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1.1 Introduction

Extensive research has shown that exercise has health benefits for everyone [1]. However, studies have also suggested that a small minority of individuals may experience negative physical and psychological effects, as they may become addicted to exercise and crave it in a similar way to those who are addicted to substances such as alcohol, nicotine, or other drugs [2,3]. Although the possible negative effects of exercise addiction (EA) were first indicated more than 50 years ago [4–7], to date it has never received formal recognition as a mental disorder in the leading clinical manuals [8,9]. In 2013, the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)* [8] incorporated gambling disorder along with substance-related disorders, so the title of this chapter in Section II was changed from ‘Substance-Related Disorders’ to ‘Substance-Related and Addictive Disorders’. This new classification appears to be based on new evidence which suggests that addiction is a disorder of the brain’s reward system, regardless of whether the system is activated by a behaviour or a substance [10–12].

The DSM-5 only includes gambling as a behavioural addiction, as well as criteria for internet gaming disorder (IGD) as a behavioural addiction within Section III (‘Emerging Measures and Models’). This decision was based on the Substance Use Disorder Workgroup’s conclusion that there was insufficient evidence to warrant the full inclusion of IGD as an official mental disorder in Section II. However, the new conceptualization of the diagnosis of addiction opens the door for research into other forms of excessive behaviour that can be potentially addictive. Furthermore, another group of repetitive behaviours, including exercise, was not included due to the lack of scientific evidence for establishing the diagnostic criteria and course descriptions needed to identify these behaviours as mental disorders [8]. Therefore, at the time of writing, EA should be considered as a potentially addictive behaviour and not a behavioural addiction – that is, a behavioural condition with a psychiatric entity that requires a diagnosis [13].

The future incorporation of exercise behaviour as an addiction appears to be contingent on the scientific community reaching some degree of consensus on two important questions that research has been addressing in recent decades [14]. First, there is a need to define the phenomenon of EA and establish a clear rationale, supported by sufficient scientific evidence, for the mechanism by which exercise can be shown to be an addiction. Second, an evidence base is needed to determine how to categorize EA in relation to other possible mental disorders, and whether EA should be considered a distinct disorder. Logistically, only when the first question has been answered will we know the relevance of the second one. If no evidence can be found that exercise may have negative consequences additional to those caused by over-training, there would be no need to consider exercise as a potential addiction or the processes relating to the development and maintenance of EA and its relationship with other mental disorders. This chapter describes in detail how these issues have been addressed over the past 50 years, and shows that although there is some consensus on the potential harm that can be caused by exercise, there is no agreement about the criteria and the mechanism of action by

which this behaviour can become addictive. This lack of unanimity has limited the definition, measurement, and treatment of EA.

1.2 The Paradox of Exercise Addiction

The overwhelming evidence for the positive effects of exercise has led to campaigns to promote exercise among the general population since the mid- twentieth century. These exercise promotion policies must be understood in the context of the development of welfare states, which have been implemented in developed countries since the Second World War [15]. However, as a larger percentage of the global population has started to exercise regularly, awareness that exercise can also have detrimental effects on some individuals has increased.

The debate about the harmful effects of exercise – and the fact that some people can become addicted to exercise and crave it in a similar way to those who are addicted to psychoactive substances such as alcohol, nicotine, or other drugs [2] – took place in North America in the late 1960s and the 1970s. Darcy Plymire reported a 10-fold increase in the number of regular runners within just one decade in North America in the 1970s [16]. However, what Plymire found most striking was not the notable rise in the number of individuals exercising, but the fact that many of these runners reported running for longer than the average time recommended by institutions for achieving exercise- related health benefits (e.g., improvement in aerobic fitness and cardiac health). This finding suggested that there had to be motivations other than the health benefits highlighted by institutions for spending so much time on this activity. In the context of this debate, the question arises as to when exercise can be considered to be intense and prolonged.

Some scholars have argued that the motivation for runners to engage in long-term activity was more about pursuing human potential or what Abraham Maslow called ‘self-actualization’ [17]. In fact, in line with positive psychology, terms such as ‘optimal experience’ or ‘peak moments’ have been used to describe the positive states of consciousness that many people with a regular exercise regime claim to experience during practice or competition [18,19]. However, in his book titled *Positive Addiction*, William Glasser proposed that a long-distance run of more than an hour could produce a state of euphoria and expansion of the mind which he called ‘positive addiction’ [20]. By coining this term, Glasser wanted to highlight the beneficial effects of exercise, in contrast to addiction to other behaviours that could have negative consequences.

The use of the term ‘addiction’ in relation to a behaviour such as exercise, which has long been considered a positive activity, has been controversial. However, Glasser connected exercising for long periods with withdrawal symptoms, and therefore described it as a positive addiction [20]. He formulated his hypothesis by studying individuals who practised transcendental meditation. People who engaged in this practice reported an altered state of consciousness that had allowed them to make decisive choices and improve their lives. If they did not exercise, they reported experiencing withdrawal symptoms such as depression, anxiety, and guilt. Glasser studied the psych- ology of running, and found that many runners fitted the criteria for positive addiction.

Glasser’s conceptualization of EA as a positive addiction [20] was soon called into question. In fact, some researchers had already pointed out at the end of the 1960s that some exercisers continued to train despite the contraindications they showed for doing so [5]. Baekeland reinforced this observation by indicating the difficulty he had experienced in recruiting athletes to an experiment that attempted to assess the effects of exercise deprivation on sleep [4]. Further

support came from some psychiatric case studies reported by Morgan, who found that physical exercise could lead not only to physical injury but also to the serious neglect of daily work and/or family responsibilities [6]. Morgan recognized the existence of negative effects of EA, warning about its dangers [6]. Thereafter, negative factors associated with exercise, such as injury, overtraining, and psychological dysfunction, were progressively identified and included in the conceptualization of EA [21,22]. Although the positive effects of exercise are still recognized today, there is a consensus that excessive and uncontrolled exercise can have negative consequences for a minority of individuals.

1.3 Criteria for Exercise Addiction

Historically, the debate about EA was focused on long-distance running, specifically because of the amount of time that some individuals spent exercising [16,23]. Unsurprisingly, therefore, the first signs of EA to be addressed were those that defined the characteristics of exercise (e.g., frequency, duration, intensity). Possible harmful effects of addictive exercise were identified, such as biomedical factors (e.g., withdrawal symptoms, tolerance), mental health problems (e.g., depression, anxiety), and social consequences (e.g., neglect of work, family, or other social obligations).

In view of the evidence of various features and consequences of problematic exercise, there is now reasonable consensus that EA, like other substance addictions, should be defined as a set of cognitive, behavioural, physiological, and psychological characteristics [24,25]. Research has shown such close similarities between addiction to behaviours (such as exercise) and drug dependence [2,12] that EA has been defined as a strong desire for physical activity, to the extent that it may involve a lack of control which is manifested as physiological characteristics (e.g., tolerance, withdrawal symptoms) and/or mental health problems (e.g. anxiety, depression) [24,26]. However, despite the consensus on the multidimensionality of EA, the criteria for its diagnosis are less clear. Several strategies have been adopted to identify the features that define EA, four of which are highlighted here.

The first strategy examined the features of EA inductively, through the informed response of individuals who exercise regularly. For example, after interviewing 56 adult female exercisers, Bamber et al. suggested that EA has two essential features: (i) impaired psychological, social, physical, and/or behavioural functioning of the individual and (ii) lack of abstinence or the experience of withdrawal symptoms, related to a reluctance to modify the type of exercise or an inability to reduce the amount of exercise [27]. In addition, Bamber et al. considered a number of features that may be indicative of EA, such as exercising in secret or lying about the amount of exercise performed, denial that there is a problem with exercise, exercising alone, and the development of tolerance (i.e., increasing volume, frequency, and/or intensity of exercise required over time) [27]. This strategy may be of interest if it is assumed that addictions may have multiple and heterogeneous characteristics and comorbidity [28], as it would then be important to identify the specific characteristics that distinguish EA from other types of behavioural addictions.

The second strategy involves identifying features of EA and relating these to substance dependence. In this context, research has focused on defining EA based on the criteria for substance use that are listed in some of the leading clinical manuals. For example, Hausenblas et al. operationalized EA as a multidimensional maladaptive pattern leading to a clinically significant disability or affliction and manifested by the presence of at least three of the following seven criteria that are listed in the fourth edition of the DSM [24]: (i) *tolerance*,

defined either as a need to increase the amount of exercise to achieve the intended effect, or a decrease in the effect with continued use of the same amount of exercise; (ii) *withdrawal*, manifested by either withdrawal symptoms when unable to exercise (e.g., anxiety, moodiness, irritability), or requiring the same (or a similar) amount of exercise to relieve or avoid withdrawal symptoms; (iii) *intention effects* – engaging in larger amounts of exercise, or exercising over a longer time period; (iv) *lack of control* – a persistent desire or unsuccessful attempts to reduce or control the amount of exercise; (v) *time* – a large amount of time is spent engaged in activities involving exercise; (vi) *reduction in other activities* – social, occupational, and/ or recreational activities are reduced or stopped in order to exercise instead; (vii) *continuance* – exercising continually despite awareness that this is causing a persistent psychological or physical problem [29].

The third strategy focuses on adapting the criteria defined for behavioural addictions to the context of exercise. This type of strategy assumes that there are common components that all behavioural addictions share. On the basis of this assumption, Sussman and Sussman conducted an extensive review of the literature on addiction and, after identifying common elements, highlighted the following five essential characteristics that EA would share with any type of behavioural addiction: (i) a high level of commitment to the behaviour in order to obtain the desired effects that it produces, rather than because of the activity itself; (ii) the activity occupies an important place in the individual's life and is prioritized over other activities; (iii) the satisfaction that is experienced during or at the end of the activity leads to a distraction from life's problems, and generates a feeling of happiness; (iv) a lack of control over decision-making about when to stop the activity; (v) the behaviour has negative consequences, which may vary depending on the type of addictive behaviour, but in exercise become more evident over time as individuals cease engaging in other activities and/or spending time with others (e.g., partner, family) [12]. Following this approach, research by Carnes (cited by Griffiths [11]) compared the signs that could be shared by behavioural addiction and substance use disorder, highlighting elements such as a pattern of uncontrolled behaviour, unsuccessful attempts to limit that behaviour, use of the behaviour as an escape mechanism, significant mood changes, and a reduction in other life activities as a consequence of the behaviour [11]. Other authors, such as Brown [30] and Griffiths [31–35], view addictions as comprising several core components. The 'addiction components model' proposed by Griffiths [33] has been used to define EA according to six core criteria for behavioural addiction: (i) *saliency* (exercise becomes the most important activity and dominates the other areas of the individual's life); (ii) *mood modification* (a subjective mood-altering experience is reported as a consequence of engaging in exercise); (iii) *tolerance* (a tendency to need to increase the amount of exercise in order to experience the desired mood-modifying effects); (iv) *withdrawal* (an unpleasant feeling caused by stopping or drastically reducing exercise); (v) *conflict* (exercise being prioritized over other educational and/or occupational activities and interpersonal relationships, and intrapsychic conflict, where the individual knows they should cut down the amount of exercise they are doing but is unable to do so, and experiences a subjective loss of control); (vi) *relapse* (a tendency to repeat the same exercise patterns after a certain time without engaging in exercise).

The fourth strategy involves trying to identify and define features of EA in relation to other associated disorders. The most important example of this strategy is represented by the view that EA is primarily a behaviour used to maintain body weight and shape (e.g., to lose weight) [36–39]. Although the authors of these studies suggest that EA has similar features to substance use disorder and other forms of behavioural addiction (e.g., withdrawal symptoms), they acknowledge that additional features need to be defined to characterize EA in terms of the main disorder from which it is derived. Hence the use of exercise as a form of weight control,

the rigid behavioural pattern, and the positive reinforcement of exercise by its effect on mood are all specific features that have been described for EA associated with eating disorders [36,37]. However, as EA may have high comorbidity and might also be associated with disorders other than eating disorders, it is likely that new specific features will be needed to define EA in relation to these additional disorders. This diversity of features essentially reflects the different ways in which EA can be understood and defined, and highlights the ongoing debate about the relationship between EA and other already recognized disorders.

1.4 The Relationship between Exercise Addiction and Other Mental Disorders

One key question that must be addressed before EA is recognized as a disorder is its relationship to other mental disorders. Underlying this question is the need to clarify whether EA can be considered a distinct disorder – that is, whether the problems associated with EA are due to the behaviour itself, or to other associated disorders [40,41]. It is essential to clarify this in order to enable future categorization of EA within the broader spectrum of mental disorders.

A key point in this debate is the distinction that Veale made between primary and secondary forms of EA [42]. EA is classified as primary when it represents a behavioural addiction in itself, whereas it is considered to be secondary when it co-occurs with another disorder, and according to the literature, secondary EA has generally been identified with an eating disorder, such as anorexia or bulimia nervosa [40,42]. In a primary addiction, the purpose of excessive exercise is to avoid something negative, although the affected individual may be unaware of this motivation. Here exercise provides a way to escape from a disturbing, persistent, and/or uncontrollable source of stress. However, in a secondary addiction, exercise is used as a means of achieving a goal that is characteristic of another dysfunction. For example, in individuals with anorexia nervosa, exercise may be used in addition to a strict diet as a means of losing weight.

The distinction between primary and secondary EA introduced by Veale has important clinical implications, as secondary EA would have a different aetiology to primary addiction, even though many symptoms of EA would be similar in both cases. The key feature suggested by Veale for distinguishing between the two forms of EA was that in primary addiction, exercise is the goal, whereas in secondary addiction, exercise is used to achieve another goal (e.g., weight loss), so exercise is only one of the possible means used to achieve this goal.

However, despite the clinical implications of this, there is currently no consensus on how to differentiate between primary and secondary EA. Although some authors assert that exercise may be a primary source of problems for some individuals [31], other authors maintain that primary EA has rarely been documented and is difficult to differentiate from problematic exercise associated with other disorders (e.g., eating disorders) [21,27,43,44]. Several factors may have contributed to the lack of agreement on how to recognize and differentiate between primary and secondary EA.

First, exercise has traditionally been seen as a healthy behaviour, so its harmful effects are often more likely to be recognized when they are associated with other disorders (e.g., eating disorders) than in relation to exercise itself [45]. Second, research has shown a relatively strong association between EA and eating disorders [46–49]. For example, Shroff et al. found that among a group of women who met the criteria for a diagnosis of anorexia and/or bulimia, 39% over-exercised, and this percentage rose to 54% in the subgroup of women with the purging subtype of anorexia nervosa [50]. Similarly, Klein et al. found that 48% of the women who

were being treated for anorexia nervosa in their study were at risk of EA [51]. A recent systematic review and meta-analysis found that the effect size of the relationship between EA and eating disorders is larger in clinical populations [46], and it has been suggested that the risk of EA among individuals with eating disorders is more than 3.5-fold higher than that for individuals without an eating disorder [49].

Finally, a number of studies have understood the difference between primary and secondary addiction as being based on eating disorders alone [27,44,52,53]. These studies generally define primary EA in terms of the absence of an eating disorder. This view may have been influenced by the fact that Veale himself initially distinguished between primary and secondary dependence mainly with reference to the absence of an eating disorder. In 1987, he stated that 'A distinction should be made between primary exercise dependence and exercise dependence which is secondary to an eating disorder. A diagnostic hierarchy occurs in a case of exercise dependence, whereby the diagnosis of Anorexia Nervosa should be first excluded, followed by Bulimia Nervosa. A diagnosis of primary exercise dependence should only then be made' [42, p. 737].

However, a definition of EA based on the absence of eating disorders does not allow for the possibility that other disorders might be found to be associated with addiction to exercise. It is possible that secondary EA may be associated with other disorders as well as those related to eating. Subsequent research has indeed shown that eating disorders are only one type of disorder associated with EA. For example, in 1995, Veale established the operational diagnostic criteria for primary exercise dependence, and among them he highlighted the criterion that 'the preoccupation with exercise is not better accounted for by another mental disorder (e.g., as a means of losing weight or controlling calorie intake as in an eating disorder)' [40, p. 2]. Therefore Veale's distinction between primary and secondary EA appears to be more nuanced than the interpretation that has sometimes been conveyed in the literature.

To date, there has been little explicit recognition that a secondary form of EA may exist related to disorders other than eating disorders. For example, although Blaydon et al. defended the idea that EA is always secondary, they recognized that it may be linked either to a form of eating disorder or to excessive concern about body image [54]. In the same vein, McCabe and Vincent argued that exercise, together with dieting, is one of the most common ways of modifying body size and shape [39]. However, they understood that excessive exercise should be studied not only in relation to eating disorders, but also in relation to other disorders linked to modification of body size and shape. Exercise, together with control of nutrition, may be used to achieve specific body ideals (e.g., a muscular, thin, lean body) [55,56]. Research has indicated associations between EA and body dysmorphic disorder [57], and it has been suggested that muscle dysmorphia could be reclassified as an addiction to body image [58]. In addition, EA has been associated with other potential disorders related to body care and a concern about health, such as orthorexia nervosa [59,60]. Finally, some studies have found an association between behavioural addictions and other disorders, such as bipolar disorder [61,62]. Therefore, classifications that establish a prevalence of primary addiction in individuals who do not present with a secondary exercise dependence associated with an eating disorder should be avoided, because they do not take into account the possibility that these individuals may have another associated mental disorder. This distinction has important practical and interventional implications, and should therefore be considered when defining what exactly authors consider to be EA.

1.5 Instruments for Assessing Exercise Addiction

To date, several self-report instruments have been designed to assess EA. In parallel with the evolution of the concept, the earliest instruments were one-dimensional assessments and generally referred to a specific activity. One of first was the Commitment to Running Scale, in which EA was conceptualized as lying at one end of a continuum of exercise characterized by a strong commitment to running [63]. This scale was subsequently revised so that it could be applied to commitment to exercise more generally [64]. Other instruments that applied to running, such as the Obligatory Running Questionnaire [65], were based on the view that running addiction is a compulsive activity that shares psychological and behavioural symptoms with those seen in patients with anorexia nervosa. The Obligatory Running Questionnaire was later adapted so that it could be applied to exercise more generally, in the form of the Obligatory Exercise Questionnaire [66]. As the harmful consequences of exercise became more widely acknowledged, new scales such as the Running Addiction Scale [26] and the Negative Addiction Scale [67] were developed to assess both running addiction and general EA. However, these one-dimensional measures assessed only specific aspects of addiction, and did not provide a more comprehensive assessment of the construct [24].

Subsequently, multidimensional approaches have been developed that have drawn parallels between EA and substance addictions, and consequently defined EA as a varied set of symptoms [25,68]. For instance, Davis et al. developed the Commitment to Exercise Scale [69] after examining several published case studies of men and women with clear pathological or excessive exercise habits. The instrument has a two-factor, eight-item structure, and evaluates both the compulsive nature of exercise (e.g., feelings of guilt about missing a training session) and its pathological aspects (e.g., continuing to exercise despite illness or injuries).

Another early multidimensional instrument was the Exercise Dependence Questionnaire (EDQ), developed by Ogden et al. [70]. The authors based their conceptualization of problematic exercise on several criteria for substance dependence included in the DSM-IV, as well as on motivational factors (e.g., physical health, psychological health). Therefore, the EDQ conceptualizes EA as a combination of traditional elements of addiction (e.g., tolerance, withdrawal, repetitive behaviour), but also recognizes the psychosocial aspects of the problem (e.g., effects on interpersonal relationships). However, all of the measures that have been discussed so far lacked a cut-off criterion that could classify individuals at risk of addiction as symptomatic or asymptomatic.

According to recent reviews [71,72] the three most widely used instruments are the Exercise Dependence Scale (EDS) [24], the Exercise Addiction Inventory (EAI) [34], and the Compulsive Exercise Test (CET) [37]. These three instruments, unlike previous ones, have established cut-off points for classifying individuals at risk of exercise as symptomatic or asymptomatic. However, there are differences between these instruments with regard to the conceptualization of EA.

The EDS [24] defines EA in terms of the DSM-IV criteria for substance dependence [29]. This instrument has undergone a revision process [73], and its latest version contains a total of 21 items, comprising seven factors: (i) tolerance, (ii) withdrawal, (iii) intention effects, (iv) lack of control, (v) time, (vi) reduction in other activities, and (vii) continuance. Each of the subscales is represented by three items, and respondents are asked to indicate their response using a Likert scale ranging from 1 (never) to 6 (always). By operationalizing EA according to the seven criteria set out in the DSM-IV, the EDS provides information on the average of each of the factors or the average of the total score. Considering the first option, the EDS allows the differentiation of individuals into three groups, namely those who are at risk of addiction (i.e.,

with scores of 5–6 on the Likert scale for at least three of the seven criteria), those who are symptomatic (i.e., with scores of 3–4 on the Likert scale for at least three criteria, or scores of 5–6 combined with scores of 3–4 for three criteria, but without meeting the conditions for being at risk), and those who are asymptomatic (i.e., with scores of 1–2 on the Likert scale for at least three criteria, but without meeting the conditions for being symptomatic). The structure of the EDS has been validated in a number of different countries [74–77]. Although the EDS has a sound theoretical basis in that it utilizes the symptoms of dependence according to the criteria established in the DSM-IV, given the time it takes to administer the instrument and the complexity of the calculations necessary to identify individuals at risk of addiction, it is arguably not practicable for use in the daily work of sports doctors, physiotherapists, occupational therapists, and sports science professionals.

Unlike the EDS, the EAI [34,35] is an abbreviated and practical instrument for assessing the risk of EA. It operationalizes EA on the basis of the components of behavioural addictions [11,31–33], which is more in line with the new classification offered by the DSM-5. In the EAI, the symptoms of EA are operationalized through six components of behavioural addiction defined by Griffiths, namely salience, mood modification, tolerance, withdrawal symptoms, conflict, and relapse [33]. Each of the six items of the instrument reflects a component of addiction. In addition, based on the total score of its items, utilizing a five-point Likert scale, the EAI serves as a screening tool that can distinguish between individuals who are at risk of EA (i.e., scores of 24 or higher), have some symptoms (scores between 13 and 23), or have no symptoms of addiction (scores between 0 and 12). In a recent update of the EAI, a modification to the item response rating and a new cut-off point (129) for identifying individuals at risk of EA were established [78].

Finally, the CET [37] is based on a cognitive–behavioural conceptualization of EA, viewing it primarily as a weight control behaviour that is maintained by concerns about body weight and body shape [36]. This instrument was specifically designed for use within the eating disorders domain. After the authors had examined the functioning of an initial pool of 31 items through three studies involving independent samples of women, they proposed a final model consisting of 24 items grouped into five factors: (i) avoidance and rule-driven behaviour; (ii) weight control exercise; (iii) mood improvement; (iv) lack of exercise enjoyment; and (v) exercise rigidity. Subsequent studies have reviewed the use of the instrument among different populations [36,79], including athletes [80]. Initially the authors did not propose cut-off points for the CET, but in a subsequent review of a sample of women with clinical eating disorders, Meyer et al. proposed a cut-off point (score of 15) to identify compulsive exercise among patients with eating disorders [79].

Although the EDS, EAI, and CET are currently the most commonly used psychometric instruments in EA research, the possibility cannot be ruled out that new instruments will be developed that will define EA according to criteria in newer editions of the clinical manuals (e.g., DSM-5), or in relation to other disorders as well as eating disorders. Moreover, with a few exceptions, such as the EAI [81], there is a lack of evidence for the instruments' validity and reliability, which would enable them to be used in different countries, cultures, and populations of people who exercise. This has made it difficult to compare the results of studies conducted in different settings and countries, including research in which a range of different instruments have been used to assess EA prevalence.

1.6 Prevalence of Exercise Addiction

The range of different criteria used to define EA, and the diversity of instruments used to assess it, have prevented an accurate estimate of its prevalence. A large number of studies indicate that the prevalence of EA is fairly low, ranging from 0.3% in the general population to 3% in populations who exercise regularly [22,33,73,82]. However, a few studies have reported EA prevalence rates of over 40% [44,83,84] – that is, five to ten times higher than the prevalence rates reported in most studies. The large discrepancy in EA prevalence may be related to three issues that have already been mentioned in this chapter.

First, there is no consensus on a precise conceptualization of the phenomenon. Therefore, as has been highlighted by Sicilia et al. [85], psychometric assessment tools are based on significant conceptual differences with regard to EA. For example, the early instruments, which use the term ‘commitment’ [63,64,69], conceptualize EA only as one end of the exercise continuum. However, as Szabo et al. have warned, the literature may include many studies of EA that measured excessive commitment to this behaviour but which did not assess negative consequences for the individual [86]. On the other hand, the fact that instruments with different conceptualizations assess different features of EA, can lead to differences between population groups. For instance, Weik and Hale assessed EA among people who exercised at a sports centre [87], using the Exercise Dependence Scale-Revised [73] and the

Exercise Dependence Questionnaire [70]. The results were interesting, indicating that when the EDS-R was used, men scored higher than women on abstinence, continuation, tolerance, lack of control, time, desired effects, and the total dependency value, whereas when the EDQ was used, women scored higher. These types of results show that the EDQ and the EDS-R assess different aspects of EA and classify either men or women as more addicted, depending on the instrument used and the dimension highlighted. Therefore, it is logical to assume that instruments designed according to different conceptualizations of EA will show differences in the prevalence of EA [82], and systematic reviews that compare the prevalence of EA using instruments with different theoretical conceptualizations should take this fact into account.

Second, when a particular instrument has been modified or used differently, the reported prevalence is no longer informative. For example, Lejoyeux et al. reported an EA prevalence of 42% among a sample of fitness centre users [83]. However, as the authors themselves acknowledged, they had designed a specific scale for this study according to the diagnostic criteria of Hausenblas and Giacobbi [88], which may explain the discrepancy between their findings and the prevalence reported with other instruments, such as the EDS. Similarly, Serier et al. found an EA prevalence of 41.7% in a group of women with unequivocal body dissatisfaction [84]. However, although these authors assessed EA using the Obligatory Eating Questionnaire [66], for this study they arbitrarily created a cut-off point of above 50 to classify individuals as being at risk of EA. These practices may account for the significant discrepancy in the prevalence of EA even when it was assessed using the same instrument.

Third, the target populations in different studies of the prevalence of EA have varied widely, and have included, for example, runners, ultra-marathoners, cyclists, university students, university student subgroups (e.g., sports science students), bodybuilders, fitness centre users, and elite athletes. Associated with this wide range of samples, not only sports modalities but also the amount of time spent exercising by participants in the studies have varied widely. Due to this great diversity, the items on the assessment instruments have been interpreted in different ways. For example, Szabo et al. suggest that the high scores on psychometric instruments that are shown by elite athletes compared with other populations should not be attributed to higher morbidity, but interpreted in relation to a high level of commitment to their profession [89].

Such differences in interpretation may well occur in relation to other population groups depending on, for example, gender or culture, and they highlight the need to provide evidence that instruments which are used to compare prevalence show measurement invariance across different population groups.

Finally, most studies of EA have been conducted using self-report assessment instruments. Consequently, the questionnaires and scales used have assessed the susceptibility to dysfunction in terms of the presence or intensity of symptoms associated with the addiction. These screening tools have limited diagnostic value, as a high score may not necessarily indicate harm or damage to the individual. If a person is identified as being at high risk for EA on the basis of psychometric instruments, this should be verified with a subsequent clinical interview and the use of scientifically validated criteria to confirm whether exercise behaviour has negative consequences for this individual. As has been highlighted by Szabo et al., there is a 'grey area' between the classification of being at risk and having a disorder, because the context of the individual and what exercise entails within that context is not known [89]. For the analysis of this context the clinical interview is a more precise approach than a self-report scale, especially with regard to assessment of the possible harm and lack of control that the behaviour produces in an individual.

1.7 Working towards a Consensus on the Definition of Exercise Addiction

Since the research conducted in the late 1970s, there has been a continuous attempt to identify the negative aspects of physical exercise as opposed to its more familiar positive effects. During that time, many terms associated with EA have emerged, such as 'exercise commitment', 'addictive exercise', 'abusive exercise', 'compulsive exercise', 'excessive exercise', 'exercise dependence', and 'obligatory exercise' [24,27,36,65,66,69]. These terms reflect the historical evolution of the phenomenon and the debates that have taken place around it [85]. Despite their conceptual diversity, all of these terms highlight possible negative effects of physical exercise, and describe a condition in which the practice of moderate or intense exercise becomes a disruptive behaviour for the individual. In an attempt to focus more on this common characteristic than on the differences, the terms 'problematic exercise' and 'morbid exercise' have been introduced [3,46,90]. These more generic terms refer to a form of exercise in which the individual loses control over their behaviour, and the behaviour is maintained despite the physical and psychological damage that it causes.

Despite the acceptance of the multidimensionality and complexity of EA, and the fact that this form of uncontrolled practice has negative consequences for the individual, the research findings have been somewhat ambiguous, due to the fact that to date the terminology of the constructs surrounding this phenomenon, their definition, and the measures designed to evaluate them have been so diverse. This presents a challenge for fundamental and applied research in the future, as the factors that prevail in, co-occur with, and perpetuate EA are still not entirely clear, making its prevention and treatment difficult.

1.8 Treatment of Exercise Addiction

Approaches to EA treatment often vary depending on whether the EA is viewed as primary or secondary. In cases of secondary addiction, treatment has been more frequent when EA has been associated with an eating disorder. Since eating disorders have long been recognized in the major diagnostic manuals (specifically the *Diagnostic and Statistical Manual of Mental Disorders*, and the *International Classification of Diseases*), there is much more literature

available on how to treat them. However, there is also a risk that when EA and an eating disorder co-occur, the eating disorder will be treated at the expense of EA, as has been pointed out by Freitmuth et al. [68]. As eating disorders are the best known and officially recognized disorders, they may be the focus of treatment, and the problem of EA may remain hidden. Moreover, treatment for EA associated with other disorders and for primary EA is even more limited, since its prevalence is lower.

Since EA is not a recognized clinical disorder, one approach to looking for treatment strategies that may be effective has been to observe what specialists do in their daily practice. For example, Adams and Kirkby interviewed 24 sports physiotherapists to examine the problems they encountered and the strategies they used to treat patients with EA [91]. Re-education of the individual and especially their relationship with exercise can help to prevent the transformation of exercise activity from healthy to unhealthy. The authors highlighted the fact that many people who exercise are not aware that exercise is a problem [21,91], and consequently have difficulty recognizing and accepting a diagnosis of EA [45]. This inability to accept that exercise has become problematic reduces the likelihood of treatment success. Education programmes generally involve providing effective information and also details about training programmes to enable the individual to learn how to differentiate between unhealthy exercise-related behaviour and healthy behaviour. These education programmes are advisable when unhealthy behaviour (e.g., overtraining) appears to be the result of a poor understanding of the negative health consequences of the individual's actions [21]. However, in combination with re-education of exercisers, physiotherapists sometimes recommend alternative exercise activities, since by changing their exercise routine or alternating it with other types of exercise, people who exercise are sometimes able to modify their training schemes. One of the challenges for physiotherapists when implementing EA interventions is to differentiate between healthy and unhealthy exercise. Unlike other behaviours or substance intake, where engaging in the behaviour or consuming the substance do not bring any positive benefit, exercise is a type of behaviour that has proven health benefits when performed properly, and indeed is used as an adjunct for the treatment of other addictions and disorders, such as anxiety and stress disorders, schizophrenia, eating disorders, prenatal and postnatal depression, attention deficit hyperactivity disorder, and substance use disorders [1,7]. Research has shown that prolonged exercise withdrawal can have negative effects on mental health [1,92]. Therefore, interventions should be focused not on the elimination of exercise behaviour, but on its control – that is, on re-education about its practice, where changing the activity or the way it is carried out can be an appropriate strategy.

Along with physiotherapists, other exercise-related professionals (e.g., trainers, instructors, personal trainers) may help to identify and attempt to prevent the negative consequences that exercise may have for some individuals. A survey by Colledge et al. showed that more than 70% of sports centre employees reported that they had observed at least one client whom they suspected of having an eating disorder or engaging in excessive exercise [93]. In addition, these employees reported that they felt able to identify when excessive exercise might be linked to eating disorders. This suggests that professionals who guide or supervise the daily exercise of population groups could (with the help of guideline documents or in collaboration with associations and centres for the treatment of these disorders) offer qualified guidance and/or educational programmes for the re-education of individuals with suspected EA.

However, in cases where a combination of educational programmes and the proposal of alternative forms of exercise is unsuccessful, physiotherapists and other professionals should direct the exerciser towards psychological treatment. For example, EA treatment can be based

on treatments for other addictions, even though the processes involved in the different forms and manifestations of EA have not yet been fully clarified. Two interventions derived from the treatment of other addictions, namely motivational interviewing and cognitive-behavioural therapy, appear promising when applied to EA. Based on the transtheoretical model of motivation [94], motivational interviewing techniques aim to generate an intrinsic motivation for change. Individuals move from a pre-contemplative phase, in which there is not yet an intention to initiate treatment, to a phase that is more committed to action and behaviour change. This intervention is based on the view that an individual who is not at an appropriate stage to change is unlikely to commit to treatment. The second type of intervention, cognitive-behavioural therapy, is an effective form of therapy that has been used in substance abuse and other behavioural addictions, such as gambling disorder [95]. Here the therapist encourages the exercise addict to identify and correct the automatic and irrational thought processes that lead to emotions and maladaptive behaviours for that individual. In this way, the therapist helps them to understand how their irrational thinking can result in uncontrollable over-exercise. Cognitive-behavioural therapy can be combined with contingency management, in which the client is regularly tested to ensure that they do not engage in exercise in an undesirable way, so that their behaviour change is associated with rewards [21].

1.9 Future Directions in Exercise Addiction

In general, EA can be understood as a person's inner urge to exercise in an uncontrolled way, as they maintain the intention to exercise despite the harmful consequences of this behaviour [24,31,42]. However, EA is manifested in various forms, and can occur in individuals who exercise in different ways and for different reasons. Studies that examine features which are characteristic of individuals who regularly exercise may be informative. However, one limitation is that the lack of clinical criteria for defining EA makes it difficult to identify individuals as clinically addicted to exercise. This has led to the identification of features not only in other behavioural addictions and substance use disorders, but also in other disorders that might be associated with EA. However, the diagnosis and treatment of EA are still difficult to implement, due to the lack of specific diagnostic criteria for this particular addiction. Several points relating to the future development of these criteria should be considered.

First, the concept of EA has evolved over the past few decades, and a more satisfactory definition is needed that includes other associated terms and concepts. Although problematic exercise has been widely associated with eating disorders, there is increasing evidence that underlying some forms of EA there may also be other potential disorders associated with body image [58,59,96]. Therefore, the diversity of terms used to refer to problematic exercise may indicate that there are a number of different manifestations of EA. Therefore the development and validation of diagnostic criteria for EA will need to ensure that these are broad enough to capture the different features of all the possible manifestations of this disorder.

Second, although the multidimensional nature of EA is now well recognized, there is no consensus on the core criteria for this disorder. Furthermore, attempts to define addiction include different elements or dimensions that can occur separately depending not only on the type of addiction, but also on the personal characteristics and specific socio-cultural circumstances surrounding this behaviour. As a result, there has been a tendency to define this phenomenon as a set of elements when in fact each of those elements might represent different phenomena that do not usually occur together [12]. Some authors, such as Shaffer et al., have proposed alternative ways of thinking about this phenomenon, and suggested that addiction (which by definition could include EA) should be thought of as a syndrome that can have

different forms of expression [97]. In this sense, a syndrome would allow EA to be thought of as a cluster of symptoms reflecting an abnormal underlying condition. Viewing EA as different clusters of symptoms would enable researchers in the field to explore this addiction as a broad family of different manifestations that can be individually distinguished by their specific combinations of factors, rather than as a single pathological phenomenon.

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Finally, excessive exercising was conceptualized as a problem when the negative consequences of this behaviour for some individuals began to be investigated and assessed. If excessive exercise had no negative consequences, and the experience was always positive and beneficial in the ongoing development of the individual, it would not make sense to talk about addiction, at least in the sense in which this term is used to refer to other substances or behaviours [3,89,98]. Therefore, one future challenge will be to characterize the defining elements of EA. In this process, only elements that result in functional impairment, psychological distress, and/or a clear separation from normative behaviour in context should be considered [99]. This will require a more detailed examination of precisely when the individual's relationship to exercise behaviour becomes problematic. Similarly, although psychometric instruments can serve as a screening tool, context assessment is crucial when evaluating the harm that exercise causes in the individual's life [45,89].

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