context of the behavior. The experienced relief and satisfaction are of short duration and the urge to engage again in the behavior resurfaces soon in parallel with the progressively increasing anxiety. This is the cyclical aspect of the dysfunction, and its constituent persistent and repetitive nature is another common characteristic of addictive behaviors. A theoretical consideration of the typical symptoms and key characteristics of the syndrome (Shaffer et al., 2004) reveals that exercise addiction may be closely connected to disorders encompassing obsession and impulse control in spite of the fact that on the continuum proposed by Hollander and Wong (1995), it could be placed closer toward the compulsive end of the spectrum (see Figure 1).

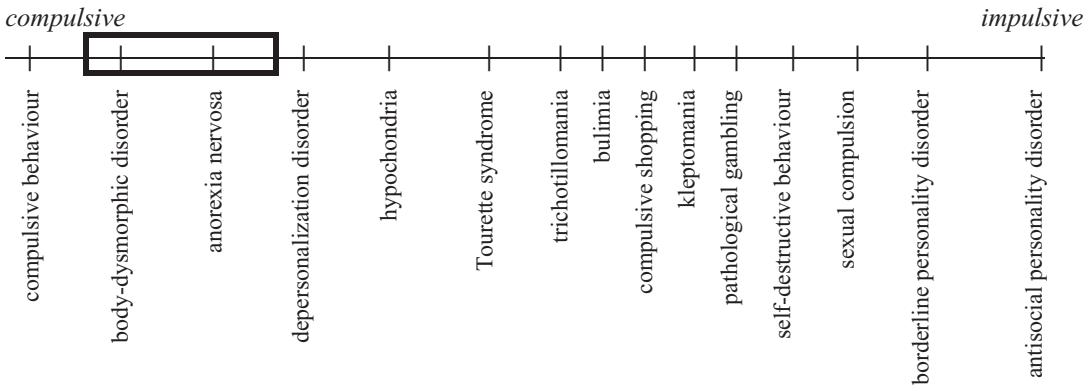

FIGURE 1. The "compulsive-obsessive" spectrum and the place of component dysfunctions on it as based on Hollander and Wong (1995). The surmised position of exercise addiction is marked with the framed segment.

INSTRUMENTS USED IN THE ASSESSMENT OF EXERCISE ADDICTION

Several instruments have been developed and adopted for the assessment of exercise addiction (Allegre et al., 2006) (see Table 1). Two relatively early scales, namely the "Commitment to Running Scale" (CRS; Carmack & Martens, 1979) and the "Negative Addiction Scale" (NAS; Hailey & Bailey, 1982), are no longer used because of theoretical and methodological shortcomings that have been discussed extensively elsewhere (e.g., Szabo et al., 1997). Among the psychometrically tested instruments, the "Obligatory Exercise Questionnaire" (OEQ; Ackard, Brehm, & Steffen, 2002; Pasman & Thompson, 1988), the "Exercise Dependence Scale" (EDS; Downs, Hausenblas, & Nigg, 2004; Hausenblas & Downs, 2002b), and the "Exercise Dependence Questionnaire" (EDQ; Ogden, Veale, & Summers, 1997) proved to be both psychometrically valid and reliable instruments for gauging the symptoms and assessing the extent of exercise addiction.

The OEQ is a 20-item self-report questionnaire that assesses the urge for undertaking exercise. Participants rate each item on a four-point Likert scale from "never" to "always." The questionnaire has three subscales: (1) emotional element of exercise, (2) exercise frequency and intensity, and (3) exercise preoccupation (Steffen & Brehm, 1999). The EDS conceptualizes compulsive exercise on the basis of the DSM-IV criteria for substance abuse or addiction (American Psychiatric Association, 2000) and empirical research shows that it is able to differentiate between at-risk, dependent and nondependent athletes, and also between physiological and nonphysiological addiction.

The EDS has seven subscales: (1) tolerance, (2) withdrawal, (3) intention effect, (4) lack of control, (5) time, (6) reduction of other activities, and (7) continuance. In contrast to the EDS, the EDQ is aimed to measure compulsive exercise behavior as a multidimensional construct. It can be used in assessing compulsion in many different forms of physical activities. The questionnaire comprises the following eight subscales: (1) interference with social/family/work life, (2) positive reward, (3) withdrawal symptoms, (4) exercise for weight control, (5) insight into problem, (6) exercise for social reasons, (7) exercise for health reasons, and (8) stereotyped behavior.

To generate a quick and easily administrable tool for surface screening of exercise addiction, Terry, Szabo and Griffiths (2004) developed the "Exercise Addiction Inventory" (EAI), a short six-item instrument aimed at identifying the risk of exercise addiction. The EAI assesses the six common symptoms of addictive behaviors: (1) salience, (2) mood modification, (3) tolerance, (4) withdrawal symptoms, (5) social conflict, and (6) relapse. The EAI has been psychometrically investigated and has relatively high internal consistency and convergent validity with the EDS (Griffiths, Szabo, & Terry, 2005; Terry et al., 2004).

There are several other instruments available for assessing exercise addiction. However, they are either rarely adopted in research or are aimed at a specific form of physical activity, such as bodybuilding. The "Bodybuilding Dependency Scale" (BDS; Smith, Hale, & Collins, 1998) was developed specifically to assess compulsive training in bodybuilding and has satisfactory reliability (Smith & Hale, 2005; Smith et al., 1998). It comprises three subscales: (1) social dependence (the need to be in the gym), (2) training dependence (compulsion to train), and (3) mastery dependence (the need to control training). A more general but seldom adopted instrument is the "Exercise Beliefs Questionnaire" (EBQ; Loumidisa & Wells, 1998), which gauges individual thoughts and beliefs about exercise and is based on four factors: (1) social desirability, (2) physical appearance, (3) mental and emotional functioning, and (4) vulnerability to disease and aging. Empirical testing shows the instrument to have acceptable psychometric properties. Another tool is the "Exercise Dependence Interview" (EXDI; Bamber, Cockerill, Rodgers et al., 2000). This not only assesses compulsive exercising but also eating disorders. The EXDI gauges excessive engagement in physical activity in the past three months prior to the date of assessment, the associated thoughts, and their association with the eating behavior. It also determines the self-appraisal of exercise dependence and exercise habits. However, one of the major limitations of this measure is that no psychometric properties have been reported.

Another scale developed by Davis, Brewer, and Ratusny (1993), the "Commitment to Exercise Scale" (CES), examines the pathological aspects of exercising (e.g., continued training despite injuries) and compulsory activities (e.g., feeling guilty when exercise is not fulfilled). The CES has a satisfactory level of reliability. Finally, the "Exercise Orientation Questionnaire" (EOQ; Yates, Edman, Crago, & Crowell, 2001) measures attitudes toward exercise and related behaviors. The EOQ comprises six factors: (1) self-control, (2) orientation to exercise, (3) self-loathing, (4) weight reduction, (5) competition, and (6) identity. It should be highlighted that among the instruments outlined, the most popular currently are the EDS and the EAI (due to its brevity and easy scoring). Research has shown that when employed together, these two instruments yield comparable results.

EPIDEMIOLOGY

In the course of assessment of exercise addiction, several incongruent results have emerged. The most likely reason beyond the inconsistency in findings may be connected to two issues, namely the instrument used in assessment and the target population studied (including the fact that sample sizes are typically very small compared with other studies of other potentially addictive behaviors). For example, one study reported that the prevalence of exercise addiction was 52% among triathletes (Blaydon & Lindner, 2002). Other scholars have found that 26% of male runners and 25% of female runners were addicted to running (Slay, Hayaki, Napolitano, & Brownell,

TABLE 1. Instruments for assessing exercise addiction

Instrument	Type	Number items	Number of subscales	Areas covered / Factors identified	Theoretical underpinnings	Empirical underpinnings	Comments
Obligatory Exercise Questionnaire' (OEQ) (Ackard, Brehm, & Steffen, 2002; Pasman & Thompson, 1988)	4-point Likert scale	20	3	Exercise fixation Exercise frequency Exercise commitment	Assesses psychological aspects of obligatory exercise	EFA	Assesses only certain aspects of exercise dependence
Exercise Dependence Scale (EDS) (Hausenblas & Downs, 2002b)	6-point Likert scale	21	7	Tolerance Withdrawal effects Continuance Lack of control Reductions in other activities Time Intention	DSM-IV	CFA	
Exercise Dependence Questionnaire (EDQ) (Ogden, Veale, & Summers, 1997)	7-point Likert scale	29	8	Social–occupational interference Positive reward Withdrawal symptoms Exercise for weight control Insight into problem Exercise for social reasons Exercise for health reasons Stereotyped behavior		EFA; Cronbach's alpha: 0.52–0.81	
Exercise Addiction Inventory, (EAI) (Terry, Szabo, & Griffiths, 2004)	5-point Likert scale	6	1	Salience, mood modification, tolerance, withdrawal symptoms, conflict, relapse	Based on Brown's (1993) general components of addictions	Cronbach's alpha = 0.84	
Bodybuilding Dependence Scale (BDS) (Smith & Hale, 2004; Smith et al., 1998)	Likert scale	9	3	Social dependence Training dependence Mastery dependence	–	EFA, CFA	Specific for bodybuilding
Commitment to Exercise Scale (CES) (Davis, Brewer, & Ratusny, 1993)	Uses a continuum line with bipolar adjectives on either end OR a 4-point Likert scale	8	2	Pathological aspects of exercising Obligatory aspects of exercising	Assesses the psychological commitment one has to exercising Takes a dimensional approach to exercise	EFA; Cronbach's alpha = 0.77	Correlations between the two factors = 0.42

Note: EFA = exploratory factor analysis; EFA = confirmatory factor analysis.

1998), although some studies report much lower rates. For instance, Allegre, Therme, and Griffiths (2007) reported 3.2% of "ultra-marathoners" were addicted to exercise. According to some researchers, the prevalence of true exercise addiction is very rare (Szabo, 2000, 2010), while others conjecture that the prevalence rate may be very high (Bamber, Cockerill, & Carroll, 2000; Thornton & Scott, 1995).

The discord about the prevalence of exercise addiction may be related to two facts. The first is the inadequate conceptualization of the phenomenon. For example, Thornton and Scott (1995) examined 40 runners who were running on average more than 40 miles (64 km) every week. Using the CRS (Carmack & Martens, 1979), the authors found that 77% of their sample could be classified as moderately or highly addicted to running. A major problem with this study and the reported results is that commitment was conceptualized akin to addiction, which is known to represent two unrelated concepts (Szabo, 2010; Szabo et al., 1997). The second reason for inconsistent results about the prevalence rates of exercise addiction could be related to the heterogeneity of instruments used in the assessment of exercise addiction (Allegre et al., 2006) and, more importantly, to the interpretation of the results obtained via paper-and-pencil assessments. What many researchers in the addiction studies field forget is that questionnaires only measure the susceptibility to the dysfunction, in terms of presence and intensity of the symptoms associated with the dysfunction (i.e., exercise addiction). In no way do these screening tools have any diagnostic value. Even the individual scoring on the upper end of the currently available screening instruments may not be identified as addicted to exercise. This argument is especially valid if one considers the fact that, to date, there are no instruments developed and validated with a clinical population. Therefore, individually conducted psychiatric evaluation is necessary to establish a diagnosis.

Admitting that the currently available tools only measure the risk and/or possibility of the presence of exercise addiction, even the most reliable instruments should be regarded as only surface screening tools. Consequently, their results may be exaggerated in terms of actual cases and, indeed, only a few of the top-scoring individuals may in fact be addicted to exercise. Considering this argument, the two most popular and psychometrically validated instruments, the EDS and the EAI (which yield comparable results), have demonstrated that the prevalence of exercise addiction may in fact be very low. Using the EDS in America, Hausenblas and Downs (2002c) found that about 2.5% of the exercising population may be affected by exercise addiction.

Using the EAI in Britain, Griffiths et al. (2005) arrived at a very similar figure (3%), although their sample mainly comprised a modest number of undergraduate students. Szabo and Griffiths (2007) replicated these findings a few years later and found 3.6% of general exercisers (gym attendees) to be possibly affected by exercise addiction using the EAI. However, they also found that among university sport science students, this figure was nearly double (7%), which either meant a greater preoccupation and involvement in sport and physical activity or simply a halo effect that has emerged as a consequence of thoughts, beliefs, or knowledge about sport and exercise. Whatever is the actual reason, the 3% estimate within the exercising population may be reliable for the risk of exercise addiction, although some meta-analyses have claimed a 3% estimate in the general population (Sussman, Lisha, & Griffiths, 2011). Given that this figure was generated through surface screening, using questionnaires, the number of clinical cases is likely to be much lower. However, even if only 1% of the exercising population suffers with an exercise addiction, it represents a very large number of people needing help. Considering the negative consequences of the self-destructive behavior in exercise addiction, the epidemiological data substantiate the need for research in this area and calls for the better understanding of the dysfunction. This goal could be achieved through a greater and closer collaboration of researchers and clinicians (Szabo, 2010).

COMORBIDITY

There is a strong link between exercise addiction and various forms of eating disorders, as noted earlier (Sussman et al., 2011). Several studies have reported that disordered eating behavior is often (if not always) accompanied by exaggerated levels of physical exercise. The reverse relationship has also been established. Individuals affected by exercise addiction often (but not always) show an excessive concern about their body image, weight, and control over their diet (Blaydon & Lindner, 2002; Klein et al., 2004; Lyons & Cromey, 1989; Sundgot-Borgen, 1994). This comorbidity makes it difficult to establish which is the primary disorder. This dilemma was approached by using trait- and personality-oriented investigations. In an early but widely cited controversial study, Yates, Leehey, and Shisslak (1983) concluded that addicted male long-distance runners resembled anorexic patients on a number of personality dispositions (e.g., introversion, inhibition of anger, high expectations, depression, and excessive use of denial) and labeled the similarity as the "anorexia analogue" hypothesis.

To further test the hypothesis, Yates et al. (1983) examined the personality characteristics of 60 male obligatory exercisers and then compared their profiles with those of clinical patients diagnosed with anorexia nervosa. While the study did not lend support to the hypothesis, Yates and colleagues (1983) claimed that running and extreme dieting were both dangerous attempts to establish an identity, as either addicted to exercise or anorexic. The study has been criticized for a number of shortcomings, including the lack of supporting data, poor methodology, lack of relevance to the average runner, over-reliance on extreme cases or individuals, and exaggerating the similarities between the groups (Blumenthal, O'Toole, & Chang, 1984). Indeed, later investigations also failed to reveal similarities between the personality characteristics of people

affected by exercise addiction and those suffering from eating disorders (e.g., Blumenthal et al., 1984; Coen & Ogles, 1993). Therefore, the anorexia analogue hypothesis has failed to secure empirical support. Numerous studies have further examined the relationship between exercise addiction and eating disorders (for a review, see Szabo, 2010), but no consensus has emerged. One reason for the inconsistent findings may be attributed to the fact that the extent of comorbidity could vary from case to case depending on personality predispositions, the underlying psychological problem that has led to exercise addiction, and/or the interaction of the two, as well as the form and severity of the eating disorder.

ISSUES IN STUDYING EXERCISE ADDICTION

To date, research on compulsive exercise and/or exercise addiction is still very limited and, therefore, the existence, prevalence, and specific characteristics of the dysfunction in different forms of exercise or physical activities remain somewhat obscure. Most knowledge about exercise addiction stems from studies conducted with long-distance runners (Allegre et al., 2007; Chapman & De Castro, 1990; Furst & Germone, 1993; Hailey & Bailey, 1982), aerobic exercisers (Kirkby & Adams, 1996), or body builders (Smith & Hale, 2005; Smith et al., 1998). Little research has been conducted in other forms of structured physical activities. Those that have examined other groups include empirical studies of dancers (Pierce, Daleng, & McGowan, 1993), triathletes (Blaydon & Lindner, 2002), martial arts fighters (Griffiths, 1997), and weightlifters (Hurst, Hale, Smith, & Collins, 2000). Qualitatively, special focus has often been devoted to body building, in which other comorbidities, primarily muscle dysmorphia, have also be investigated.

With regard to exercise habits and quality of training, compulsive and noncompulsive forms of exercise are distinguished. The former involves very intensive training that is sustained in spite of physical injuries, other medical contraindications, damage to social relationships, and/or negligence of personal responsibilities. Yates et al. (1983) have compared obligatory and nonobligatory runners and concluded that while obligatory runners differ in certain perspectives from their nonobligatory counterparts, they show test values within the normal range on a battery of other common psychological measures (e.g., Eysenck Personality Questionnaire, Beck Depression Inventory, Eating Attitude Test [EAT]). However, the obligatory runners reported more positive changes in self-image and experienced more control over life events since they started running when compared with nonobligatory runners (Yates, Shisslak, Allender, Crago, & Leehey, 1992).

In another investigation, Blaydon and Lindner (2002) examined triathletes by administering the EDQ and the EAT to determine their level of exercise addiction, as well as their degree of eating disorders. On the basis of a statistical cluster analysis, they identified four different groups. The group classified as nondependent showed low scores for both exercise addiction and eating disorders. The group identified as suffering from eating disorders showed high scores for eating disorders but low scores for exercise addiction. The other two groups were described as either suffering from *primary exercise addiction* (high scores for exercise addiction accompanied by low scores for eating disorders) or from *secondary exercise addiction* (high scores for exercise addiction accompanied by high scores for eating disorders). Using cluster analysis, it was reported that 52% of the triathletes were classified as addicted to their exercise (30% suffering from primary exercise addiction and 22% suffering from secondary exercise addiction).

Since the method may not necessarily yield groups that were based on top (or at risk, or cutoff) scores, the rate of addiction established in this study—in light of definition as harmful or destructive exercise—appears somewhat exaggerated. This speculation is also substantiated by the fact that the groups identified as primary or secondary exercise addicts did not differ significantly from each other. However, gender differences were highly apparent as males tended to be in majority in the primary exercise addiction group, whereas females were in majority in the secondary exercise addiction group. The lack of symptoms of addiction and eating disorders was higher in men than in women (41% versus 25%). This finding was consistent with Hausenblas and Downs' (2002c) study that also found a higher prevalence of exercise addiction in males among university students. Finally, and somewhat predictably, primary exercise addiction was more likely in the professional and experienced triathletes (41%) than in the less-experienced amateur triathletes (23%) (Blaydon & Linder, 2002).

In a similar study, Bamber, Cockerill and Carroll (2000) examined the psychological profiles of women affected by primary and secondary exercise addiction and eating disorders. In addition, a nonsymptomatic control group was also tested. Women classified as suffering from secondary exercise addiction did not differ significantly from the eating disorders group. However, they exhibited greater neuroticism, impulsivity, and lower self-concept as well as more preoccupation with their appearance and body weight than the participants who were classified as suffering from primary exercise addiction. Unexpectedly, the primary exercise addiction group exhibited no significant differences in comparison with the control group. In line with the results of these and other studies (e.g., Basson, 2001), some authors have denied the existence of primary exercise addiction as a pathological and/or a psychological dysfunction (Yates et al., 1992). Nevertheless, the issue here is whether the results of the reviewed studies are based on the *intensity or severity of symptoms* of addiction or on *clearly established* case(s) of exercise addiction (which, by definition, is harmful to individuals and their social surroundings).

ETIOLOGY

Physiological Explanations

As a physiological explanation for exercise addiction, perhaps the oldest, most popular, and most controversial

among runners and many other exercisers—in light of the scientific evidence for it—is the *runners' high* hypothesis. It has long been reported that after intensive running, it is not fatigue or exhaustion runners report but an intense feeling of euphoria. It has been described as the sensation of flying, characterized by effortless movements that have become the legendary goal referred to as *the zone* (Goldberg, 1988). The sensation has been ascribed to beta-endorphin activity in the brain. Research has shown that the human body produces endorphins, which similarly to morphine, may cause dependence (Farrell, Gates, Maksud, & Morgan, 1982). Exercise intensity and the duration of exercise are crucial factors in increasing peripheral beta-endorphin concentration. Indeed, exercise needs to be performed at above 60% of the individual's maximal oxygen uptake (VO_2 max) (Goldfarb & Jamurtas, 1997). Furthermore, it needs to be sustained for at least 3 minutes to detect changes in beta-endorphin levels (Kjaer & Dela, 1996). The dilemma is that the changes observed in beta-endorphin levels were seen in the plasma and, therefore, it is a peripheral change. However, because of its chemical structure, beta-endorphins cannot cross the blood–brain barrier (BBB), meaning that changes in plasma levels may not be accompanied by simultaneous changes in the brain.

In spite of this serious dilemma, some researchers believe that endogenous opiates in the plasma also act centrally and, therefore, may be used to trace central nervous system activity (Biddle & Mutrie, 1991). Currently, this hypothesis relies on the speculation that met-enkephalin and dynorphin, two other endogenous opioids, possess a modification mechanism that could possibly transport them across the BBB (Sforzo, 1988). Unfortunately, direct measurement of changes in brain beta-endorphins involves dissecting the brain and performing radioimmunoassay on its slices. Similar studies with rats have revealed an increase in the opioid receptor-binding sites after exercise (Sforzo, Seeger, Pert, Pert, & Dotson, 1986). Nevertheless, the evidence for the *runners' high* hypothesis and its mediation through changes in beta-endorphin levels in the brain remains inconclusive.

Another physiological explanation is based on Thompson and Blanton's (1987) work. 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. According to Thomson and Blanton, 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* 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 (de Vries, 1981; Morgan & O'Connor, 1988). 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.

Empirical observations that there were increased levels of circulating catecholamines following exercise led to the formulation of the *catecholamine hypothesis* (Cousineau et al., 1977). 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. Indeed, similarly 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.

Psychological Explanations

Szabo (1995) proposed a *cognitive appraisal hypothesis* for the better understanding of the etiology of exercise addiction. According to this theory, once the habitual exerciser uses exercise as a means of coping with stress, the affected individual learns to depend on (and need) exercise at times of stress. The individual is convinced that exercise is a healthy means of coping with stress, as recommended in both scholastic and public media sources. Therefore, the person uses rationalization to explain the exaggerated amounts of exercise, which slowly but progressively takes its toll on other obligations and normal daily activities. If unforeseen events prevent the person from exercising or require the person to reduce the amount of daily exercise, negative psychological feelings emerge. These appear in the form of irritability, guilt, anxiousness, sluggishness, etc. These collective feelings are thought to represent the withdrawal symptoms experienced due to a lack of exercise.

When exercise is used to cope with stress, apart from the negative psychological feelings, there is also a loss of the coping mechanism (exercise). Concomitantly, exercisers lose control over the stressful situation(s) that they used to deal with through exercise. The loss of the coping mechanism, followed by the loss of control over stress, generates an increased perception of vulnerability to stress, which further amplifies the negative psychological feelings associated with the lack of exercise. The mounting pressure urges the individual to resume exercise even at the expense of the other obligations in their daily life. Obviously, while exercise provides an instant reduction in the negative psychological feelings, the ignorance or superficial treatment of other social and work obligations results in conflict with people, possibly detriments at work or school, or even loss of job, that together causes further stress. The addicted exerciser is then trapped in a vicious circle, needing more 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 dual effect on mood (Hamer & Karageorghis, 2007). Firstly, it increases positive *affect* (defined as momentary psychological feeling states of longer persistence than momentary emotions) and, therefore, contributes to an improved general *mood* state (defined as prolonged psychological feeling states lasting for several hours or even days). Secondly, it decreases negative affect or the temporary states of guilt, irritability, sluggishness, and anxiety associated with missed exercise or training sessions. Through this relief, exercise further contributes to improved general mood state (Hamer & Karageorghis, 2007). 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. In fact, after prolonged periods of abstention from exercise, these negative affective states become 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. Progressively, the inter-exercise rest periods decrease as a way of preventing the surfacing of withdrawal symptoms.

Etiology from Behaviourist Perspective

The incentive or motive for fulfilling planned exercise is an important distinguishing characteristic between addicted and non-addicted exercisers. Indeed, people exercise for unique reasons. The reason is often 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 strengthens the exercise behaviour. Behaviourists postulate that all human behaviour can be understood and explained through reinforcement and punishment. Paradoxically, exercise addiction may be seen as self-punishing behaviour. It is a rare form of addiction in contrast to alcohol, tobacco, or drug use because it requires substantial physical effort and stubborn willpower.

Individuals addicted to exercise may be motivated via negative reinforcement (e.g., to avoid withdrawal symptoms) as well as via positive reinforcement (e.g., to enjoy an aspect of exercise, to experience the *runner's high* [Pierce, Eastman, Tripathi, Olson, & Dewey, 1993; Szabo, 1995]). Exercise for negative reinforcement is not a characteristic of the committed exercisers who wish to improve and to enjoy their exercise (Szabo, 1995). Indeed, committed exercisers maintain their exercise for benefiting or gaining from their activity and, thus, their behaviour is motivated via positive reinforcement. However, addicted exercisers *have to* exercise or else something bad could happen to them. Their exercise may be a chore that needs to be fulfilled or otherwise an unwanted life event would occur such as the inability to cope with stress, or gaining weight, becoming moody, etc. Every time a person undertakes some behaviour to avoid something negative, bad, and/or unpleasant, the motive behind that behaviour appears as a negative reinforcement.

In these situations, the person involved *has to do it* as opposed to *wants to do it*. Duncan (1974)—in relation to drug addiction–-has suggested that addiction is almost identical with, and semantically just another name for, avoidance or escape behaviour when the unpleasant or painful feeling is being negatively reinforced by drug taking. In this view, people addicted to exercise reach for a means–-with which they have had past relief-inducing experience—that provides them with temporary escape from an ongoing state of stress or hassle with the daily challenges. In Duncan's view, all addictions represent similar negatively reinforced behaviours. Duncan has also argued that negative reinforcement is a powerful means for sustaining highly frequent and persistent behaviours. Animals that can escape a noxious stimulus or event by pressing a bar will often do so to the point of ignoring other instinctual activities such as eating, sleeping, and sexual activity. Avoidance behaviours are highly resistant to extinction and even when they appear to have been finally eliminated, they often reoccur spontaneously. For this reason, the relapse rate in addictions is high. In Duncan's view, the intensity, compulsiveness, and proneness to relapse, that are important components of addictive behaviours, result from the negative reinforcement of the behaviour.

CONCLUSION AND IMPLICATIONS

The behaviourist approach to understanding exercise addiction and eating disorders is not limited to the motives and maintenance of those behaviours, but it could also be helpful in putting in a responsible social context on these modern dysfunctions. Indeed, society acts as the most important reinforcer in these behaviours. Health and educational organizations along with the media purport the beneficial effects of exercise and slimness. This is one reason why addiction to exercise may not be seen by people in some quarters as being a genuine addiction. Other reasons

as to why exercise addiction is one of the more "hidden" behavioural addictions are similar to arguments put forward as to why addictions to work are not treated as seriously as they should be (Griffiths, 2011). It is likely that exercise (1) is viewed by society as being somewhat of a necessity for healthy living, (2) is viewed positively by both society (macro-level) and individuals (micro-level), and (3) exercising many hours a day is viewed as being more "normal" than engaging in a non-exercise activity many hours a day (e.g., playing video games, gambling, exercise, Internet use, etc.), which is viewed as "abnormal." It is factual information that individually tailored exercise or fitness programs and carefully planned diet contribute to the maintenance of health and aid in the prevention of disease. However, misconception about the required doses of exercise and exaggerated engagement in exercise—to escape from stress, for example—could lead to dysfunction.

The socially praised benefits of exercise should be presented with caution and warning that exercising when losing control over the behaviour can potentially be as dangerous to a person's health as the misuse of any other behaviour or substance. The early teaching of self-control and moderation is an important social obligation by parents and educators. The body needs to recover after exercise through carefully planned rest periods that are as integral parts of a well-designed exercise regimen as the workout itself. Parents, teachers, health educators, coaches, fitness instructors, and other professionals involved should cooperate to recognize and intervene when signs of dysfunctional exercise or eating habits are noted. What is important to remember at the surfacing of these signs is that the route of the problem is usually deeper than the overt symptom. Therefore, thorough professional psychological evaluation and/or intervention may be necessary to stop something that could become a self-destructive vicious circle.

Although all addictive behaviours have idiosyncratic differences, addictions commonly share more similarities than dissimilarities[3] (Griffiths, 2005). However, those working in the exercise addiction field need to be careful concerning research into excessive exercise, exercise addiction, and especially possible interventions. It should also be noted that for a diagnosis of exercise addiction to be useful, the requisite information needed includes information about etiology, process, and prognosis (i.e., within systems that assess the person's resources, including a person's adaptational and functioning strengths and their limitation). Such information helps aid (1) treatment planning, (2) technique choices, (3) process and outcome assessments, (4) policies to enable the development and sustaining of needed treatment alliances, and (5) staff training needs. However, while there is a need to make relevant stakeholders aware of a potential problem, there is also a need to avoid too much medicalization of the problem. Identification of excessive exercise as an addiction carries the risk of stigmatization as well as due to the behaviour's pejorative adjudication. In order to avoid this, all possible interventions should find a smart balance between the promotion of exercise and workout on one hand, while prevention of excessive exercise on the other hand. This way, similar to several other behavioural addictions (e.g. gambling, online gaming), or even chemical substance use (alcohol), temperance could be the focus of communication and possible interventions, with the condition that recreational exercise is not only tolerable but definitely a desirable factor that contributes to facilitate health.

Finally, it is concluded based on the literature reviewed and the arguments put forward in this review that there are clear indications that exercise addiction is a robust representative of behavioural addictions (Grant et al., 2010; Griffiths, 1996). However, many aspects concerning this behavioural disorder are unexplored and/or require research. Though many assessment tools for exercise addiction and its derivatives (e.g., exercise dependence, exercise compulsion, etc.) exist, psychometric and especially clinical validation of these tools remain tasks for the future. One related task is thus the definition of diagnostic criteria. Further studies are needed to explore the relationship between exercise addiction and eating disorders as well as the relationship and association of exercise addiction with other behavioural addictions. One further possible and necessary branch of research is on the factors that have an influence on sustaining exercise addiction. To date—and because of the lack of longitudinal studies—we know next to nothing about the course of the exercise addiction disorder. Considering that internal factors (e.g., personality characteristics) usually play a greater role than external factors (e.g., environmental characteristics) in the acquisition, development, and maintenance of addiction-type disorders, the long-term sustainment of the problem may be due to these more hidden factors. Exercise addiction may at present be regarded as a dysfunction present at the level of personality, but there may be transient stressors and/or environmental factors that in turn might also have an influence on the course of the problem. However, exploration of these processes remains a subject of future research.

Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article.

RÉSUMÉ

Dépendance de l'exercice physique: Symptômes, diagnostics, épidémiologie et étiologie

L'activité physique régulière a un rôle crucial dans la subsistance de la santé et prévention des maladies.

[3] The reader is reminded that whatever the dimensions of a selected and consensualized "addiction," the empirical literature notes that the "addicted" represent heterogeneity and not homogeneity, which has implications for intervention planning, implementation and assessment. Editors note.

Au même temps, l'exercice fait à l'excès peut être déficitaire au niveau physique et mental. La discussion scientifique et empirique sur l'activité physique est concentrée sur l'exercice obsessionnel-compulsionnel utilisant des étiquettes divers pour cette phénomène. Néanmoins, dans cette revue de la littérature, nous disputons que, l'expression la plus appropriée est *'dépendance le l'exercice'* qui exprime que l'exercice physique fait à l'excès est en effet une dépendance du comportement qui se révèle des attributs caractéristique pour ce maladie. Le but de cette revue est de synthétiser les connaissances courantes sur les symptômes, diagnostics, épidémiologie et l'étiologie de la dépendance de l'exercice.

RESUMEN

Adicción al ejercicio: síntomas, diagnosis, epidemiología y etiología

La actividad física regular juega un rol crucial en mantener la salud y en la prevención de enfermedades. Por otra parte, ejercicio excesivo puede tener efectos adversos sobre la salud física y mental. La discusión académica y empírica sobre el ejercisio físico excesivo se centra en ejercisio obsesivo y compulsivo y se utilizan varias denominaciones. Sin embargo, en esta recensión se argumenta que el término más apropiado para este fenómeno es la *adicción al ejercicio*, haciendo hincapié en que el ejercicio físico excesivo ajusta a las características típicas y comunes de las adicciones comportamentales. El objetivo de esta recensión es sintetizar los conocimientos actuales sobre la sintomatología, diagnosis, epidemiología y etiología de ejercicio excesivo.

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GLOSSARY

Behavioural addiction: Behavioural addictions, also known as process addictions, non-chemical addictions, or non-substance-related addictions, include both compulsion to and dependence on activities that have harmful consequences to the individual's well-being and social life.

Compulsive exercise: An analogue to exercise addiction but it lacks the element of dependence, since addiction involves both compulsion and dependence.

Exercise abuse: Over-exercising to the point where the exercise behaviour may become dangerous to one's health and well-being.

Exercise addiction: An abnormal reliance on exercise behaviour to cope with chronic stress or the hassles and challenges of the everyday life and featuring the core components of addiction found in more traditional addictions.

Exercise dependence: An analogue to exercise addiction but it lacks the element of compulsion, since addictions involve both dependence and compulsion.

Negative addiction: Addiction that has negative consequences to the individual and her/his social environment.

Obligatory exercising: An analogue to compulsive exercising, highlighting the obligatory (compulsive) element of exercise addiction; however, it lacks the aspect of dependence, which is also an integral part of exercise addiction.

Positive addiction: Opposite to negative addiction, believed to counteract the former. However, by definition, all addictions are negative and, therefore, the term is highly disputed in the literature.

Primary exercise addiction: Exercise addiction in which the fulfilment of the scheduled bout of exercise provides mental relief and/or satisfaction to the individual. In the case of primary exercise addiction, the co-existence of any eating disorder can be excluded.

Secondary exercise addiction: A behavioural manifestation in which exaggerated volume of exercise is undertaken as a means of weight loss in addition to severe and strict dieting. It is often a co-morbidity of eating disorders.

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