Szabo, A., Griffiths, M.D. & Demetrovics, Z. (2018). Morbid exercise behavior: Addiction or psychological escape? In M. Wegner & H. Budde (Eds.), *Exercise and Mental Health: Neurobiological Mechanisms* (pp. 277-311) New York: Taylor & Francis.

4.3.1 Introduction: Definition and Terminology

Competitive athletes train hard and for long hours within a well-balanced schedule, having full control over their exercise behavior. Sometimes, the same exercise pattern may also be observed in leisure exercisers. However, a very small proportion of these people may lose control over their exercise behavior and experience the compulsive need to engage in the activity at unpredictable times, that is determined by the severity of an inner urge. This "inner urge" may occasionally be the attempt to conquer something behind an individual's ability (like running a marathon in a subjectively perceived possible time-frame that is in discord with the physical ability of the person), or more often may be *to escape* from something to cope with and/or escape something in their lives (e.g., job stress, relationship problems, etc.). Exercising to the point where an individual *loses control* over the behavior that becomes obligatory and leads to physical and mental damage is referred to as *exercise addiction* (Griffiths 1997; Thaxton 1982). The same concept is also often described as *exercise dependence* by a number of scholars (e.g., Cockerill and Riddington 1996; Hausenblas and Symons Downs 2002). Furthermore, scientists have often referred to the condition as *obligatory exercising* (e.g., Pasman and Thompson 1988), by stressing the *compulsive* aspect of the behavior. Indeed, in the mass media, exercise addiction is also frequently termed *compulsive exercise* (Eberle 2004), or as *exercise abuse* (Davis 2000). It is important to re-emphasize that all these seemingly synonymous terms, are theoretically intended to label the *same* psychological condition (Figure 4.3.1). However, there are several reasons why alternating the terminology in naming the same phenomenon may be unproductive. There is a convincing argument for differentiating addiction from dependence (O'Brien, Volkow and Li 2006). While the term *dependence* is often "carelessly" used as a synonym for addiction, the latter includes the former, and also includes *compulsion* (Goodman 1990). Accordingly, the general formula for addiction may be described as: *addiction* = *dependence* + *compulsion.* Consequently, by adopting the term "dependence", one misses a key component of

the morbid exercise behavior that is the urge or *compulsion,* which is the main propelling force behind the disorder. Goodman highlights that not all dependencies and compulsions may be classified as addiction(s).

Figure 4.3.1

4.3.2 Primary and Secondary Exercise Addiction

In addition to terminology issues, there is a conceptually incorrect separation between two similar exaggerated forms of exercise behavior in the academic literature. The terms 'primary exercise dependence' and 'secondary exercise dependence' were used by De Coverley Veale (1987) to differentiate between compulsive exercise with no other comorbid behavior (addiction), or an obligatory form of exercise that surfaced as a comorbidly with other behaviors such as eating disorders (i.e., anorexia nervosa, bulimia, binge eating, etc.). Some authors (including one of the present authors) have rejected the concept of secondary exercise addiction (Szabo 2010), because the purpose of the exaggerated exercise in eating disorders is to lose or control one's weight. Consequently, exercise is an auxiliary means of achieving an end. In the "actual" (or primary) exercise addiction. the uncontrolled workouts represent a false expectation for solving or avoiding something importing to the person via the high volume (and also intensity in some cases) of exercise.

Indeed, exercise addiction has two distinctive features, that in addition to high risk scores on screening tools, should affirm the morbid nature of the behavior. The first is *loss of control* and the second is a *negative consequence* to the physical or social health of the person. A false belief, or the expectation that exercise is the solution (for example) to escape stress, is also a general feature of exercise addiction. This false belief, leading to (i) compulsive urges and tolerance, (ii) frequent and intense exercise sessions at times when the urge becomes unbearable, and (iii) exercise tolerance with short-duration relief after exercise, represent a morbid pattern of the behavior. In contrast to eating disorders, exercise addiction involves the

loss of control, the uncontrolled urge to exercise, and a compulsion fuelled by false expectation(s). These are the morbid aspects of the exercise behavior that are not usually observed in eating disorder, which is a relatively common morbidity in contrast to primary exercise addiction which is much rarer. In fact, Bamber, Cockerill and Carroll (2000) suggested that primary exercise addiction may not even warrant serious scholastic attention. In spite of the ongoing heated debate in acknowledging primary and/or secondary exercise addiction, Veale (1995) affirmed that primary exercise addiction exists but it is very rare. This assertion of rarity is corroborated by empirical research showing that the risk for exercise addiction is approximately 0.3% - 05% of the population (Mónok et al. 2012). The present authors believe that high volumes of exercise could only be perceived as morbid when addiction is also present, that usually means an escape and temporary psychological relief from the pain of something else in the person's life. In most eating disorders, the morbidity is associated with various psychological problems resulting in distorted and an unacceptable body image and self-concept. One should be able to see the relatively large difference between escape and or pain-avoidance (in exercise addiction) and drive for thinness (in eating disorders). Therefore, exercise addiction should not be classified as primary or secondary, but simply as a morbid pattern of behavior.

4.3.3. Diagnosis and Risk-Assessment of Exercise Addiction

It should be emphasized that the diagnosis of exercise addiction cannot be made without an in-depth clinical interview, identifying the causes, the etiology and the consequences of the behavior. These interviews should not only look not for presence of symptoms, but also to the severity of the symptoms of addiction and the risk of damage to the physical and mental health of the individual. Any existing, or foreseeable, detrimental health effects, in parallel with the observance of the markers of other behavioral addictions (i.e. gambling disorder) in DSM-5 (Diagnostic and Statistical Manual for Mental Disorders (5th edition; American

Psychiatric Association, 2013), should be interpreted as indices of the morbid exercise pattern.

The *risk*, or proneness, for morbid exercise behavior can be approximated with brief screening tools. Several screening measures have been developed for assessing exercise addiction. Most of them are based on the most common symptoms of behavioral and/or chemical addictions. In general, the frequency and intensity of the symptoms reported by the tested individuals are computed to generate a score that may reflect exercise addiction. However, these self-reported scores only mirror the *risk* for the morbidity, which by no means should they be interpreted as a diagnosis.

4.3.3.1 The Obligatory Exercise Questionnaire (OEQ)

The OEQ was among the first instruments developed to assess exercise addiction and was modified from the original Obligatory Running Questionnaire (ORQ – Blumenthal et al. 1984). Later, the OEQ was modified to a version that was a more general measure of running and exercise activity (Thompson and Pasman 1991). The new version of the scale consists of 20 items relating to running or exercise habits, and are rated on a 4-point frequency scale: 1-never, 2-sometimes, 3-usually, 4-always. Two of the items are inversely rated during scoring. The psychometric properties of the tool have been well established (Coen and Ogles, 1993). The internal reliability (Cronbach α) of the OEQ was reported to be α =. 96 and its concurrent validity was r =.96 (Thompson and Pasman 1991).

4.3.3.2 The Exercise Dependence Questionnaire (EDQ)

The EDQ was developed with a sample of 449 participants who exercised for more than four hours a week (Ogden, Veale, and Summers 1997). The scale consists of 29 items and includes eight subscales: 1) interference with social/family/work life, 2) positive reward, 3) withdrawal symptoms, 4) exercise for weight control, 5) insight into the problem, 6) exercise for social reasons, 7) exercise for health reasons, and 8) stereotyped behavior. The EDQ has moderate to

good internal reliability, ranging from α =. 52 to α =. 84. Its concurrent validity with other instruments has not been reported. Furthermore, certain items assess attitudes and social practices rather than addiction.

4.3.3.3 The Exercise Dependence Scale (EDS)

The EDS is a popular and well-validated instrument developed by Hausenblas and Symons Downs (2002) The authors use the term exercise *dependence* rather than exercise addiction. Dependence is described as a craving for exercise that results in uncontrolled and excessive workouts and manifests in the form of physiological symptoms, psychological symptoms, or both (Hausenblas and Symons Downs 2002). The EDS was based on the earlier *Diagnostic and Statistical Manual of Mental Disorders* criteria for substance dependence (DSM-IV - American Psychiatric Association, 1994). This measure differentiates between at-risk, non-dependent-symptomatic, and non-dependent-asymptomatic exercisers. It also specifies whether individuals may have a physiological dependence or non-physiological dependence. All the items on the EDS are rated on a six-point Likert scale, ranging from 1 (never) to 6 (always). Evaluation is made in reference to the DSM-IV criteria (APA, 1994), screening for the presence of three or more of the following symptoms: 1) tolerance, 2) withdrawal, 3) intention effects (exercise is often taken in larger amounts or over longer period than was intended), 4) loss of control, 5) time (too much time is spent in activities conducive to the obtainment of exercise), 6) conflict, and 7) continuance (exercise is continued in spite of recurrent physical or psychological problems caused by exaggerated exercise). The EDS provides a total score and subscale scores. The higher the score, the higher is the risk for *dependence*. It has been shown that the scale possesses good internal reliability (α =. 78 to α =. 92) and test–retest reliability (r = 0.92). Not long after the development of the original scale, an improved (fully revised) scale was released by the developers (Symons Downs,

Hausenblas, and Nigg 2004). The EDS has excellent psychometric properties, and has been translated in several languages, including Spanish (Sicilia and González-Cutre 2011).

4.3.3.4 The Exercise Addiction Inventory (EAI)

As noted earlier, loss of control and negative consequences are prime classifying components of the morbidity. Griffiths (2005) proposed a modified *components model* for behavioral addictions based on the earlier work of Brown (1993). This model comprises six symptoms that are common to all addictions: 1) salience, 2) mood modification, 3) tolerance, 4) withdrawal, 5) conflict, and 6) relapse. Griffiths conceptualizes that addictions are part of a biopsychosocial process and there is growing evidence that all addictions appear to share these symptoms.

These six components of addictions served the theoretical basis for the Exercise Addiction Inventory (EAI; Terry, Szabo, and Griffiths 2004). The EAI is a short, psychometrically validated questionnaire that comprises only six statements, each corresponding to one of the six symptoms in the components model of addictions (Griffiths 2005). Each statement is rated on a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The suggested EAI cutoff score for individuals considered at-risk of exercise addiction was originally defined as 24 (i.e., most answers agree or strongly agree with the presence of the six symptoms). However, this cutoff point was never tested psychometrically. The EAI was developed on the basis of an opportunistic sample of 200 habitual exercisers in the United Kingdom. The internal reliability of the original scale was excellent ($\alpha = 0.84$) and concurrent validity was also high ($r = 0.80$). A recent study by Griffiths et al. (2015) collated data gathered from EAI use in five nations (N=6,031). Confirmatory factor analyses using the combined dataset supported the configural invariance and metric invariance, but not scalar invariance, showing a vulnerability in cultural and gender-related interpretation. The internal reliability was also lower than that of the original scale, ranging between $\alpha = .58$ (USA) to $\alpha =$

.80 (UK). It should also be noted that the USA sample consisted of elite triathletes, and as discussed later, may have interpreted EAI items differently than non-elite athletes.

4.3.3.5 Other less frequently used tools in the assessment of exercise addiction

Before the development of reliable and psychometrically validated tools for gauging the risk for exercise addiction, exercise morbidity was investigated by using in-depth interviews (Sachs and Pargman 1979) and the *Commitment to Running Scale* (CRS; Carmack and Martens 1979). However, as its name implies, the CRS measures *commitment*, rather than addiction. Therefore, its use in exercise addiction research has been criticized (Szabo 2010). While addiction is clearly a morbidity, commitment to exercise implies a dedicated involvement in the activity for mastery and enjoyment (as already discussed).

The Negative Addiction Scale (NAS; Hailey and Bailey 1982) has been used primarily with runners. Its items measure the psychological rather than physiological aspects of compulsive running. No psychometric properties were reported for the original scale, but a recent translation in Portuguese language reported that the questionnaire had good internal consistency (Cronbach $\alpha = .79$; Modolo et al. 2011).

The Exercise Beliefs Questionnaire (EBQ; Loumidis and Wells 1998) assesses personal assumptions about exercise behavior on the bases of four factors: 1) social desirability, 2) physical appearance, 3) mental and emotional functioning, and 4) vulnerability to disease and aging. The instrument's internal reliability is relatively good, ranging between $\alpha = .67$ and $\alpha = .89$ and its concurrent validity ranges between $r = .67$ and $r = .77$.

Another instrument, the *Bodybuilding Dependency Scale* (BDS; Smith, Hale, and Collins 1998), was specifically developed to assess excessive exercise in bodybuilders. The BDS contains three subscales: 1) social dependence (i.e., individual's need to be in the weightlifting environment), 2) training dependence (i.e., individual's compulsion to lift weights) and 3) mastery dependence (i.e, individual's need to exert control over his/her training schedule).

Each subscale showes satisfactory internal consistency (α = 0.78, 0.76, and 0.75 respectively; Hurst et al. 2000). Because of its sports (or workout) specificity, the BDS has restricted range of applicability in sport and exercise psychology.

Despite the name, the *Compulsive Exercise Test* (CET; Taranis, Touyz, and Meyer 2011) may not be directly related to exercise addiction. Primarily, it is claimed to be a tool that assesses morbid exercise pattern specifically developed to aid studies examining eating disorders. The CET is based on a cognitive-behavioral framework and has 24 items and five subscales that assess avoidance and rule-driven behavior, weight control form of exercise, mood improvement, lack of exercise enjoyment, and exercise rigidity. The psychometric validation of the CET revealed good internal consistency, content validity, and concurrent validity.

The *Exercise Dependence and Elite Athletes Scale* (EDEAS) was developed by McNamara and McCabe (2013) with the aim to study morbid exercise pattern in competitive athletes. The 24-item EDEAS has six factors: 1) unhealthy eating behavior, 2) conflict and dissatisfaction, 3) more training, 4) withdrawal, 5) emotional difficulties, and 6) continuance behavior. The internal reliability of the scale was reported to be acceptable (i.e., α > .60). Based on the developers' report, the EDEAS appears to have good concurrent validity as well. To date, this instrument has only been adopted in a few studies.

4.3.3.6 A note of caution on the interpretation of scalar tools

As noted earlier, screening tools primarily assess the *risk* for exercise addiction. However, few of those classified at risk – based on scalar measures – may turn into addicts. As discussed later, the more recent models forwarded for exercise addiction, recognize a *triggering factor* (a switch) in the onset of the morbidity that contradicts the continuum view or the slowly growing and accumulating evolutionary perspective (Figure 4.3.2).

Figure 4.3.2

4.3.4 Theoretical Explanations for Exercise Addiction

4.3.4.1 The Sympathetic Arousal Hypothesis

This physiological model claims that sympathetic adaptation to regular exercise lowers the overall level of arousal (Thompson and Blanton 1987). Lower levels of arousal may be experienced as a lethargic or low-energy state. This uncomfortable feeling urges the person to increase the level of arousal. For the regular exerciser, their exercise activity is an obvious way to increase arousal. However, since the effects of exercise in increasing arousal are relatively short-lasting, increased bouts of exercise are necessary to generate an optimal state of arousal, and eventually leads to tolerance. An issue with this model is that sympathetic adaptation to exercise occurs in everyone, while not all exercisers become addicted.

4.3.4.2 The Cognitive Appraisal Hypothesis

Another model, proposed by Szabo (1995), suggests that exercise addiction occurs when exercise becomes a means of coping with cognitive stress. Here, repeated and heavy sessions of exercise provide an escape from stress. Once exercise is used for coping with stress, the individual also depends on it to function. When exercise is not possible for any reason, psychological hardship occurs (i.e., withdrawal symptoms). In fact, the loss of exercise may mean the loss – or the inability – of coping. Therefore, the exerciser loses control that generates further vulnerability to stress by amplifying the negative feelings associated with the lack of exercise. The problem can only be resolved via the resumption of the previous pattern of exercise often at the expense of the other obligations in the individual's daily life. While this model perceives exercise addiction as a means of coping or escape, it only accounts for the maintenance of addiction, but not for its onset.

4.3.4.3 The Four Phase Model

The four phase hierarchical model was proposed by Freimuth, Moniz and Kim (2011). In the first phase, they argue that exercise is pleasurable and it is under control. There are no negative

experiences, apart from minor strains or muscle soreness. In phase two, the psychological benefits of exercise are more specifically used and the mood-modifying effects can be adopted for coping with stress. Addiction is most likely to occur when exercise becomes the primary or the sole means of coping with stress. Thus, the second phase may pinpoint the onset of exercise addiction, but it does not specify two key issues: 1) a major life stress must exist (whether that is a progressively mounting passive stress or a suddenly appearing uncontrollable form of stress), and 2) it is not known under what conditions or influences exercise will be adopted for coping with the stress. In the third phase, the daily activities are rigidly organized around exercise and the negative consequences are evident. Exercise is performed individually, rather than with friends, in a team, or during scheduled fitness classes. In the fourth stage, the typical symptoms of addiction – such as tolerance, conflict, need for mood modification, withdrawal symptoms and relapse – become evident and the exercise controls the individual rather than vice-versa.

4.3.4.4 The Biopsychosocial Model

The biopsychosocial model contrasts with several conceptualizations of exercise addiction. It was put forward for the explanation of exercise addiction in elite athletes (McNamara and McCabe 2012). In the present authors's view view this may be very unlikely. The model states that exercise addiction has a biological factor (e.g., BMI) as its route of origin in the elite athletes. Social and psychological processes may interact to determine whether exercise addiction occurs or not. However, Freimuth et al. (2011) asserted that hard training for long hours, and ambitious strivings in becoming the best – that which characterizes successful elite athletes – should not be confused with the symptoms of addiction.

4.3.4.5 The Interleukin Six (IL-6) Model

Another theoretical model has highlighted the possible role of interleukin six (IL-6) in exercise addiction (Hamer and Karageorghis 2007). The IL-6 is a pro-inflammatory and anti-inflammatory cytokine secreted by T cells and macrophages to increase the immune response to

trauma, such as burning or other types of tissue damage leading to inflammation. The blood concentration level of IL-6 increases during exercise (Aguiló et al. 2014), and higher levels of IL-6 are associated with increased cardiovascular mortality, depression and negative affect (Puterman et al. 2014). Hamer and Karageorghis (2007) suggest that IL-6 acts as a link from the periphery to the brain. This link may mediate the components of exercise addiction. In people prone to the morbidity, exercise results in a momentary reduction in negative affect. However, at the same time it raises the synthesis of IL-6 and activates the neuroendocrine pathways, which contribute to the negative feelings manifested through the experiencing of withdrawal symptoms. Therefore, exercise acts as a vicious circle by lowering and increasing negative affect. This is a psycho-neuroimmunological model that deserves further research attention.

4.3.4.6 The Monoamine Model

The monoamine model is derived from the early observation that exercise triggers an increase in the levels of catecholamines in the peripheral blood circulation (Cousineau et al. 1977). Later, Szabo, Billett and Turner (2001) showed that a 30-minute episode of medium to high intensity aerobic exercise increased uric phenylacetic acid levels – reflecting the phenylethylamine concentration – in healthy males who were habituated to exercise. While catecholamines, among other functions, are involved in the stress response, phenylethylamine is more closely linked to changes in mood. In light of the monoamine hypothesis, it is thought that in addition to an increase in monoamines in the peripheral circulation, the central aminergic activity may also rise in response to exercise. Since brain monoamines are involved in the regulation of mood and affect, their alteration by exercise seems to be an attractive explanation for the role of exercise in the stress response. This is a psychophysiological model that is probably more closely linked to the positive mood-enhancing effects of exercise that exercise addiction *per se.* Nevertheless, in light of this model exercise may act as a buffer in the addiction process, in that the negative emotional experiences resulting from life stress are soaked up by the positive effects of exercise.

4.3.4.7 The Endorphin Model

This endorphin model is popular in the literature, and posits that exercise leads to increased levels of beta-endorphins in the brain, that it turn act as internal psychoactive agents by generating feelings of euphoria. In fact, this hypothesis may be analogous to substance or recreational drug addiction (e.g., heroin, morphine, etc.) with the exception that the psychoactive agent (beta-endorphin) is generated *internally* during exercise instead of being administered externally. Endogenous opioids are involved in modulating several of the sensory, motivational, emotional, and mental functions (McNally & Akil, 2002). A novel investigation, using positron emission tomography (PET), found that acute exercise – performed between aerobic and anaerobic threshold for 60 minutes – resulted in an increase in the availability of μ-opioid receptors in anterior cingulate cortex, prefrontal-, and temporal cortex of young healthy recreational exercising men (Saanijoki et al. 2014). While further research is this area is needed, the opioid response to exercise is likely to be workload- or dose-dependent in addition to individual variability, and could be one of the several explanations for exercise addiction in connection to stress management.

4.3.4.8 The Pragmatics, Attraction, Communication, Expectation (PACE) Model

The PACE model is not specific to exercise addiction *per se*, because it was proposed for behavioral addictions in general (Sussman et al. 2011). According to this model, when a situation gets out of control, the individual will *gravitate* towards the means of available coping, reflected by the 'Pragmatics' phase in the model. The selection of the coping mechanism is determined by conscious and subconscious analysis via interactions between individual characteristics, situational factors, and (in case of exercise addiction) earlier history of exercise behaviour (that is reflected in the 'Attraction' part of the model). This attentional focus in the decision forms the 'Communication' part of the PACE model, in that experience, interpersonal and intra-personal thoughts, beliefs, and convictions will influence the decision about the means of coping selected

by the person. In the final part of the model, the choice is determined by the 'Expectation' (i.e., exercise yielding a solution to the problem). The interactional model presented in the next subsection, developed specifically for exercise addiction, is in full accord with the PACE model.

4.3.4.9 The Interactional Model of Exercise Addiction

A shortcoming of the above listed models for exercise addiction is that they do not provide an explanation for the choice of exercise as a means of coping. Egorov and Szabo (2013) stress that there is an interaction (see Figure 4.3.3) between several factors, including (but not restricted to) personal/social values, social image, past exercise experience, actual life situations, etc. that determine whether an individual will use exercise for coping or resort to other means of dealing with stress. The number of interactions between situational and personal factors is so large the each case is idiographic in a mindset akin to a “black-box”. The box can only be opened during diagnosis with the help of mental health professionals. Indeed, exercise addiction, unlike other chemical or behavioral addictions, has a unique characteristic not present in other addictions, which is the physical effort. Earlier it was proposed, based on preliminary laboratory evidence, that exercise acts as cathartic-buffer for stress (Szabo and Tsang 2003). When faced with a stressor, regular exercisers – knowing the mood improving effects of exercise from past experience (Freimuth et al. 2011) – may resort to exercise to cope with the challenge. However, not all exercisers will try to reduce the pain of a novel emotional hardship with exercise, but instead may resort to passive forms of escape behaviors or addiction(s). Therefore, the Interactional Model of exercise addiction (Egorov and Szabo 2013) claims that each case is relatively unique and the nomothetic approach in predicting the etiology of the morbidity may be unproductive. Building from case studies (via an inductive approach) may be the way towards a better understanding of the morbidity. A deeper consideration of the model, allows the realization that the research into exercise addiction does not – in fact – deal with the morbidity,

but simply the presence and severity of the symptoms that occur in it and, therefore, may be perceived as *risk factors*.

Figure 4.3.3

4.3.5 Research Trends in Exercise Addiction

A three year analysis of published research using *PubMed* and *Google Scholar* databases found 128 papers dealing with exercise addiction (Szabo et al. 2015). This number reveals that there are approximately 40 publications per year in the area of exercise addiction over recent years. The 128 papers appeared in a 89 different journals, indicating that exercise addiction appears to be studied from a multidisciplinary perspective. The majority of the research in the field (>50%) came from the USA, UK and Australia, but researchers from 25 other nations also contributed to the field (Szabo et al. 2015).

Based on this bibliometric analysis, research examining exercise addiction can be broadly grouped into two categories: (i) survey research, that measure the prevalence and risk for exercise addiction in various exercise- and social contexts, and (ii) methodological research aimed at developing, validating, and testing assessment tools, mainly questionnaires (see Table 4.3.1). Research into exercise addiction significantly rose after two psychometrically valid and reliable tools were developed, namely the EDS and the EAI. In fact, as also illustrated in Table 4.3.1, most (over 80%) of the studies have adopted the EDS or EAI, with or without additional tools, in their investigations. It is also worth noting that from the past 20 years of research examining exercise addiction, there is an extremely wide range of prevalence estimates reported for its morbidity (see Table 4.3.1), ranging from 0.3% (Mónok et al. 2012) up to 42% (Lejoyeux et al. 2008). This is most likely explained via the use of sampling techniques (mostly convenience samples), different samples (different kinds of exercisers, student populations, the general public), and different screening measures employed.

Table 4.3.1

4.3.5.1 The prevalence of risk for exercise addiction

Diagnosed cases of exercise addiction have not been reported in the literature, because the morbidity is not listed as a mental disorder in any version of the DSM, and therefore clinical diagnosis is not possible (Szabo et al. 2015). To the best of these authors' knowledge, only three case studies have been published in journals or book chapters (i.e., Griffiths 1997; Kotbagi et al. 2014; Veale 1995), along with case accounts by Schreiber and Hausenblas (2015) in a recent book that presents several cases in support for the existence and severity of the morbidity. These in-depth case studies clearly reveal an exercise-related morbidity that is consistent with the diagnostic criteria for other behavioral addictions (i.e., disordered gambling), involves the common symptoms of addictions, and shows loss of control over the behavior accompanied by negative consequences to the individual. However, these cases seem to be too few for justifying the research effort reflected in the number of publications in this area. However, the fact is that until now, most studies into exercise addiction have assessed a level of *risk* for the emerging morbidity that may never actually turn into problematic behavior.

The bulk of research on exercise addiction has been carried out using British and American participants. Griffiths, Szabo and Terry (2005), using the EAI, found that 3.0% of a British sample of university students were identified as *at risk* of exercise addiction. In a series of five studies, examining American university students during the development of the EDS, Hausenblas and Downs (2002) found a risk prevalence that ranged between 3.4% and 13.4%. Among those with deeper involvement is sport, the rate may be higher. Indeed, Szabo and Griffiths (2007) found that 6.9% of British sport science students were considered at risk for the morbidity as based on the EAI. Furthermore, in more intense exercise, the rate could be even higher. As shown in Table 4.3.1, triathletes, for example, show a risk for the morbidity that ranges between 19.9% (Youngman 2007) to 30.6% (Blaydon and Linder 2002). However,

volume of exercise may not be the sole factor in the prevalence of the risk for exercise addiction because in a study of 95 ultra-marathon runners, Allegre, Therme, and Griffiths (2007) only identified 3.2% to be at risk of exercise addiction. To date, the only population-wide study examining exercise addiction (i.e., Mónok et al. 2012), was conducted on the Hungarian population aged 18–64 years (N = 2,710). The study assessed exercise addiction using both the EDS and the EAI and reported that 0.3% (EDS) and 0.5% (EAI) of the population were at risk for exercise addiction. As noted above, the wide range of the reported risk-prevalence estimates for the morbidity raises serious methodological and conceptual issues in the research area of exercise addiction (and are discussed in more depth in a recent review by Szabo et al. 2015).

4.3.6 Co-morbidities and predisposing factors in exercise addiction

Exercise addiction may be a composite disorder in which other dysfunctions may emerge as a co-morbidity. The eating disorders are the most closely related to exercise addiction, because they often involve exaggerated exercise as a means of weight loss but other comorbid behaviors with exercise addiction have been identified such as muscle dysmorphia (Foster, et al. 2015). Research also suggests that some personality factors may predispose an individual to exercise addiction.

4.3.6.1 Eating disorders

It was mentioned earlier that exercise addiction has been classified as both primary and secondary. The latter is the manifestation of excessive exercise in eating disorders as an additional means (to dieting and purging) of weight loss. Excessive involvement in exercise is a common characteristic of eating disorders such as Anorexia Nervosa and Bulimia Nervosa (De Coverley Veale 1987). Involvement in exercise occurs in different "doses" in individuals affected by eating disorders. Over 35 years ago, it was estimated that approximately one-third of anorexic patients may also show abnormally high levels (‘doses’) of exercise (Crisp et al. 1980). Yates et al. (1983) observed a striking resemblance between the psychology of anorexic patients and the

very committed runners. They labelled this group of runners as obligatory runners. In the course of their research, the authors interviewed 60 marathoners and examined the traits of a subgroup of male athletes who corresponded to the *obligatory* category. They reported that the male obligatory runners resembled anorexic women in some personality traits, such as feelings of anger, high self-expectation, tolerance of pain, and depression. Yates et al. (1983) related these observations in a unique and hazardous way of establishment of self-identity. This study marked the foundation of research into the relationship between exercise and eating disorders.

Since Yates et al. (1983) published their study, a number of studies have examined the relationship between exercise and eating disorders. A close examination of these studies reveals some controversial findings compared to the original study. For example, three studies comparing anorexic patients with high level, or obligatory, exercisers (Blumenthal et al. 1984; Davis et al. 1995; Knight et al. 1987) failed to demonstrate a relationship between anorexia and excessive exercising. However, Zmijewski and Howard (2003) reported an association between exercise addiction and eating disorders in a student population. A large proportion of the same partipants exhibited symptoms of exercise addiction without any sign of eating disorder. Differences in the adopted research methodology between these inquiries are significant. They all investigated the relationship between exaggerated exercise and anorexia, but from a different perspective. Blumenthal et al. (1984) and Knight et al. (1987) examined mixed gender samples' scores on a popular personality test (the Minnesota Multiphasic Personality Inventory - MMPI). Davis et al. (1995) tested an all-female sample using very specific instruments aimed at assessing compulsiveness, commitment to exercise, and eating disorders. Yates et al. (1983) examined demographic and personality parallels between obligatory runners and anorexic patients. Finally, Zmijewski and Howard (2003) examined a group of healthy students. Furthermore, the classification of the exercise behavior may have differed in these studies. Therefore, the results of all these studies are not directly comparable.

Controversy among the above studies may be reconciled at least in part by considering the results of a study by Wolf and Akamatsu (1994). These authors examined female athletes who exhibited strong tendencies for eating disorders. However, these women did not manifest the personality characteristics associated with eating disorders. Therefore, in agreement with Blumenthal et al.'s (1984) and Knight et al.'s (1987) explanation, differences between people addicted to exercise and the anorexic patients may outweigh the similarities reported by Yates et al. (1983). In a theoretical paper, Yates et al. (1994) also conceded that the comparison of excessive exercisers with eating disordered patients was incorrect because the two populations may be significantly different.

A number of studies conducted by Davis (1990; 1990b; Davis et al. 1993) examined exercising and non-exercising individuals and their tendency for eating disorders. None of these investigations showed a relationship between exercise behavior and eating disorders. However, a number of studies have reported such a relationship (e.g., French et al. 1994; Pasman and Thompson 1988; Richert and Hummers 1986; Szymanski and Chrisler 1990;, Wolf and Akamatsu 1994). Because, in general, similar measurements were used, the discrepancy between the two sets of studies may be most closely related to the definition of exercise. In the latter set of studies, either excessive exercisers or athletes were tested in contrast to those tested in the first set. However, the definition of *excessive exercise* needs to be standardised in research. Four key factors, including mode, frequency, intensity, and duration, should be reported. Otherwise, it remains unclear what is meant by *excessive exercise* or what is the definition of an *athlete*. Reporting only one or two exercise parameters is not enough, especially in studies dealing with eating disorders, because the latter appears to occur only in a very limited segment of the physically active population.

Several studies suggest that high levels of exercise or athleticism is associated with symptoms of eating disorders. However, the determinants of this relationship are not well understood.

Williamson et al. (1995) proposed a psychosocial model for the development of eating disorder symptoms in female athletes (see Figure 4.3.4). They asserted that overconcern with body size, that is mediated in part by social influence for thinness, anxiety about athletic performance, and negative appraisal of athletic achievement, is a primary and a strong determinant of the etiology of eating disorder symptoms. This model should be given serious consideration in testing several segments of the athletic and exercising population.

Although women appear to be at higher risk for developing eating disorders (Yates et al. 1994), male athletes may be at risk too. For example, Thiel et al. (1993) reported a high frequency of eating disorder symptoms and even sub-clinical incidences of diagnosed eating disorders in low weight male wrestlers and rowers. This study brings attention to the fact that in some sports (i.e., gymnastics, boxing, wrestling), in which weight maintenance is critical, athletes may be at high risk for developing eating disorders. Athletes in these sports may turn to often *unhealthy* weight control methods (i.e., Enns et al. 1987). However, this high-risk population has received little attention in the extant literature. In future, more research should be targeted at this segment of the athletic population.

Figure 4.3.4

4.3.6.2 Narcissism

The manifestation of exercise addiction symptoms has been linked to narcissistic personality traits (Flynn 1987; Jibaja-Rusth 1989). However, contrasting findings (at least in women) were also disclosed (Davis and Fox 1993). Recently, Bruno et al. (2014) studied a sample of 150 male and female gym attendees who exhibited higher or lower exercise addiction scores as based on the EAI. While, the mean EAI score did not reach the "at risk" category (i.e., mean EAI < 24), gym attendees who scored higher on the EAI also exhibited higher scores of narcissism and lower self-esteem than their exercising mates who scored at the lower end of the EAI. Similar findings were also reported by Miller and Mesagno (2014). These

researchers studied 90 male and female gym, fitness centre, and sport contest attendees and found that exercise addiction was positively related to narcissism and perfectionism. Their hierarchical regression analysis revealed that narcissism and self-oriented perfectionism combined predict the risk for exercise addiction. Increased scores of narcissism have also been reported in substance and alcohol addiction (Carter et al. 2012; Stinson et al. 2008). Furthermore, a group of scholars suggested that a narcissistic personality may predict predisposition to drug addiction (Cohen et al. 2007). Spano (2001) revealed a weak correlation between frequency of physical activity and narcissism, but was not investigated in terms of exercise addiction. It appears that traits of narcissism, combined with low self-esteem and high perfectionism, play a moderating role in individual's predispositions in using exercise as a means of coping with life's adversities.

4.3.6.3 Perfectionism

Researchers examining the relationship between personality and exercise addiction have demonstrated a positive association between the symptoms of the morbidity and perfectionism (Coen and Ogles 1993; Cook 1997; Hagan and Hausenblas 2003; Hall et al. 2007, 2009; Hausenblas and Symons Downs 2002; Miller and Mesagno 2014). Coen and Ogles (1993) studied a sample of 142 marathon runners grouped into a high-risk (obligatory) and a low-risk exercise groups. The perfectionism scores were higher in the high-risk group in contrast to the low-risk group. However, multidimensional perfectionism only accounted for 11.6% of the variance in exercise addiction. In spite of the low shared variance, the study provided good evidence for the association between exercise addiction and perfectionism. Later, Cook (1997) also reported a positive link between exercise addiction scores and perfectionism, in addition to compulsiveness and body dissatisfaction. Cook also reported a negative relationship between self-esteem and scores of exercise addiction. In another study of 262 exercisers classified as at-risk, symptomatic, and asymptomatic for exercise addiction, the at-

risk group scored 15% higher on perfectionism than the asymptomatic subjects (Hausenblas and Symons Downs 2002). In a follow-up study, Symons Downs et al. (2004) replicated these earlier findings with a multidimensional perfectionism tool, on which the group classified as at at-risk for exercise addiction demonstrated higher scores than the asymptomatic and the symptomatic group. The latter group also reported higher perfectionism scores than the asymptomatic group on four of the six perfectionism indices. Similar findings emerged in a study of 246 British middle-distance runners (Hall et al. 2007) in which high ability and perfectionism together explained 29% of the variance in the exercise addiction scores of women. High task and ego orientation, together with perfectionism, explained 27% of the variance in exercise addiction in men. Hall et al. (2009) then replicated the study with 307 British middle-distance runners and found that self-oriented perfectionism and socially prescribed perfectionism were linked to increased scores of exercise addiction.

More recently, Miller and Mesagno (2014) also reported that exercise addiction scores are positively associated with self-oriented perfectionism as well as socially prescribed perfectionism. The positive relationship between perfectionism and indices of exercise addiction may reflect an individual's motivational striving to solve problems according to personal and social expectations, and/or to avoid failure, criticism and shame. This orientation, may also explain why a habituated exerciser with specific personality and behavioral predisposition may choose to rely on a physically effortful coping instead of escape into a passive and instantly gratifying – but marked by a social stigma – form of ill-coping behavior, like drug or alcohol abuse.

4.3.6.3 Self-esteem

People at risk for exercise addiction appear to demonstrate lower levels of self-esteem than controls or asymptomatic individuals (Ackard et al. 2002; Chittester and Hausenblas 2009; Cook 1997; Grandi et al. 2011; Hall et al. 2009). A study conducted with 155 female aerobic

instructors reported a negative correlation between the risk for exercise addiction and self-esteem (Cook 1997). However, the author adopted the Commitment to Exercise Scale to determine the risk for exercise addiction. Therefore, the actual tendency for addiction or a morbid exercise pattern cannot be established in this study. In another survey of 586 college women, Ackard et al. (2002) found that compared to well adjusted exercisers, women at risk for exercise addiction reported significantly lower self-esteem. Furthermore, a similar study of 113 men, also demonstrated a negative correlation between the risk for exercise addiction and self-esteem. However, the shared variance (r^2) was only 4% between the two variables (Chittester and Hausenblas 2009).

A study of 307 British middle-distance runners revealed that labile self-esteem (defined as A fluctuating or unstable self-esteem) mediated the relationship between unconditional self-acceptance and the risk for exercise addiction (Hall et al. 2009). A positive correlation between addiction and labile self-esteem indicated that the two shared 15.2% of the variance. In another study of 107 volunteers, Grandi et al. (2011) also found lower self-esteem in exercisers at risk for exercise addiction in comparison to an asymptomatic control group. In contrast with these findings, Bamber et al. (2000) reported that individuals exhibiting eating disorder symptoms, with or without risk for exercise addiction, had significantly lower levels of self-esteem than a group of control participants and individuals at risk for exercise addiction without symptoms of eating disorders. It appears that self-esteem may play a role in the etiology of exercise addiction, but it may be connected with other personality traits such as perfectionism (Hall et al. 2009; Miller and Mesagno 2014) or other psychological dysfunction like labile self-esteem (Hall et al. 2009). Given that exercise is a socially accepted and rewarded behavior, its adoption for coping with life-adversities may preserve - or at least generate the illusion of preservation - one's self-esteem in contrast to destructive and scornful forms of coping like drug or alcohol abuse.

4.3.6.4 Neuroticism and extroversion

Neuroticism and extroversion are two relatively widely studied personality traits that have also been linked the risk for exercise addiction. A study of 246 male and female runners found that among several psychological variables, only neuroticism predicted the risk for exercise addiction (Jibaja-Rusth 1989). Another study (Yates et al. 1992) reported that compulsive runners were more neuroticic than asymptomatic runners. Similarly, Adams and Kirkby (1996) found that among a sample of 306 aerobics participants, instructors, and competitors the risk for exercise addiction could be predicted by elevated scores of neuroticism. Bamber et al. (2000) found higher neuroticism scores in people at risk for exercise addiction, who also exhibited eating disorders, in contrast to the exercisers who did not. In another investigation conducted with 390 university students, results demonstrated that extroversion, neuroticism, as well as agreeableness, predicted the risk scores for exercise addiction (Hausenblas and Giacobbi 2004). These findings were later replicated by Costa and Oliva (2012) who tested 423 volunteers who exercised for at least one full year before the study. Their results suggested that extraversion, neuroticism, and agreeableness are linked to the etiology of exercise addiction. Furthermore, in a study of 806 students and sport association exercisers, Kern (2010) demonstrated a significant inverse relationship between the risk for exercise addiction and emotional stability. Therefore, participants with higher scores of exercise addiction exhibited greater neuroticism. A more recent study conducted with 218 psychology students in Norway, has also confirmed that neuroticism may be related to the risk for exercise addiction (Andreassen et al. 2013).

With regard to extroversion, Mathers and Walker (1999) examined 12 exercising students who were at risk for exercise addiction in contrast to 12 asymptomatic and another 12 non-exercising students recruited from the same student population. The "at risk" group did not differ from the asymptomatic group on extraversion, although the two exercise groups were

more extroverted than the non-exercise group. The results were interpreted as evidence against the claim that extroversion is a component of the addictive exercise behavior. Similar negative findings were presented by Davis (1990) in an investigation of 96 exercising women. The author failed to report an association between the risk for exercise addiction and neuroticism and extroversion. Bamber et al. (2000) showed that participants affected by the risk of exercise addiction, and also having symptoms of eating disorders, showed the lowest levels of extroversion. Recently, a group of Danish researchers (Lichtenstein et al. 2014) failed to find a difference in neuroticism between a group of exercisers at risk for exercise addiction and an asymptomatic exercise control group. However, the two groups differed in extroversion, but the effect size was only small to moderate. It appears that findings in the context of an association between the risk for exercise addiction and personality traits are inconsistent.

Neuroticism has also linked to other behavioral addictions, including internet addiction (Lei, Yang, and Liu 2006; Tamanaeifar, Arfeei, and Gandomi 2014), pathological gambling (Bagby et al. 2007), compulsive shopping mainly for clothes (Johnson and Attmann 2009), and addiction to pornography and sex (Egan and Parmar 2013; Pinto, Carvalho, and Nobre 2013). Consequently, some personality traits may act as predisposing factors for a wide range of behaviors, including addictive behaviors, that may depend strongly on an interaction with the social and physical environment. For example, the motivation of the individual is determined by past experience and learning. Therefore, non-exercisers who have no affinity for exercise will be unlikely to escape in sports and exercise at times of coping with adversity. However, the exerciser having some personality predisposition, interacting with personal and social motives and/or values, may use exercise to escape from stress in the same way as the social drinker who initially enjoyed alcohol in moderation, but upon experiencing a life-trauma starts to drink for pain relief.

It can be posited that some personality traits may increase the risk of escape into excessive exercise. Exercise is not only a part of the everyday life of the habitually physically active individual, but also a conditioned routine behavior. This conditioned aspect of exercise behavior is illustrated by the fact that all exercisers report feelings of deprivation when the exercise routine must be stopped for a reason or another (Szabo 2010). Conditioned behaviors are reinforced with a reward, either positively or negatively. A gray area between the two may depict the transition from the healthy and positively reinforced behavior, that is carried out in moderation, and the morbid pattern of exaggerated exercise behavior, fuelled by negative reinforcement. Not all exercisers, or even the therapeutic exercisers, as illustrated in the interactional model (Egorov and Szabo 2013) will choose exercise as their means of escape from stress and hardship. Personality and learned factors, in combination with environmental factors, will all contribute to the cognitive decision-making process (see Figure 4.3.3). This complex set of interactions is most likely the moderating factor in the transition from mastery to a *therapeutic* exercise (Egorov and Szabo 2013; Freimuth et al. 2011) as well as in the appraisal of the means of coping when a major or uncontrollable life event strikes. It should be noted that all determinants (gray boxes in Figure 4.3.3) also interact with each other and all of them bears a different weight at any given time in every person's case. This is why the pathological reliance on exercise behavior can (and should) only be studied from an idiographic perspective as suggested by the interactional model (Egorov and Szabo 2013).

4.3.7 Addiction or Psychological Escape?

To understand what fuels exercise addiction, the motivations for exercise that may trigger an irresistible urge for the behavior need to be considered. People exercise for a reward and the reward may come in different forms. Some common incentives of exercise may include being in good physical shape, looking good, making friends, staying healthy, building muscle, losing weight, etc. The personal experience of the anticipated reward strengthens the exercise

behaviour. Behaviorists maintain that human action may be understood and explained through reinforcement and punishment. Operant conditioning theory suggests that there are three basic principles of behaviour: 1) positive-, and 2) negative reinforcement, and 3) punishment (Bozarth, 1994). Positive reinforcement is an incentive for doing something to *gain a reward* that is pleasant or desirable (e.g., increased muscle tone). The reward increases the likelihood of that behaviour to reoccur. In contrast, negative reinforcement is an incentive for engaging in a behavior to *escape* a noxious or unpleasant event (e.g., gaining weight). The successful escape is then the reward, which then strengthens the behavior. It should be noted that both positive and negative reinforcers increase the likelihood of a particular behavior to reoccur (Bozarth 1994), but their mechanism is different, because in positive reinforcement there is a *gain* that follows the action (e.g., feeling good), whereas in behaviors motivated by negative reinforcement one attempts to *escape* something bad or unpleasant *before happening* that otherwise would occur (e.g., feeling guilty or fat if a planned exercise session is missed).

Punishment refers situations in which the imposition of some noxious or unpleasant stimulus or the removal of a pleasant or a desired stimulus reduces the probability of a given behavior to reoccur. In contrast to reinforcement, punishment suppresses the behavior and, therefore, exercise should never be used as a means of punishment. Paradoxically, exercise addiction may be perceived as self-punishing behavior. It is a very rare form of addiction that requires substantial physical effort, often to the point of exhaustion.

Individuals addicted to exercise may be motivated by both positive and negative reinforcement. In the former case, high achievers may have an unrealistic self-expectation concerning their goal in exercise that is beyond their physical capacity. Hall et al. (2007) found that ego orientation, perceived ability, task orientation, concern about mistakes, and personal standards accounted for 31% of the variance in exercise addiction. But what are the other factors that account for the rest of the variance? The answer is speculative, but a

number of personality factors and also escape behavior(s), associated with the expectancy that exercise can provide a solution for a problem, could be a part of it. Indeed, Duncan (1974) in relation to drug addiction suggests that addiction is almost identical with, and semantically is just another name for, avoidance or *escape behavior* when the unpleasant feeling is being negatively reinforced by drug or alcohol intake. People addicted to exercise, in this view, reach for a means – with which they had past relief-inducing experience – that provides them with *temporary escape* from an ongoing state of emotional distress and pain. In Duncan's view, all addictions represent similar negatively reinforced behaviors. The term *obligatory exercise* (i.e., Hall et al., 2007) implies a negatively reinforced exercise behavior through which one can avoid something noxious or unwanted. In this view, morbid exercise behavior serves as an escape from stress and adversity.

4.3.8 Conclusions

Exaggerated and morbid patterns of exercise behavior may represent a means for achieving something that is beyond the capacity of the person, or escape from the emotional pain of a reality, that usually appears in the form of chronic and passive stress. The sudden appearance of the latter could be the triggering factor in exercise abuse. Therefore, morbid exercising may be rather "revolutionary" (suddenly appearing) than evolutionary (slowly progressing). High volumes of exercise are not necessarily problematic, considering athletic training at advanced levels. Exercise becomes morbid when it results in harm or exerts negative consequences for the individual. This form of morbidity is known as exercise addiction, and it is different from exaggerated volumes of exercise that accompany various eating disorders with the objective of complementary means to diet for weight loss. The scholastic work on exercise addiction is relatively widespread and it may be out of proportion when considering how rare the disorder appears to be. Indeed, most studies in the area only assess the presumed risk for exercise addiction by using two popular and well validated instruments translated into several

languages (i.e., the EAI and EDS). Very few studies have followed up questionnaire data with interviews. The latter is needed, because it becomes increasingly evident that the triggering causes of exercise addiction are very personal and subjective. From a scientific perspective, the subjective aspect of the morbidity makes it difficult to study the disorder with the nomothetic approach. Only a level of risk, that is often misinterpreted as a predisposition for the disorder, can be addressed via the scientific method. However, most of those showing high risk scores on the various exercise addiction screening instruments may in fact never become addicted to exercise. Therefore, as several newer models may suggest, the exploration of individual cases could yield a more profound understanding of the morbidity surrounding exercise addiction.

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Table 4.3.1 Summary table of research on exercise addiction over the past 20 years.

Year	Author(s)	Type of Study	Term	n	Age (yr)	Type of Sport	QTR	Interview	Data Source	Prevalence (%)
1995	Thornton and Scott	Survey	EA	40	?	Runners	Other	No	Field	22,5
1998	Slay et al.	Survey	OE	324	?	Runners	Other	No	?	26
2000	Bamber et al.	Survey	ED	194	28,8	Mixed	Other	No	Field	13,9 -22,2
2002	Hausenblas and Symons Downs (S1)	MT	ED	266	21,7	Mixed	EDS+ Other	Yes	Field	3,4
2002	Hausenblas and Symons Downs (S2)	MT	ED	553	22	Mixed	EDS+ Other	No	Field	13,4
2002	Hausenblas and Symons Downs (S3)	MT	ED	862	21,2	Mixed	EDS+ Other	No	?	3,1
2002	Hausenblas and Symons Downs (S4)	MT	ED	366	20,6	Mixed	EDS+ Other	No	?	9,6
2002	Hausenblas and Symons Downs (S5)	MT	ED	46, 373	22,9 20,3	Mixed	EDS+ Other	No	?	9,8
2002	Hausenblas and Fallon	Survey	ED	474	20,3	?	EDS+ Other	No	Field	?
2002	Ackard et al.	Survey	EE	586	20,6	Mixed	Other	No	?	?
2002	Blaydon and Lindner	Survey	ED	203	29,8	Triathlon	Other	No	?	21,6 -30,4
2003	Hagan and Hausenblas	Survey	ED	79	21,8	Mixed	EDS+ Other	No	Field	?
2004	Terry et al.	MT	EA, ED, OE	200	21,2	Mixed	EAI, EDS+ Other	No	Field	2,5 -3
2004	Hausenblas and Giacobbi Jr.	Survey	ED	390	21,8	?	EDS+ Other	No	Field	?
2004	Symons Downs et al. (S1)	MT	ED	408	20,2	?	EDS+ Other	No	Field	3,6

2004	Symons Downs et al. (S2)	MT	ED	885	20,2	?	EDS+ Other	No	Field	5
2005	Griffiths et al.	MT	EA	279	21,2	Mixed	EAI+ EDS	No	Field	3
2006	Edmunds et al.	Survey	ED	339	32,1	Mixed	EDS+ Other	No	Field	3,4
2006	Warner and Griffiths	Survey	EA	100	37.6	Gym Users	EAI	No	Field	8
2007	Youngman	Survey	EA	1273	37,9	Triathlon	EAI+ Other	No	Internet	19,9
2007	Szabo and Griffiths	Survey	EA	455	?	Mixed	EAI	No	Field	3.6 - 6.9
2007	Allegre et al.	Survey	ED	95	43,5	Runners	EDS+ Other	No	?	3,2
2008	Lejoyeux et al.	Survey	ED	300	28,6	Mixed	Other	Yes	Field	42
2008	Cook and Hausenblas	Survey	ED	330	19,9	Mixed	EDS+ Other	No	Internet	?
2008	Hausenblas et al.	Survey	ED	40	20,5	Mixed	EDS+ Other	No	Field	?
2009	Chittester and Hausenblas	Survey	ED	113	20,3	Weights	EDS+ Other	No	Lab	?
2009	Lindwall and Palmeira	MT	ED	162	22,6	Mixed	EDS+ Other	No	Field	9,2
2009	Lindwall and Palmeira	MT	ED	269	26,1	Mixed	EDS+ Other	No	Field	5,2
2010	Bratland-Sanda et al.	Survey	ED, EE	38	30,9	Mixed	EDS+ Other	Yes	Field	29
2010	Kern	Survey	ED	484	25,7	Mixed	EDS+ Other	No	Field	?
2010	Smith et al.	Survey	ED	184	28,1	Runners	EAI+ EDS	No	Field	<10 leisure >30 if also competition
2011	Villella et al.	Survey	EA	2853	16,7	Mixed	EAI+ Other	No	Field	8,7
2011	Pugh and Hadjistavro-poulos	Survey	ED	144	20,7	Mixed	EDS+ Other	No	Internet	?

2011	Sicilia and González-Cutra	Survey	ED	527	29,6	Mixed	EDS+ Other	No	Field	?
2011	Cook et al.	Survey	ED	539	19,8	Mixed	EDS+ Other	No	Field	?
2011	Bratland-Sanda et al.	Survey	ED	112	30,7	Mixed	EDS+ Other	Yes	Field	?
2011	Modolo et al.	Survey	ED	300	21,2	Mixed	Other	No	?	33
2011	Cook and Hausenblas	Survey	ED	387	20,1	Mixed	EDS+ Other	No	Field	?
2011	Grandi et al.	Survey	ED	79	30	Mixed	Other	No	Field	29,9
2012	Lejoyeux et al.	Survey	ED	500	29	Mixed	EDS+ Other	Yes	Field	29,6
2012	Costa et al.	MT	ED	519	37,1	Mixed	EDS+ Other	No	Field	6,6
2012	Mónok et al.	Survey +MT	EA, ED	474	33,2	Popl. S	EAI+ EDS	Yes	Internet	EAI = 0,5-EDS = 0,3
2012	Lichtenstein et al.	Survey + MT	EA, EE	590	28,4	Fitness+ Football	EAI+ Other	No	?	5,8
2012	McNamara and McCabe	Survey +MT	ED	234	22,5	Mixed	Other	No	Internet	34,8
2013	Cook et al.	Survey	ED	513	19,9	Mixed	EDS+ Other	No	Field	?
2013	Cook, Karr, et al.	Survey	ED	2660	38,8	Runners	EDS+ Other	No	Internet	1,4
2013	Costa et al.	Survey	ED	409	18-64	Mixed	EDS+ Other	No	Field	4.4
2013	Menczel et al.	Survey	ED	1732	31,7	Fitness	EDS+ Other	?	Field	?
2013	Szabo et al.	Survey	EA	242	27,5	Mixed, Runners	EAI+ Other	No	Field	7-17
2013	Trana	Survey	ED	1546	43	Popl. S	EDS	No	By post	0.4
2014	Cook et al.	Survey	ED	387	20,1	Mixed	EDS+ Other	No	Field	?
2014	Costa et al.	Survey	ED	262	20,9	Mixed	EDS+ Other	No	Field	18.3

2014	Li et al.	Survey	ED	617	19-22	Mixed	EAI	No	Field	8.8
2014	Lichtenstein et al.	Survey	EA	274	16-39	Football, Fitness	EAI	No	Field	7.1, 9.7
2014	Müller et al.	MT	ED	134	22,2	Mixed	EDS+ Other	Yes	Field	10,4
2015	Babusa et al.	Survey	EA, ED	304	27.8	Body-builders	EAI+ Other	No	Internet	12-23
2015	Maráz et al.	Survey	EA	447	32.8	Dancers	EAI+ Other	No	Internet	11
2015	Venturella et al.	Survey	EA	686	18-65	Mixed	EAI+ Other	No	Field	15.8

Abbreviations: ? = not clear or not known; EA = Exercise Addiction; ED = Exercise Dependence; EAI = Exercise Addiction Inventory; EDS = Exercise Dependence Scale; EE = Excessive Exercise; MT = Test development, validation; n = number of observations; OE = Obligatory Exercise; Other = Other QTRs than the EDS or EAI; Popl. = Population; QTR = Questionnaire; (S) = Study; yr = years

Figure 4.3.1 Personal, social, and environmental factors interacting in the cognitive arbitration used by an individual in making the choice of coping means with stress or psychological hardship.

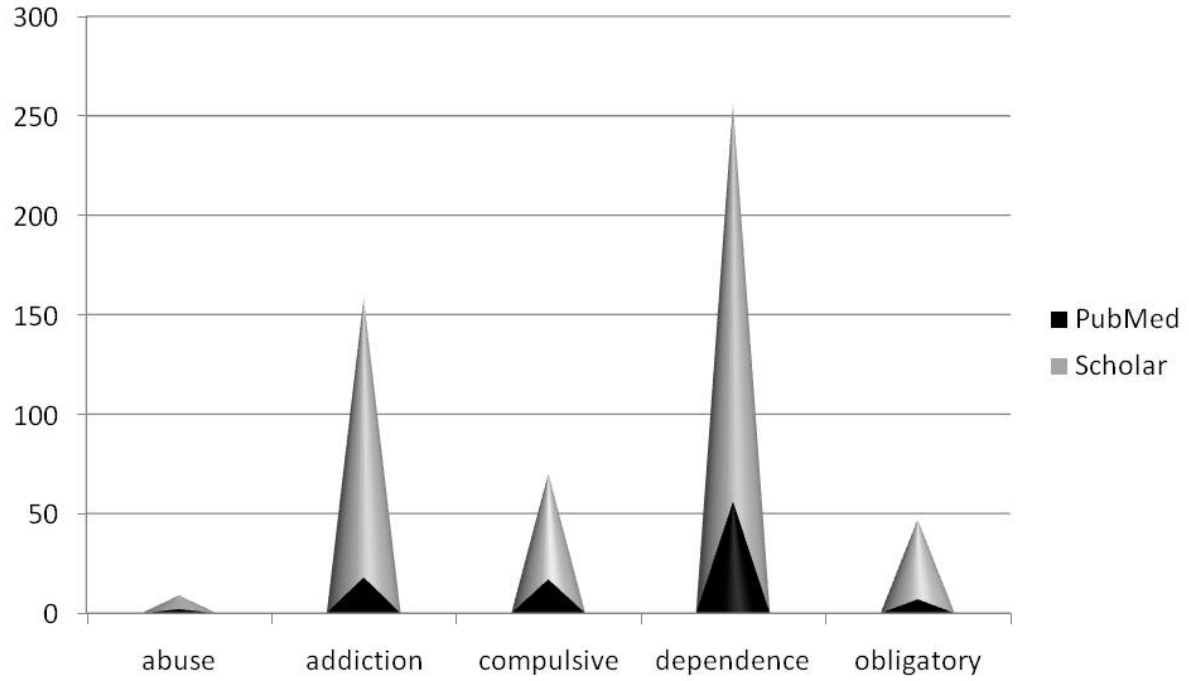

Figure 4.3.2 A hierarchical and evolutionary conceptualization of exercise addiction.

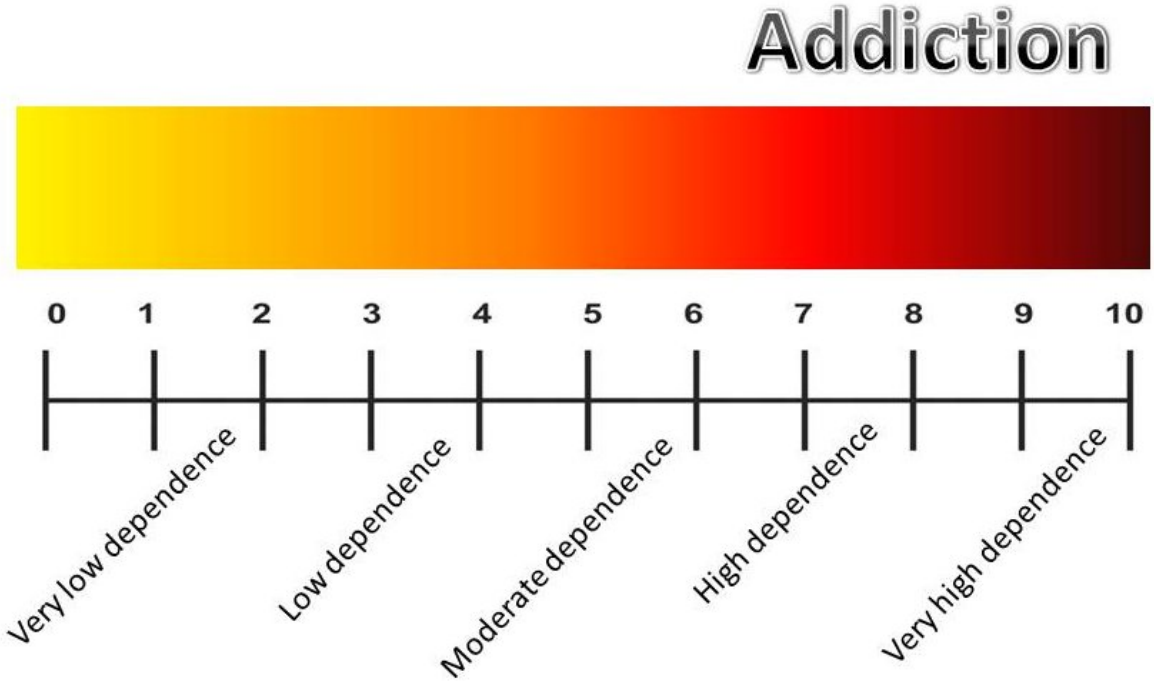

Figure 4.3.3. The complex interaction through which a person selects a coping strategy with stress.

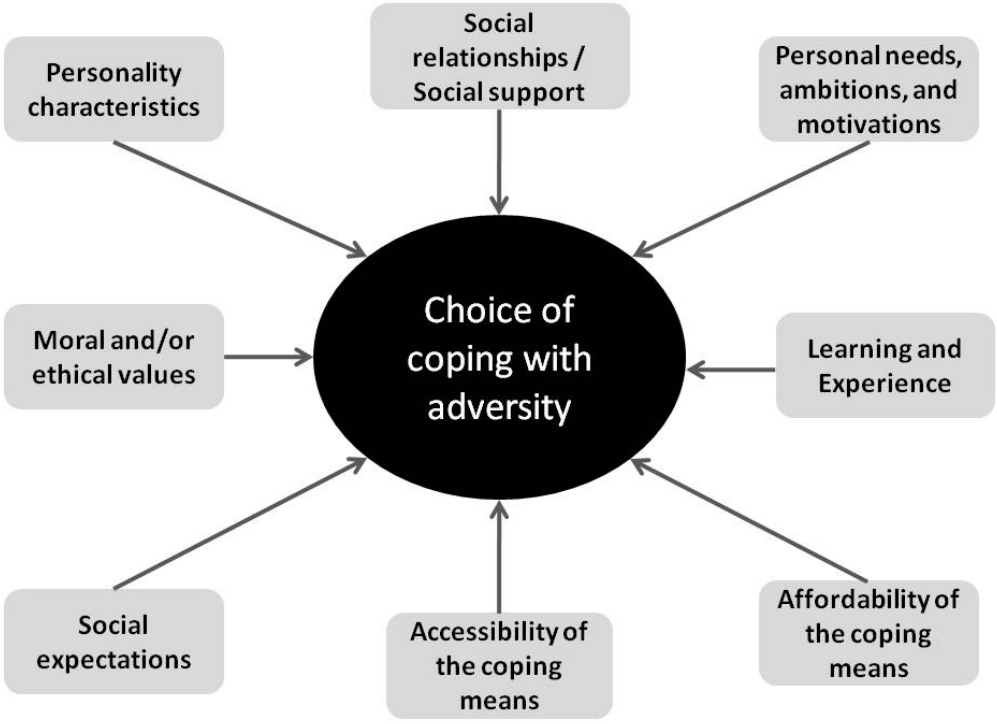

Figure 4.3.4 A psychosocial model for the development of eating disorder symptoms in female athletes proposed by Williamson et al. (1995); Figure fully re-drawn on the basis of Szabo's (2000) work.