DISSERTATION

AN EXAMINATION OF THE EXERCISE DEPENDENCE SCALE-REVISED IN ASYMPTOMATIC INDIVIDUALS AND INDIVIDUALS DISPLAYING PATHOGENIC EATING BEHAVIORS

Submitted by

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WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY ERIN NICOLE TRACY ENTITLED "AN EXAMINATION OF THE EXERCISE DEPENDENCE SCALE-REVISED IN ASYMPTOMATIC INDIVIDUALS AND INDIVIDUALS DISPLAYING PATHOGENIC EATING BEHAVIORS" BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

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ABSTRACT OF DISSERTATION

AN EXAMINATION OF THE EXERCISE DEPENDENCE SCALE-REVISED IN ASYMPTOMATIC INDIVIDUALS AND INDIVIDUALS DISPLAYING PATHOGENIC EATING BEHAVIORS

This investigation had two primary objectives. The first objective was to conduct both exploratory and confirmatory factor analyses on the Exercise Dependence Scale-Revised (EDS-R; Symons Downs, Hausenblas, and Nigg, 2004). These analyses provided information regarding the applicability of the seven *DSM-IV* Substance Dependence criteria to the assessment of exercise dependence. The second objective of the present investigation was to explore the relations between exercise dependence, as defined by factors that emerged from the factor analyses, and two related personality characteristics, addictiveness and obsessive-compulsiveness. Our earlier research examined the relations between exercise dependence and addictiveness and between exercise dependence and obsessive-compulsiveness in a sample who self-reported no symptoms of disordered eating (i.e., the asymptomatic sample). The present study examined the same relations in a sample who self-reported at least one pathogenic eating behavior (i.e., the symptomatic sample). Amount of exercise and weight dissatisfaction were also included in the correlational analyses. Results were discussed with regard to a model of the relations

between addictiveness, obsessive-compulsiveness, exercise attitudes, and exercise behavior (Davis, Katzman, & Kirsh, 1999).

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CHAPTER I

Introduction

Despite its obvious physical benefits, exercise has been shown to have potentially deleterious effects on individuals who become preoccupied with physical activity at the expense of other significant areas of their lives. The term exercise dependence has been used to denote attitudes and behaviors in some exercisers that are akin to the attitudes and behaviors of an individual dependent on a substance. However, exercise dependence is not a diagnosis included in the fourth edition of the *Diagnostic and statistical manual of mental disorders, text revision* (*DSM-IV-TR*; American Psychiatric Association, 2000). There is considerable debate regarding the definition of exercise dependence and, therefore, the criteria required for diagnosing the condition. Additionally, it is unclear whether the available assessment measures effectively determine who is at-risk. In their comprehensive review of various definitions and measures of exercise dependence, Allegre, Souville, Therme, and Griffiths (2006) outlined two different conceptualizations of exercise dependence. The first conceptualization was based on the diagnostic criteria for Substance Dependence as described in the fourth edition of the *Diagnostic and statistical manual of mental disorders*, the *DSM-IV* (American Psychiatric Association, 1994). The other was based on the behavioral components common to all addictions, as defined by Griffiths (1997). The *DSM-IV* criteria for Substance Dependence are tolerance, withdrawal effects, intention effect, lack of control, time, reductions in other activities, and continuance. The behavioral components of addictions include salience, mood modification, tolerance, withdrawal symptoms, conflict, and relapse (Griffiths).

The behavioral aspects of addictions

Consistent with the latter behavioral perspective, Marlatt, Baer, Donovan, and Kivlahan (1988, p. 224) defined addictive behavior as "...a repetitive habit pattern that increases the risk of disease and/or associated personal and social problems." Furthermore, these authors recognized that addicted individuals experience a subjective "loss of control" and are unable to abstain from or moderate their behaviors. Brown (1993) highlighted the role of arousal in the development and maintenance of different types of addictions. He remarked that for addicted individuals, the regulation of emotions in general, and the attainment and maintenance of positive mood states in particular, become goals in their own right. Brown noted that non-addicted individuals strategically manipulate their levels of arousal in day-to-day living, yet rarely maintain good hedonic tone for sustained periods of time. He described addictive behaviors "...in contrast to this normal state of poorly managed uncertainty, as the discovery and continuous use by the individual of relatively reliable and effective methods which do enable him or her to manipulate hedonic tone in the directions wanted, at least in the short term" (Brown, p. 248).

According to Brown (1993), the term "dependence" was first introduced by the World Health Organization to depart from the sensationalist and value-laden term "addiction." Additionally, it was intended to capture the physical consequences that result when an individual who is dependent on a substance discontinues use. However, Brown emphasized that the core features of dependence are more psychological than physical and include reliable changes in mood, a coping strategy, and the ability to do things one could not do before (i.e., disinhibition). Brown explained that as the addiction progresses,

decisions are simplified as they are made according to whether or not they support the addiction. Thus, a safe emotional distance is maintained in relationships given the addicted person's lack of energy and time, and the addiction becomes a source of meaning and purpose in life. He emphasized that individuals benefit to some extent from all addictions, not just those considered "positive," such as exercise.

Brown (1993, p. 263) stated that there is "...a single core process in the development and maintenance of addictions, the continual mismanagement of the quest for happiness." In an addicted individual, when the normal functions of planning for intermediate and long-term goals are disrupted, a "crisis management style," as termed by Brown, is developed. This style involves hour-to-hour and minute-to-minute manipulations of arousal in order to sustain high hedonic tone. That is, the individual requires the addictive behavior to cope in general and, therefore, "lurches" from one crisis intervention (i.e., the addictive activity) to another. The individual gradually loses (or fails to learn) the management skills involved in setting intermediate and long-term goals and becomes trapped in the lifestyle of their particular addictive activity.

The seven components of addictions as outlined by Brown (1993) include salience, conflict, lack of control, relief, tolerance, withdrawal symptoms, and relapse. Salience represents the importance the addictive activity plays in an individual's life in terms of both thinking (i.e., preoccupations and cognitive distortions) and behavior (i.e., impairment in socialized behavior). According to Brown, salience is a feature of addictions involved in several positive feedback loops that sustain the addiction. Conflict includes tension and disputes between the addicted person and others and the addicted person's internal conflict. Withdrawal symptoms are the unpleasant physical and

emotional effects of reducing or discontinuing the addictive activity. Relief refers to the avoidance of unpleasant withdrawal symptoms by engaging in the addictive activity, despite negative consequences and potential long-term damage. Loss of control reflects the amount of time and resources devoted to the addiction, while tolerance is evidenced by the need for more of the addictive activity in order to achieve the same effects. Relapse refers to the tendency to revert to earlier patterns of addictive behavior even after many years of abstinence or control.

Within the field of addiction research, there is no single agreed upon definition for addiction. Furthermore, the question of whether behavioral addictions can be defined by the same criteria as substance use addictions has not been resolved. Shaffer (1997, p. 1574) emphasized the necessity of resolving the "conceptual chaos surrounding addiction" in order to clarify the similarities and differences between "process or activity addictions" (e.g., pathological gambling) and "substance-using addictions" (e.g., heroin dependence). Referring to naturally occurring neurotransmitters as likely mediating causes of many process addictions, he suggested that an addiction can exist with or without physical dependence and that it is inappropriate to consider drugs as a necessary precondition for addiction. Consequently, in Shaffer's (p. 1567) view, the objects of addictions should include any substances or behaviors that "...reliably and robustly shift subjective experience," suggesting that individuals can become addicted to a behavior in a way that resembles addiction to an ingested substance. Similarly, Holden (2001) argued that the reward circuitry in the brain does not differentiate between ingested mood-altering chemicals and the endogenous opioids that result from experiences or activities.

He proposed that, in either case, the activated reward circuitry places an individual at risk for becoming trapped in a cycle of compulsive reward seeking.

Measurement of exercise addiction based on key behavioral components

Griffiths (1997) referred to Brown's (1993) addictive components in a slightly modified format that included salience, euphoria, conflict, tolerance, withdrawal symptoms, and relapse. Terry, Szabo, and Griffiths (2004) later utilized these six criteria to develop the Exercise Addiction Inventory (EAI). Prior to creating the EAI, they reviewed the array of instruments measuring different aspects of excessive exercise and noted that "...none of the current screening instruments are theory driven" (Terry et al., p. 492). They also suggested that strong commitment to exercise and addiction to exercise have been confused in previous studies. That is, they argued that many studies on exercise addiction actually measured commitment. The stated objective of Terry et al. was to develop a brief, theory-based exercise addiction inventory. The EAI consisted of six items, which reflected the six components of addictions as outlined by Griffiths. Terry et al. demonstrated that the EAI had strong internal reliability and excellent concurrent validity when compared to other measures of exercise dependence. They also argued that the EAI could distinguish between exercise addiction and exercise commitment. Notably, they claimed an advantage over other inventories given that the EAI is based on the behavioral addiction theory as opposed to the *DSM* criteria for Substance Dependence, "...which may be an inadequate comparison" in regard to exercise (Terry et al., p. 497).

The EAI is one of many self-report questionnaires that have been developed to assess the excessive and unhealthy use of exercise. As noted above, it is based on the behavioral components theorized as common to all addictions. The *DSM-IV*-based

Exercise Dependence Scale-Revised (EDS-R; Symons Downs, Hausenblas, & Nigg, 2004) reflects the other method by which exercise dependence is currently conceptualized (Allegre et al., 2006) and appears to be more widely used than the EAI. Given the argument made by Terry et al. (2004) regarding the questionable applicability of the *DSM* Substance Dependence criteria to exercise dependence, it seems important to investigate further the EDS-R's psychometric properties. This study represents an additional step in clarifying whether all seven *DSM* Substance Dependence criteria are applicable to exercise dependence. The following is a review of the evolution of exercise dependence assessment tools over the past thirty years. This background will provide a useful framework for evaluation of the EDS-R in the present investigation.

Positive versus negative addiction

Prior to conceptualizations of exercise dependence based on *DSM* criteria, the term addiction, as opposed to dependence, was commonly used to denote excessive and potentially harmful exercise behavior. However, before these potential negative effects of exercise were introduced, many viewed addiction to exercise as an exclusively positive condition. For instance, Glasser (1976) argued that in order to cultivate physical vitality and mental strength, one should strive to develop a *positive addiction*, such as an addiction to running. He regarded a positive addiction as producing a pleasurable and transcendent state of mind, which enhances other areas of an individual's life. According to Glasser (p. 40), positive addicts use their "...extra strength to gain more love and more worth, more pleasure, more meaning, more zest from life in general." Importantly, positive addicts choose their addictions without allowing the behavior to control their lives. Glasser described running as a positive addiction that can be accomplished on one's

own in about an hour per day. However, he acknowledged that once a positive addiction to running is established, an individual who attempts to discontinue running experiences withdrawal in the form of pain, discomfort, anxiety, or guilt that can be relieved only by running itself.

In contrast, Morgan (1979) pointed to the potential for exercise, particularly running, to become a *negative addiction*. He proposed that individuals are addicted to exercise when they cannot cope without daily exercise and, if unable to exercise, they experience withdrawal symptoms. Morgan noted that these withdrawal symptoms include depression, anxiety, irritability, restlessness, insomnia, and fatigue. Additionally, an individual who is addicted to exercise may develop tics, muscle tension and soreness, decreased appetite, and constipation when forced to stop exercising. However, Morgan (p. 59) added that "...the true exercise addict will continue to exercise even when it is medically, vocationally, and socially contraindicated." Thus, the priorities for an exercise addict shift away from family, work, and even one's health to exercising at any expense. Moreover, as Morgan explained, the addictive behavior is perpetuated and intensified by the fact that increased frequency or duration is sometimes necessary to maintain the euphoria an exercise addict seeks.

More recently, the literature has referred to positive addiction to exercise as *commitment* to exercise. Measures of this adaptive use of exercise include the Commitment to Running Scale (Carmack & Martens, 1979) and the Commitment to Physical Activity Scale (Corbin, Nielsen, Borsdorf, & Laurie, 1987). Likewise, the term exercise *dependence* has increasingly been used to replace exercise addiction or negative addiction to exercise. Self-report measures of exercise dependence aim to capture the

negative consequences of compulsive physical activity and include the Exercise Dependence Questionnaire (Ogden, Veale, & Summers, 1997) and the Exercise Dependence Scale-Revised (Symons Downs et al., 2004). These and other measures have been described in comprehensive reviews (Adams & Kirkby, 1998; Allegre et al., 2006; Hausenblas & Symons Downs, 2000). Some of the confusion surrounding exercise dependence results from the use of various synonymous terms (e.g., obligatory exercise, compulsive exercise, obsessive exercise, and excessive exercise, among others). Lack of conceptual clarity also results from overlap between items on questionnaires intended to measure the positive aspects of commitment to exercise and items on questionnaires intended to measure the negative aspects of exercise dependence. Notably, both commitment to exercise and exercise dependence are characterized by withdrawal symptoms when the exercise behavior is ceased. The primary difference between commitment and dependence appears to be the adverse consequences (e.g., exercising despite physical injury, interference with family responsibilities, etc.) that occur in the case of the latter and not the former.

Qualitative research on exercise addiction

In addition to self-report measures, investigators have utilized qualitative research methods to better understand whether addiction to exercise is more accurately described as a commitment to a beneficial activity or a potentially debilitating dependence. Sachs and Pargman (1979) conducted a "depth interview" investigation of 12 adult male runners in order to better understand the concept of exercise addiction from the addicted person's perspective. They found that "...although it is possible to produce a general psychological description of the exercise addict, considerable variety exists in individual

attributes which tends to preclude sweeping characterizations" (Sachs & Pargman, p. 148). In terms of similarities across participants identified as addicted, they concluded that psychological and physiological withdrawal symptoms may be the critical feature in exercise addiction. These researchers noted that anxiety and guilt were the predominant effects of withdrawal from exercise.

More recently, Bamber, Cockerill, Rodgers, and Carroll (2003) utilized qualitative methods to explore the concept of exercise dependence. Specifically, their stated objective was to determine whether exercise dependence might exist as a primary clinical disorder and how it is related to the eating disorders. Using self-report measures for both exercise dependence and disordered eating, these investigators classified individuals into one of four categories (those with exercise dependence, those with an eating disorder, those with exercise` dependence secondary to an eating disorder, and controls who had neither). Bamber et al. (2003) conducted two-part, semi-structured interviews that covered attitudes and behaviors related to both eating and exercise. Qualitative analysis of the narratives revealed that participants who had been classified by the self-report questionnaire as exercise dependent fell into one of two categories. During their interviews, they either did not demonstrate exercise dependent attitudes or behaviors (i.e., their a priori classifications were incorrect), or they described symptoms of an eating disorder. Thus, the qualitative data provided evidence for exercise dependence that is secondary to an eating disorder but not exercise dependence as a primary clinical disorder.

Cox and Orford (2004) also challenged the idea that high frequency exercise warrants the pathological label of "addiction." They argued against the recent trend of

applying the biomedical addiction model to exercise; rather they recommended investigating and understanding high frequency exercise within its social context. Accordingly, Cox and Orford used a qualitative method to explore the meanings associated with exercise for 10 individuals who scored above the mid-point on the Exercise Dependence Questionnaire (Ogden et al., 1997). They explained that by using grounded theory, "...there is an opportunity to explore [high frequency exercising] without an assumption that it fits a preconceived theory but rather to ground a model in the words, experience and meaning of the participants within their social world and context" (Cox & Orford, p. 168).

Regarding the meaning of exercise for Cox and Orford's (2004) participants, themes that emerged included a sense of both psychological and physiological control, the predictability of a routine, and pursuit of a specific body type. Participants discussed their motivations to exercise in terms of both short-term goals (i.e., satisfying an urge) and long-term goals (e.g., improved health and weight control). The authors underscored the fact that having long-term goals is usually not a component of addiction models. Additionally, they suggested that the desire to create a particular body shape through exercise must be considered within the context of contemporary sociocultural ideals for bodies of both men and women. Cox and Orford (p.186) argued that examining individuals' motives to be perceived physically in particular ways may be a more sensible way of understanding exercise behaviors than "...fitting exercise into an existing pathological framework."

Case studies and exercise dependence

Case studies have provided compelling evidence for the existence of primary exercise dependence. Veale (1995) described a 27 year-old marathon runner who did not work and lost her romantic partner because of exercise. She reportedly experienced withdrawal symptoms, including depressed mood, insomnia, restlessness, and indecisiveness, when an injury required her to train less. According to Veale, this woman exercised through back pain and completed a marathon with a fever from German measles. She had a history of depression but no psychiatric disorders during the period of investigation. Notably, she did not have a diagnosable eating disorder. Veale considered this woman to fit the criteria for primary exercise dependence.

Griffiths (1997) detailed another case study of a 25 year-old who engaged in Jiu-Jitsu training for approximately six hours per day or more. At the time of study, her sessions were becoming longer, which suggested she was increasingly tolerant to exercise. In terms of withdrawal effects, she reportedly became agitated and irritable and experienced physical discomfort if more than a day passed without training. Additionally, this woman experienced euphoria as a result of intense and lengthy training sessions and claimed she could not resist the urge to exercise. Griffiths noted that she had lost a long-term romantic partner and had gone into debt as a result of her compulsion to exercise. She acknowledged that exercise had taken over her life, and she was unsuccessful in her attempts to stop or cut down. According to Griffiths (p.164), she "...eats very well and describes herself as being in excellent physical condition except for a recent injury..." Although the condition appears to be rare, this case study also provided support for the existence of primary exercise dependence.

Self-report assessment measures of exercise dependence

Consensus has not been reached regarding which criteria are necessary to determine if an individual is at-risk for exercise dependence and what the label implies regarding the personality traits of those identified as at-risk. Yates, Leehey, and Shisslak (1983) generated considerable controversy when they compared a group of middle-aged marathoners and trail runners—whose identities were tied to obsessive, habitual running—to teenage women with Anorexia Nervosa. Yates (1991) described similarities between the two groups in terms of personality traits, conflicts, adaptive styles, and behaviors. These similarities included a lack of investment in relationships, a strong investment in their activity of choice (i.e., dieting or running), and a discomfort with leisure time. Yates also noted the exaggerated value these individuals placed on their activity and the penalties they envisioned resulting from diverting from their established routines.

Additionally, Yates et al. (1983) observed traits characteristic of obligatory runners in the women with Anorexia Nervosa and traits characteristic of women with Anorexia Nervosa in the obligatory runners. For instance, women with Anorexia Nervosa and their family members were often compulsively athletic, while obligatory runners demonstrated an unusual preoccupation with food and emphasis on lean body mass. Yates (1991) suggested that both Anorexia Nervosa and excessive exercising could represent an attempt to establish an identity and that they are manifestations of a common phenomenon. She proposed a more inclusive category, termed "activity disorder," which captured the observed similarities between compulsive exercisers and individuals with eating disorders. Blumenthal, O'Toole, and Chang (1984) challenged the arguments

made by Yates et al. (1983) by empirically assessing the personality functioning of runners and individuals with Anorexia Nervosa using the Minnesota Multiphasic Personality Inventory (MMPI). Blumenthal et al. created the Obligatory Running Questionnaire, a 21-item self-report questionnaire based on the characteristics of the middle-aged runners described by Yates et al., 1983). This questionnaire was used to identify a pool of study participants who could be considered obligatory in their approach to running. Results indicated that the study participants with Anorexia Nervosa had almost four times the rate of psychopathology (as defined by at least one MMPI T score greater than 70) compared with the group of obligatory runners. Accordingly, Blumenthal et al. (p. 523) advised that "…caution be exercised in overinterpreting the superficial similarity between obligatory exercise and anorexia nervosa."

Pasman and Thompson (1988) emphasized the need for a psychometrically evaluated measure of obligatory exercise. Using the Obligatory Running Questionnaire developed by Blumenthal et al. (1984) as a starting point, they made several changes in order to construct the Obligatory Exercise Questionnaire (OEQ). Exploratory factor analysis resulted in all items loading onto a single factor (i.e., a subjective need to engage in repetitive exercise behaviors). Using a different set of data than Pasman and Thompson, Steffen and Brehm (1999) conducted an exploratory factor analysis of the OEQ and obtained different results. They reported the emergence of three factors: the emotional element of exercise, exercise frequency and intensity, and exercise preoccupation. Among a sample of adolescent girls, correlation and regression analyses indicated that the attitude of the exerciser toward the exercise activity, as opposed to the

amount or intensity of exercise, may be the link between problematic exercising and eating disorders (Steffen & Brehm).

The Commitment to Exercise Scale (CES; Davis, Brewer, & Ratusny, 1993) was also intended to account for the multi-dimensional nature of exercise behavior. (In this case, *commitment* to exercise refers to attitudes and behaviors akin to exercise dependence or a negative addiction to exercise.) The authors of the CES reportedly examined several published case studies of men and women who exercised excessively. The scale's eight items were developed to reflect the central attitudinal and behavioral features of these men and women. An exploratory factor analysis was conducted on the eight items, which resulted in a two-factor solution. These factors highlighted the potential for exercise to become "obligatory" and "pathological." That is, questionnaire items either reflected the contingency of psychological well being on strict adherence to an exercise routine or the continuation of exercise despite adverse consequences.

Items from the previously described measures were based on published clinical descriptions of individuals who exercise despite consequent impairment in terms of their occupations, relationships, or health. The Obligatory Running Questionnaire (Blumenthal et al., 1984) and Obligatory Exercise Questionnaire (Pasman and Thompson, 1988) items were derived from Yates et al.'s (1983) characterization of middle-aged runners as similar to young women with Anorexia Nervosa. Similarly, the Commitment to Exercise Scale (Davis et al., 1993) items were based on case studies of excessive exercisers. The items initially selected for both the Obligatory Exercise Questionnaire and the Commitment to Exercise Questionnaire were examined using exploratory factor analyses. Analyses of the Obligatory Exercise Questionnaire by two different teams of researchers

resulted in different factor structures (i.e., a one-factor versus a three-factor solution). Analysis of the Commitment to Exercise Scale resulted in a two-factor solution. Evidently, ideas regarding the definition of exercise dependence have differed greatly. The issue of "what defines exercise dependence" is further complicated by the various methods by which researchers have developed their exercise dependence assessment measures.

Referring to Beckian schema theory, Loumidis and Wells (1998) suggested that exercise dependence may result from the activation of dysfunctional schemas, which are based on past experience and serve to organize and guide ongoing experiences. They developed the Exercise Beliefs Questionnaire (EBQ) in an effort to assess beliefs and attitudes that precipitate and maintain exercise dependence. Ultimately, their objective was to further develop cognitive conceptualizations of exercise dependence. They began with 13 participants who were randomly selected from a university sports facility and agreed to be interviewed. These individuals were first asked to create mental images associated with being unable to exercise and then asked to focus on sensory, emotional, and cognitive aspects of the images. Additionally, they were asked to ponder the personal meaning of the images that emerged. Following this exercise, they were asked six semi-structured interview questions intended to obtain qualitative data, from which 28 questionnaire items were derived. An exploratory factor analysis was conducted on these items, and four factors emerged: beliefs related to social desirability, beliefs regarding vulnerability to disease, beliefs about becoming unattractive, and beliefs about problems with mental functioning (Loumidis & Wells). The authors noted that the EBQ differed from other measures of exercise dependence in that it was developed using males and

females who participated in a range of physical activities or sports and whose exercise activities ranged in terms of both frequency and duration.

With the development of the Exercise Orientation Questionnaire (EOQ), Yates, Edman, Crago, Crowell, and Zimmerman (1999) added to the growing number of measures that assessed potentially negative aspects of exercise. Yates et al. (1999) referred to a previous investigation, which compared high-level exercisers to hospitalized patients with Anorexia Nervosa, and noted the difficulty in distinguishing these two groups utilizing the Commitment to Exercise Scale (Davis et al., 1995). Whereas the Commitment to Exercise Scale did not reveal differences between high-level exercisers and individuals with Anorexia Nervosa (Davis et al., 1995), Yates et al. (1999) intended to develop an instrument capable of making such distinctions. Their stated objective was to "...assess the gamut of commonly expressed attitudes toward exercise, including those that might be associated with psychopathology" (Yates et al., 1999, p. 202). Items considered for the EOQ were based on statements made by athletes about sports and exercise and statements made by patients with eating disorders about their investment in exercise. Items selected for the initial questionnaire were based on the authors' collective clinical experience and a review of the existing literature. Exploratory factor analysis was used to evaluate these items in a non-clinical sample, and six factors reportedly emerged: self-control, orientation to exercise, self-loathing, weight reduction, identity, and competition.

Loumidis and Wells (1998) derived the Exercise Beliefs Questionnaire items from cognitive, emotional, and sensory associations reported by individuals from an exercise facility who were asked to imagine being unable to exercise. Alternatively, Yates et al.

(1999) elicited statements about exercise from both athletes and patients with eating disorders in order to obtain items for the Exercise Orientation Questionnaire. Both research teams utilized factor analysis, which resulted in two distinctly different factor structures. Both of these measures were intended to distinguish between healthy and pathological involvement with exercise. Again, these investigations demonstrate the range of methods used for developing scales of exercise dependence and the inconsistencies across definitions of the construct itself.

Application of Substance Dependence criteria to exercise dependence questionnaires

Veale's (1987) proposed set of diagnostic criteria for exercise dependence was based on the characteristic features of Substance Dependence which were to be incorporated into the revised third edition of the *Diagnostic and statistical manual of mental disorders*, the *DSM-III-R* (American Psychiatric Association, 1987). These criteria included a stereotyped pattern of exercise, salience, tolerance, withdrawal symptoms, relief of withdrawal by exercise, subjective awareness of a compulsion to exercise, and rapid reinstatement of one's exercise routine after a period of abstinence. Utilizing these criteria, Veale (1987) stated that a diagnosis of primary exercise dependence should not be applied to individuals who meet the criteria for either Anorexia Nervosa or Bulimia Nervosa. He proposed that individuals with these eating disorders, who use physical activity as a means to control their weight and to compensate for specific eating episodes, should be diagnosed with secondary exercise dependence.

Veale (1991) reevaluated his proposed set of criteria in light of the fact that exercise dependence and staleness, which results from chronic overtraining, share common features. In Veale's (1991) opinion, severe primary exercise dependence would

only occur in an extremely small percentage of elite athletes. However, even then it would be difficult in a practical sense to distinguish an exercise dependent individual from a typical world-class athlete. Several years after his initial proposal of diagnostic criteria for exercise dependence, Veale (1995) updated his criteria for primary exercise dependence based on additional clinical experience and administration of a self-report measure. The revised guidelines included a stereotyped and routine preoccupation with exercise, withdrawal symptoms in the absence of exercise, and significant distress or impairment in important areas of functioning as a result of exercise. This reduced set of diagnostic criteria indicated that not all of the *DSM* criteria for Substance Dependence were necessarily useful for diagnosing exercise dependence, yet research has neither confirmed nor refuted this. That is, research has not addressed the question of which *DSM* Substance Dependence criteria are applicable to exercise dependence.

Ogden et al. (1997) selected an initial pool of 86 items for the Exercise Dependence Questionnaire (EDQ) using themes that emerged from unstructured self-report questionnaires completed by individuals who considered themselves to be addicted to exercise. The following factors were produced: interference with social, family, or work life, positive reward, withdrawal symptoms, exercise for weight control, insight into problem, exercise for social reasons, exercise for health reasons, and stereotyped behavior. Some of these factors mirrored Veale's (1991) modified criteria and, therefore, certain Substance Dependence criteria listed in the *DSM-III-R*. Ogden et al. reduced the original 86-item questionnaire to 29 items and eight factors by exploratory factor analysis. The EDQ improved on previous measures of exercise dependence by incorporating both traditional models of addiction and psychosocial perspectives.

However, its utility was limited by its lack of specific cut-off scores for determining whether an individual is at risk for exercise dependence or not. Notably, not all of the *DSM* Substance Dependence criteria are assessed by the EDQ.

A study conducted by Bamber, Cockerill, and Carroll (2000) utilized the EDQ to investigate the characteristics of individuals with primary versus secondary exercise dependence. They compared the personality characteristics and levels of psychological distress in four groups of women who had been screened for both eating disorders and exercise dependence. Based on pre-established criteria for the EDQ and the Eating Disorder Examination Self Report Questionnaire (EDE-Q), the women were assigned to the primary exercise dependence group (EDQ criteria met), the secondary exercise dependence group (EDQ and EDE-Q criteria met), the eating disorder group (only EDE-Q criteria met), and a control group (neither criteria met). This design was based on the rationale that individuals who demonstrate primary exercise dependence should report symptoms of psychological distress at levels comparable to those documented for other addictions.

However, their results suggested otherwise. Bamber, Cockerill, and Carroll (2000) found similarities between the primary exercise dependence group and the control group on the General Health Questionnaire (GHQ), on indicators of psychological morbidity, and on the Rosenberg self-esteem scale. In contrast, the secondary dependence group was similar to the eating disorder group on all of the GHQ measures except severe depression. The secondary exercise dependence group reported significantly higher overall GHQ scores and GHQ subscale scores for anxiety/insomnia, social dysfunction, and severe depression than both the primary exercise dependence

group and the control group. Furthermore, the profile of the secondary exercise dependence group was similar to that reported for people with other behavioral pathologies, such as addictions. Thus, the primary exercise dependent group and the control group demonstrated similar personality profiles, while the secondary exercise dependent group and the eating disorder group demonstrated comparable profiles.

These results supported the claim that exercise dependence has been prematurely pathologized. Like Veale (1995), Bamber, Cockerill, and Carroll (2000) concluded that primary exercise dependence, if it exists, is an extremely rare condition. They argued that symptoms characterized as exercise dependence are most likely the manifestation of an eating disorder. As determined by later diagnostic interviews, Bamber, Cockerill, Rodgers, and Carroll (2000) found that the EDQ failed to identify all of the individuals with secondary exercise dependence and characterized the EDQ as an invalid diagnostic instrument. Bamber, et al. (2003) identified three general problems with the questionnaire approach to identifying exercise dependent individuals, given the current level of understanding of this condition. First, without agreed upon and validated criteria for exercise dependence, the choice of items used in questionnaires has been somewhat arbitrary. Second, useful cut-off points have not been established for questionnaires. Third, the questionnaires have failed to differentiate between primary exercise dependence and secondary exercise dependence.

Development of the Exercise Dependence Scale-Revised

The development of the Exercise Dependence Scale-Revised specifically addressed Bamber et al.'s (2003) first two criticisms of the questionnaire approach to assessing exercise dependence. The initial pool of Exercise Dependence Scale items was

based on interviews with exercisers and reviews of existing exercise dependence measures (Hausenblas & Symons Downs, 2002). These items were not selected in an arbitrary manner in that they collectively addressed all seven *DSM-IV* criteria for Substance Dependence (i.e., tolerance, withdrawal symptoms, continuance despite physical or psychological problems, lack of control, reductions in other activities, time spent in activities necessary to obtain exercise, and exercising more than intended; American Psychiatric Association, 1994). In order to assess for each of the criteria for Substance Dependence, Hausenblas and Symons Downs (2002) created an initial pool of 35 items. After review by four exercise science experts and four avid exercisers, 6 of the 35 items were eliminated. This resulted in a 29-item scale, which differentiated between at-risk, symptomatic, and asymptomatic individuals based on cut-off criterion scores.

Further development of the EDS by Hausenblas and Symons Downs (2002) resulted in a 28-item scale. The scale items were further reduced from 28 to 21 by confirmatory factor analysis (Symons Downs et al., 2004). This 21-item scale became the Exercise Dependence Scale-Revised (EDS-R) and comprises seven factors corresponding to each of the seven criteria for Substance Dependence. In terms of Substance Dependence, an individual must meet three of the seven *DSM-IV* criteria at any time in the same 12-month period to be diagnosed (American Psychiatric Association, 1994). Each of the EDS-R subscales contains three items, and each item is assessed on a 6-point Likert scale, where 1 corresponds to "never," and 6 corresponds to "always." Responses to items are based on beliefs and behaviors that have occurred in the past three months. An individual must score 15 or greater on three or more subscales to be considered at-risk for exercise dependence. The EDS-R has been used to examine the relation between

exercise dependence and a variety of constructs (Hausenblas & Fallon, 2002; Hausenblas & Giacobbi, 2004; Symons Downs, et al.).

Regarding the third criticism made by Bamber et al. (2003), the EDS-R does not specifically differentiate between primary and secondary exercise dependence. However, Hausenblas and Symons Downs (2002) acknowledged that an eating disorder should be ruled out before a diagnosis of primary exercise dependence is made. In several notable ways, the EDS-R improves upon the EDQ. In addition to the EDS-R's more systematic choice of items and its use of cut-off criterion scores, the EDS-R factors uniformly reflect negative aspects of exercise. In contrast, the EDQ factors include the experience of positive rewards from exercising, exercising for social reasons, and exercising for health reasons, all of which underscore the benefits of exercise. Additionally, the EDQ includes items assessing the extent to which an individual exercises for weight control. These items seem to confound the measurement of primary exercise dependence with variables that could reflect exercise dependence secondary to an eating disorder.

At this point, the EDS-R serves as an adequate screening tool for individuals who are at-risk for exercise dependence. However, continued improvement in terms of its psychometric properties is warranted based on its initial development. Symons Downs et al. (2004) reported only confirmatory factor analysis, which should be based on theory or previous work and not to examine the underlying factor structure of a new measure (Kline, 1994). Hausenblas and Symons Downs (2002, p. 390) described the EDS as a "...theoretical-based measure of exercise dependence symptoms..." However, the lack of conclusive evidence suggesting that substance dependence and exercise dependence are equivalent necessitates that exploratory factor analysis precede confirmatory factor

analysis of the EDS-R. Confirmatory factor analysis alone does not allow for a thorough investigation of the EDS-R's psychometric properties. In particular, it does not allow for the possibility that some of the Substance Dependence criteria may be redundant or unnecessary in the assessment of exercise dependence. Based on this limitation in prior research, an exploratory factor analysis and a subsequent confirmatory factor analysis were conducted on the EDS-R scale items as part of the present investigation. Discriminant function analyses were used to compare the factor structure that emerged from the factor analyses to the seven-factor EDS-R proposed by Symons Downs et al.

Previous research using the Exercise Dependence Criteria (EDC; as cited in Zmijewski & Howard, 2003) justifies further exploration of the utility of applying all seven *DSM-IV* Substance Dependence criteria to the assessment of exercise dependence. The EDC is a 14-item, self-report questionnaire based on the seven *DSM-IV* criteria for Substance Dependence. Zmijewski and Howard reported that about three fourths of their sample of 237 men and women had met three or more *DSM-IV*-based criteria for exercise dependence within the past 12 months. That is, approximately 80 of the 237 respondents met the criteria for exercise dependence within the past 12 months as measured by the *DSM-IV*-based EDC. It is important to recognize that the large number of men and women who were identified as dependent by the EDC may indicate that not all of the *DSM* criteria for Substance Dependence are applicable to exercise dependence. Cautious and skeptical use of self-report measures based on the *DSM* criteria seems appropriate in light of these results and those reported by Bamber, Cockerill, and Carroll (2000) and Bamber, Cockerill, Rodgers, et al. (2000).

Caution is further warranted when research that evaluated the usefulness of the *DSM-IV* Substance Dependence criteria across different substances is considered. Gillespie, Neale, Prescott, Aggen, and Kendler (2007) determined that across substances, the dependence criteria do not measure equivalent levels of severity. For example, cannabis users in this study began to manifest the *DSM-IV* criteria for dependence at much higher levels of risk than observed with other substances (e.g., cocaine). Given these discrepancies across substances, it seems inappropriate to assume that the Substance Dependence criteria would determine a pathological level of risk for dependence on exercise.

Exercise dependence and subclinical eating disorders

The debate regarding the existence of primary exercise dependence is confounded by the fact that a large percentage of individuals, even those who do not meet diagnostic criteria for an eating disorder, engage in subclinical, pathogenic eating behaviors. Thus, the line between primary exercise dependence and secondary exercise dependence is unclear. Research aimed at determining how primary and secondary exercise dependence are distinct conditions must account for this ambiguity in their classification attempts. For example, if an individual meets the criteria for exercise dependence, purges by vomiting two times per month, and has a distorted body image, would that person be classified as having primary or secondary exercise dependence?

Currently, there is a dearth of research on subclinical eating disorders, including accurate information regarding their prevalence rates. To date, exercise dependence research has not addressed the question of whether exercise dependence combined with a subclinical eating disorder is considered primary or secondary exercise dependence.

Individuals are typically classified using screening tools as being at-risk for an eating disorder or not. However, these screening instruments were not intended for diagnostic purposes and may not result in accurate classifications. Consequently, many of the studies on primary exercise dependence may have been confounded by the presence of subclinical eating disorders in some of their participants. Addressing this possibility is imperative. Additionally, conducting exercise dependence research on this "in the middle" population of subclinical individuals is essential. Given the lack of research on the relation between subclinical eating disorders and exercise dependence, investigations highlighting the relation between eating disorders and exercise dependence will be briefly reviewed.

Exercise dependence and the eating disorders

Controversy is ongoing regarding the existence of primary exercise dependence as a pathological condition independent of the eating disorders. Bamber, Cockerill, and Carroll (2000) and Bamber, Cockerill, Rodgers, et al. (2000) argued that exercise dependence exists only in combination with an eating disorder (i.e., as a secondary condition). However, Blaydon, Lindner, and Kerr (2002) claimed that the conclusion drawn by both of these research teams was erroneous. Blaydon et al. (2002) suggested that the cut-off point for the EDQ used by Bamber, Cockerill, and Carroll and by Bamber, Cockerill, Rodgers, et al. was too low to distinguish exercise dependent individuals from those who were not dependent. Second, they pointed out that several significant differences between the primary exercise dependent group and the control group were in fact reported by Bamber, Cockerill, and Carroll (i.e., higher anxiety, insomnia, neuroticism, addictiveness, and impulsiveness scores for the exercise

dependent group). Blaydon et al. (2002) also noted a lack of significant differences between the primary and secondary exercise dependence groups on the GHQ and the EPQ-R. Lastly, Blaydon et al. (2002) suggested the possibility that, in their follow-up qualitative investigation, Bamber, Cockerill, Rodgers, et al. did not interview any individuals who actually met the criteria for primary exercise dependence. Blaydon, Lindner, and Kerr (2004) stressed the current need for researchers to determine how primary exercise dependence and secondary exercise dependence are separate and distinct conditions. Additionally, they suggested that comparing a wide range of sporting activities will be essential in terms of understanding the variations in personality profiles of exercise dependent and eating disordered individuals.

Reportedly, excessive exercise affects 40 to 50% of patients with Anorexia Nervosa and 20 to 24% of patients with Bulimia Nervosa (Shroff et al., 2006). Additionally, there is evidence that it affects up to 81% of patients with Anorexia Nervosa and 57% of patients with Bulimia Nervosa during the acute phase of the disorders (Davis et al., 1997). Patients for whom exercise is a predominant symptom report higher levels of psychological distress and related psychopathology (e.g., anxiety, perfectionism, obsessions, compulsions, and persistence) than non-exercising patients (Shroff et al.). Meyer, Taranis, and Touyz (2008) provided a summary of the current state of research regarding excessive exercise in the eating disorders, and their overall conclusion was that a great deal more needs to be done.

Meyer et al. (2008) suggested several possible reasons why research on the role of excessive exercise in the eating disorders is a neglected area of investigation. First, they noted that there is no consensus on what constitutes "excessive" exercise, how it should

be assessed, and whether the term is the most appropriate in the first place. Second, they acknowledged a lack of agreement among clinicians regarding what constitutes healthy versus unhealthy exercise behaviors for patients with eating disorders. Finally, they reported that exercise has been conceptualized as a compensatory behavior in the eating disorders without sufficient consideration given to its other functions. Importantly, excessive exercise often precedes the onset of an eating disorder (Davis, et al., 1997; Davis, Kennedy, Ravelski, and Dionne, 1994). Thus, exercise attitudes and behaviors among individuals with subclinical disordered eating warrant investigation. The role of exercise in the development of subclinical disordered eating and full-blown eating disorders must be clarified for the purposes of both treatment and prevention. Additionally, clarification is needed regarding the ways by which eating disorders and exercise behaviors resemble addictions and the ways by which they resemble obsessive-compulsive behavior.

Eating disorders, exercise, and addictiveness

Davis and Claridge (1998) investigated the theoretical conceptualization of eating disorders as addictions by assessing addictive personality characteristics in patients with Anorexia Nervosa and Bulimia Nervosa. Additionally, they examined the relations between addictiveness and exercise behaviors and between addictiveness and weight preoccupation. First, they found that scores for addictiveness, as measured by the Eysenck Personality Questionnaire Addiction Scale, were comparable to those reported for drug addicts and alcoholics. This was true for patients with Anorexia Nervosa and patients with Bulimia Nervosa and was consistent with previous results (Feldman & Eysenck, 1986). Second, Davis and Claridge found that addictiveness was positively

associated with both excessive exercising and weight preoccupation in patients with Anorexia Nervosa and Bulimia Nervosa. This latter finding was consistent with the auto-addiction opioid theory of chronic Anorexia Nervosa.

According to Marrazzi and Luby (1986), the auto-addiction opioid theory of Anorexia Nervosa explains how starvation in patients with Anorexia Nervosa stimulates the release of endogenous opioids, resulting in physiological changes that may perpetuate self-starvation. Since both severe food restriction and physical exertion stimulate the endogenous opioid, β-endorphin (Marrazzi & Luby), exercise is likely to play a role in the aetiology and maintenance of Anorexia Nervosa. Based on interview data collected from hospitalized eating disorder patients, Davis et al. (1994) reported that prior to the onset of their disorders, 78% of patients exercised excessively, 60% were competitive athletes, and 60% reported that exercise preceded food restriction. During the acute weight-loss phase of their disorder, 75% reported that their level of physical activity increased. Additionally, Klein et al. (2004) found that 48% of inpatients with Anorexia Nervosa reported symptoms of exercise dependence, as measured by an adapted version of the Substance Dependence Severity Scale (SDSS).

Animal research has provided evidence that hyperactivity may be induced by food restriction (Epling & Pierce, 1984; Kanarek & Collier, 1983). Kanarek and Collier observed that rats that were food-restricted during certain portions of the day initially lost weight and then regained it as they adjusted to the newly established feeding schedule. However, those rats that were food-restricted at particular times during the day, and had access to a running wheel, began to ignore the food when it was available and, ultimately,

ran themselves to death. Thus, food restriction seems to be more reinforcing in combination with exercise than by itself.

Hebebrand et al. (2003) reported evidence that rats displaying semi-starvation-induced hyperactivity (SIH) had decreased levels of leptin as a result of weight loss. Leptin is an adipose-derived hormone that provides the brain with input regarding energy storage (i.e., adiposity) and satiety. It acts on hypothalamus receptors that regulate appetite and metabolism (Brennan & Mantzoros, 2006). Plasma leptin levels are correlated with weight and body fat in normal, obese, and anorexic individuals (Balligand, Brichard, Brichard, Desager, & Lambert, 1998). Exogenous administration of leptin was shown to inhibit SIH in rats, suggesting that hypoleptinemia may to some extent explain the link between starvation and hyperactivity in individuals with Anorexia Nervosa (Hebebrand et al.).

It should be noted that 36 men in the Minnesota Experiment who voluntarily experienced semistarvation for six months did not exhibit hyperactivity. According to Franklin, Schiele, Brozek, and Keys (1948), the attitude of these men toward physical activity was "ambivalent." Those who did exercise more than was required reportedly were attempting to either obtain increased bread rations through rapid weight loss or avoid reduced rations resulting from slow weight loss. Thus, semistarvation alone does not seem to be a precondition for hyperactivity.

Eating disorders, exercise, and Obsessive-Compulsive Disorder

Davis et al. (1995) provided evidence for positive relations between physical activity levels and three other variables, obsessive-compulsiveness, weight preoccupation, and pathological attitudes toward exercising, among patients with

Anorexia Nervosa. Based on their results, they proposed a model whereby the combination of obsessive-compulsive tendencies and extreme weight preoccupation increase commitment to exercise, in terms of both quantity and attitude. They argued that starvation, exercise, and obsessionality tend to influence one another "...in a destructive feedback/feedfoward loop that becomes self-perpetuating, resistant to change, and may be a significant influence in the development and maintenance of eating disorders for some women" (Davis et al., 1995, p. 974). Data from animal research supported the hypothesis of a self-perpetuating feedback loop, involving activity-induced stimulation of serotonin, a neurotransmitter whose dysregulation has been implicated in the pathogenesis of Obsessive-Compulsive Disorder (Abel, 1993). Results reported by Broocks, Schweiger, and Pirke (1991) suggested that activity-induced stimulation of serotonin in rats led to reduced food intake and body weight, which further stimulated physical activity.

Given evidence that physical activity is relevant to the association between Anorexia Nervosa and obsessive-compulsiveness (Davis et al., 1995), Davis, Kaptein, Kaplan, Olmstead, and Woodside (1998) investigated the moderating influence of exercise on the obsessionality characteristic of Anorexia Nervosa. These researchers identified patients with Anorexia Nervosa as either high-level exercisers or moderate/nonexercisers. They found that individuals who exhibited starvation combined with excessive exercising reported greater obsessive-compulsive symptomatology and obsessive-compulsive personality traits than those who exhibited starvation alone. Davis et al. (1998) highlighted the links between Anorexia Nervosa and Obsessive-Compulsive Disorder. In addition to substantial comorbidity, they noted psychopathological,

behavioral, and neurochemical similarities between the two conditions. However, Davis et al. (1998) pointed out that making causal inferences regarding the relation between Anorexia Nervosa and Obsessive-Compulsive Disorder is confounded by the fact that starvation can contribute to obsessionality. Sparse and inconsistent longitudinal research adds to the difficulty.

McCabe and Boivin (2008) provided several arguments for conceptualizing eating disorders as obsessive-compulsive spectrum disorders. First, obsessive-compulsive disorders and eating disorders are comorbid more frequently than would be expected by chance. Second, both Anorexia Nervosa and Bulimia Nervosa are characterized by obsessions (e.g., preoccupation with weight and eating, intrusive thoughts regarding bingeing and/or adherence to rigid rules) and compulsions (e.g., strict dieting to manage anxiety about weight gain, purging behaviors to manage anxiety about food intake). Lastly, patients with Anorexia Nervosa seem to experience some obsessions (i.e., symmetry and somatic obsessions) and compulsions (i.e., ordering and arranging) to the same degree as patients with Obsessive-Compulsive Disorder (Halmi et al., 2003).

Exercise dependence has also been conceptualized as an obsessive-compulsive spectrum disorder. Rather than viewing anxiety as a withdrawal symptom associated with exercise addiction, Gulker, Laskis, and Kuba (2001) suggested that excessive exercisers might have an underlying anxiety disorder. In this way, exercise is a compulsion that serves to neutralize anxiety and obsessive thoughts about one's appearance or health. This combination of compulsive behavior and obsessive thinking meets the criteria for Obsessive-Compulsive Disorder or, as Gulker et al. proposed, obsessive-compulsive spectrum disorder. Thus, exercise dependent individuals could be exercising to ward off

anxiety related to their appearance or health. This approach to understanding exercise dependence is congruent with Blayden and Lindner's (2002) suggestion that exercise dependence could be secondary to either an eating disorder or body image preoccupation.

Given the view of addictions as ego syntonic and of compulsions as ego dystonic, the conceptualization of eating disorders and exercise dependence as related to both addictiveness and obsessionality may seem contradictory (Yates, 1991). However, Marrazzi and Luby (1986) argued that compulsive behavior is a defining characteristic of the psychopathology of drug addictions. Likewise, Jaffe (1990) claimed that addictions are always compulsive in that the addicted individuals experience a diminished ability to abstain from their drug using behaviors. The question that elicits more controversy is whether compulsive behaviors (e.g., gambling, hair-pulling, exercise, etc.) can be characterized as addictive. In terms of underlying personality traits, it appears that both addictiveness and obsessive-compulsiveness may be closely related to the development of exercise dependence, eating disorders, and subclinical disordered eating.

Personality profiles and the role of exercise in the eating disorders

Ackard, Brehm, and Steffen (2002) examined the relations between obligatory exercise (i.e., attitudes and activities related to exercise), eating disordered characteristics and behavior, and selected psychological characteristics in college women. Their results strongly suggested that research linking eating disorders and exercise must consider the motivation and meaning of exercise for individuals, not only the amount or intensity. Using the Obligatory Exercise Questionnaire (OEQ), they categorized participants based on scores in the following three areas: exercise fixation, exercise frequency, and exercise commitment. Those individuals who scored high on the exercise frequency subscale of

the OEQ were further subdivided based on their exercise fixation scores. The OEQ exercise fixation factor is characterized by preoccupation with an exercise routine, negative emotionality resulting from a missed exercise session, and the use of exercise to compensate for overeating.

A clear distinction emerged between individuals who exercised frequently and had a strong emotional fixation on their exercise activity and those who exercised frequently and did not evidence a psychological fixation (Ackard et al., 2002). That is, the high fixation group scored high on almost all of the Eating Disorder Inventory subscales, and the low fixation group scored low on the same subscales. Additionally, the former group scored higher on measures of depression, self-esteem, and affect regulation, while the latter group demonstrated minimal psychopathology. Thus, it appears that the key link between eating disorders and obligatory exercise is the exercise fixation factor.

Davis and Claridge (1998) found that individuals with eating disorders (i.e., Anorexia Nervosa or Bulimia Nervosa) who were also identified as excessive exercisers had higher scores for both addictiveness and obsessive-compulsiveness than nonexercising individuals with eating disorders. Based on these results, Davis et al. (1999) used structural equation modeling to test the hypothesis that addictiveness and obsessive-compulsiveness moderate the relation between attitudes toward exercise and exercise behavior in adolescent girls with Anorexia Nervosa (Figure 1). Obligatory attitudes toward exercise were measured by the Commitment to Exercise Scale. The proposed model was supported in that both personality variables, addictiveness and obsessive-compulsiveness, significantly predicted the extent to which participants

endorsed obligatory attitudes toward exercising. Additionally, attitudes toward exercising and exercise behavior were reciprocal and self-perpetuating within the model. Importantly, results suggested that the personality variables did not have direct effects on exercise behavior. Rather, they indirectly influenced behavior through their effects on attitudes about exercise. In light of their findings, Davis et al. (1999) argued that the significance of physical activity in Anorexia Nervosa extends beyond a purposeful and calculated means for burning calories. They suggested that calorie restriction, weight loss, and exercise are interconnected and that exercise plays a role in the "progressive pathology" of Anorexia Nervosa (Davis et al., 1999, p. 336).

Davis et al.'s (1999) model was further tested in a non-clinical sample of women in college using the Obligatory Exercise Questionnaire as a measure of attitudes toward exercise (Thome & Espelage, 2007). Again, addictiveness and obsessive-compulsiveness indirectly influenced exercise behavior through their direct effect on attitudes toward exercise. The current study provided information regarding these relations for a sample of college women and men who self-reported at least one pathogenic eating behavior. The EDS-R was used as the measure of exercise attitudes. Correlational analyses determined which subscales of the EDS-R most strongly accounted for the relations between addictiveness and exercise dependence and between obsessive-compulsiveness and exercise dependence. Amount of exercise and weight dissatisfaction were also correlated with each other and with the previously mentioned variables.

Our earlier research demonstrated that exercise dependence may manifest in different ways for men and women who are asymptomatic in terms of disordered eating. For women, total EDS-R scores and four of the seven EDS-R subscale scores were

positively and significantly related to a measure of obsessive-compulsiveness. None of the EDS-R subscale scores were significantly correlated with the addictiveness measure. For men, total EDS-R scores and two of the seven EDS-R subscale scores were positively and significantly related to a measure of addictiveness, and one of the EDS-R subscales scores was significantly correlated with the obsessive-compulsiveness measure.

Thus, for the previously studied asymptomatic sample, the model utilized by Davis et al. (1999) and by Thome and Espelage (2007) was not supported. As reported by these researchers, both addictiveness and obsessive-compulsiveness predicted obligatory exercise attitudes in adolescent girls with Anorexia Nervosa and women in college, respectively. However, our earlier research suggested no relation between addictiveness and obligatory exercise attitudes in women in college. This lack of relation may have resulted from the strict exclusionary criteria we used regarding symptoms of eating disorders. Thome and Espelage identified their sample as non-clinical; however, they did not eliminate individuals based on attitudes or behaviors related to eating. Thus, their sample may have included individuals with disordered eating or subclinical eating disorders.

The relation between eating disorders and exercise dependence appears to be complex. Likewise, the demonstrated links between secondary exercise dependence, the behavioral addictions, and Obsessive-Compulsive Disorder are not well understood. Much less is known about the role that excessive exercise plays in subclinical disordered eating. In the current study, correlational analyses were conducted for men and women who self-reported at least one symptom of disordered eating. The following variables were included in the analyses: the EDS-R factors that emerged from the exploratory and

confirmatory factor analyses, a measure of addictiveness, a measure of obsessive-compulsiveness, amount of exercise, and weight dissatisfaction. Given that the factors to be used in the correlation analyses had not been determined, specific a priori hypotheses were not developed.

Overall, based on research reported by Thome and Espelage (2007), positive correlations were expected between some of the EDS-R factors and both addictiveness and obsessive-compulsiveness in the symptomatic samples of both women and men. (As noted, our earlier research demonstrated no correlations between the seven EDS-R subscales and addictiveness for the asymptomatic sample of women.) Given evidence that addictiveness was associated with both excessive exercising and weight preoccupation in patients with eating disorders (Davis & Claridge, 1998), correlations between the EDS-R subscales and addictiveness for the symptomatic samples were hypothesized to be positive and greater than the same correlations for the asymptomatic samples. Based on the reinforcing properties of restricted food intake and excessive physical activity (Davis et al., 1995; Klein et al., 2004), correlations between the EDS-R subscales and obsessive-compulsiveness for the symptomatic samples were hypothesized to be positive and greater than the same correlations for the asymptomatic samples. The correlations between total EDS-R scores and both addictiveness and obsessive-compulsiveness were also expected to be positive and greater for the symptomatic samples when compared to the asymptomatic samples.

Based on results reported by Thome and Espelage (2007), amount of exercise was expected to correlate positively with some of the EDS-R factors in the symptomatic samples of women and men. However, addictiveness and obsessive-compulsiveness were

not expected to correlate with amount of exercise. For women, mean weight dissatisfaction was expected to be positive, indicating a desire to lose weight. Weight dissatisfaction was hypothesized to correlate positively with all of the other variables (addictiveness, obsessive-compulsiveness, EDS-R factors, and amount of exercise) in the symptomatic sample of women. For men, mean weight dissatisfaction was expected to be negative, indicating a desire to gain weight. Weight dissatisfaction was hypothesized to correlate negatively with all of the other variables in the symptomatic sample of men.

CHAPTER II

Method

Participants

The questionnaires used in the present study were previously administered to 145 male and 216 female PY100 students at CSU during the 2006-2007 academic year. All PY100 students who completed the questionnaire received research credit. Questionnaires were turned in by all of the study participants, and all of the questionnaires were valid. Participants were separated into two groups, one comprising asymptomatic individuals and the other comprising individuals who reported at least one symptom of disordered eating. Criteria for disordered eating were derived from the Questionnaire for Eating Disorder Diagnosis (Mintz, O'Halloran, Mulholland, & Schneider, 1997). Self-report of any of the following symptoms resulted in classification of a participant as symptomatic: maintenance of a BMI ≤ 20; use of strict dieting and/or appetite pills to prevent weight gain, and no binging, use of vomiting, laxatives, enemas, diuretics, fasting for at least 24 hours, and/or chewing food and spitting it out to prevent weight gain, and no binging; binging described as "out of control" and use of strict dieting and/or appetite pills to prevent weight gain; binging described as "out of control" with compensation by vomiting, laxatives, enemas, diuretics, fasting for at least 24 hours, and/or chewing food and spitting it out; binging described as "in control," and use of strict dieting and/or appetite pills to prevent weight gain; or binging described as "in control," with compensation by vomiting, laxatives, enemas, diuretics, fasting for at least 24 hours, and/or chewing food and spitting it out.

Those participants who denied symptoms of disordered eating were classified as asymptomatic. The asymptomatic sample initially included 113 women and 100 men. A criterion was necessary to ensure that participants were exercising at or above a minimal level. Church, Earnest, Skinner, and Blair (2007) found that approximately 72 minutes of exercise per week was associated with a significant improvement in fitness. A more stringent criterion would have resulted in too few participants to conduct an exploratory factor analysis (EFA).

Of the 113 women who denied symptoms of disordered eating, 93 exercised an average of 72 minutes per week or more. Of the 100 men who denied symptoms of disordered eating, 82 exercised an average of 72 minutes per week or more. Thus, the asymptomatic sample used for the current study consisted of 93 women and 82 men. In terms of pathogenic eating behaviors, 103 women and 45 men reported at least one symptom of disordered eating. Of the 103 women, 90 exercised an average of 72 minutes per week or more. Of the 45 men, 35 exercised an average of 72 minutes per week or more. Thus, the symptomatic sample used for the current study consisted of 90 women and 35 men.

Materials

The previously completed questionnaire packets consisted of the following:

Demographic information. Participants were asked to provide their gender and to report medical and psychiatric problems, including any history of eating disorders.

Weight dissatisfaction. Weight dissatisfaction was assessed by asking participants their current weight and ideal weight at their current height. Weight dissatisfaction was

equivalent to the numerical difference between ideal and current weights (Bamber, Cockerill, & Carroll, 2000).

Physical activity. Estimates of physical activity levels were obtained by asking participants to list all types of exercise in which they have engaged over the past twelve months. For each activity, they were asked to specify the average number of weeks a year during which they exercised, the average number of sessions a week, and the average duration of each session in minutes. Activity levels were scored by multiplying weeks exercised in a year by frequency a week by duration (in units equal to 30 minutes). These scores were summed across activities for a total physical activity score (Davis, et al., 1993).

Exercise Dependence Scale-Revised (EDS-R). The EDS-R is a multidimensional, 21-item measure of exercise dependence symptoms based on the *DSM-IV* criteria for Substance Dependence. The scale contains seven subscales: tolerance, withdrawal, continuance, lack of control, reductions in other activities, time, and intention effects. Possible scores on each of the subscales range from 0 to 18, and total scores for exercise dependence range from 0 to 126. Internal reliability in a sample of 855 university students ranged from $\alpha = 0.78$ to 0.95, and the 7-day test-retest reliability in a sample of 30 university students was $r = 0.95$ (Hausenblas & Symons Downs, 2002). Internal reliability in the current study was $\alpha = 0.88$.

Obsessive-Compulsive Scale (OCS). The OCS is a measure of compulsiveness and obsessiveness present in everyday routines and thought processes. The 20-item scale has true or false response categories, and possible scores range from 0 to 20. Over a 3-week period, the test-retest reliability correlation for 77 of the original 114 participants was $r =$

0.82 (Gibb, Bailey, Best, & Lambirth, 1983). Internal reliability was moderate ($\alpha = 0.73$, $n = 114$; Gulker et al., 2001).

Eysenck Personality Questionnaire (EPQ). The EPQ is a measure of neuroticism, extroversion, psychoticism, and a lie scale (social desirability) with 101 items and yes or no response categories. Total possible scores for each of the subscales are 28 for Neuroticism, 26 for Extraversion, 37 for Psychoticism, and 25 for the Lie Scale. The subscales were reported to have the following psychometric properties in a sample of 408 men and 494 women: Neuroticism Scale, $\alpha = 0.88$ for men and $\alpha = 0.85$ for women; Extraversion Scale, $\alpha = 0.90$ for men and $\alpha = 0.85$ for women; Psychoticism Scale, $\alpha = 0.78$ for men and $\alpha = 0.76$ for women; Lie Scale, $\alpha = 0.82$ for men and $\alpha = 0.79$ for women (Eysenck, Eysenck, & Barrett, 1985). An Addiction Scale comprises thirty-two of the EPQ items, derived from all four subscales. Scores on this scale can range from 0 to 32. Reliabilities for the Addiction Scale were $\alpha = 0.78$ ($n = 155$) for men who were addicts, $\alpha = 0.84$ ($n = 66$) for women who were addicts, $\alpha = 0.78$ ($n = 155$) for men who were non-addicts, and $\alpha = 0.70$ ($n = 155$) for women who were non-addicts (Gossop & Eysenck, 1980).

Questionnaire for Eating Disorder Diagnosis (Q-EED). The Q-EED is a 24-item measure that operationalizes the eating disorder criteria of the *DSM-IV*. The Q-EED differentiates between eating-disordered and non-eating-disordered individuals, between eating-disordered, symptomatic, and asymptomatic individuals, and between those with Anorexia Nervosa and Bulimia Nervosa. In regard to the eating-disordered versus non-eating-disordered diagnostic differentiation, the accuracy rate of the Q-EED was 98% ($\kappa = .94$) for a sample of 136 female university students. For the same sample, the accuracy

rate was 90% (κ = .82) in terms of the eating-disordered, symptomatic, and asymptomatic diagnostic differentiation. The accuracy rate for the diagnostic differentiation between Anorexia Nervosa and Bulimia Nervosa could not be examined with this sample. The 2-week test-retest reliability was calculated for changes in diagnostic categories over a 2-week period for 167 female university students. For changes between the eating-disordered and non-eating disordered groups, the kappa value was .94. For changes between the eating-disordered, symptomatic, and asymptomatic groups, the kappa value was .85. There were no changes between the Anorexia Nervosa and Bulimia Nervosa groups, but there was only one participant in each category (Mintz et al., 1997).

Data Analysis

In the present study, SPSS (SPSS, 2008) was used to conduct an exploratory factor analysis (EFA) on the data from the men and women who reported no symptoms of an eating disorder (i.e., the asymptomatic sample) and met the minimum exercise criterion. EFA is a statistical procedure used to discover the underlying factor structure of an instrument. In this case, it was used to determine the factor structure of the 21-item EDS-R (Symons Downs et al., 2004).

Three competing models were evaluated for goodness of fit using confirmatory factor analysis (CFA). These models included the resulting factor structure from the EFA of the 21 EDS-R items, a single-factor model of the EDS-R, and the seven-factor model of the EDS-R proposed by Symons Downs et al. (2004). The three CFA models were applied to the data from men and women who reported at least one symptom of disordered eating (i.e., the symptomatic sample) and met the minimum exercise criterion. In addition, they were applied separately to the data from men and women meeting the

minimum exercise criterion in the asymptomatic sample. The CFA models were analyzed using AMOS (Analysis of Moment Structures; Arbuckle, 1993; Arbuckle & Wothke, 1995).

Discriminant function analyses were conducted in SPSS (SPSS, 2008) to determine whether the factor structure that emerged from the EFA and CFA could predict classification into groups (i.e., at-risk, symptomatic, and asymptomatic) as well as the original seven-factor model of the EDS-R. These analyses were conducted separately for the asymptomatic and symptomatic samples.

Using the modified version of the EDS-R that emerged from the exploratory and confirmatory factor analyses, EDS-R factor scores were correlated with both addictiveness scores and obsessive-compulsiveness scores. Amount of exercise and degree of weight dissatisfaction were also included in the correlational analyses. These analyses were conducted for the symptomatic sample of women and men. The results were compared with results from previous, similar analyses conducted for the asymptomatic sample of women and men.

CHAPTER III

Results

Exploratory factor analysis

SPSS (SPSS, 2008) was used to conduct an exploratory factor analysis (EFA) on the asymptomatic sample to determine which of the 21 EDS-R items explained the most variance and on which factors these items loaded. The sample size (n = 175) used for this analysis is considered to be adequate according to Gorsuch (1983) and Nunnally (1994). Principle Axis Factoring (with Promax rotation) was used because research suggests it is more precise than principal components analysis (Gorsuch, 1997).

The initial solution demonstrated the correlation matrix was factorable (Kaiser-Meyer Olkin measure of sampling adequacy = .819, Bartlett's Test of Sphericity- $X^2(210, n = 175) = 2064.399$, p<.000, Determinant = 4.02E-006). Decisions about the number of factors retained for the final rotation were formed by an evaluation of the items that had eigenvalues ≥ 1, the scree plot, percent of variance accounted for by the factors, and the theoretical interpretability of the factors. Using these criteria, five factors were retained for the final analysis. The final five-factor extraction of 15 items resulted in a factorable matrix (Kaiser-Meyer Olkin measure of sampling adequacy = .779, Bartlett's Test of Sphericity- $X^2(105, n = 175) = 1457.927$, p<.000, Determinant = .000).

Results of the final EFA suggested an appropriate criterion for evaluating item loadings was $\geq .7$ due to the presence of many items with high loadings, and the use of this criterion resulted in no cross-loading items. The eigenvalues for the five extracted factors were 4.788, 2.246, 1.898, 1.630, and 1.338, respectively. The first factor accounted for 30.0% of the variance. The remaining four factors accounted for 13.1%,

10.8%, 8.6% and 7.0% of the variance, respectively, with a total of 69.5% being explained by all five factors (Table 1). Deletion of the 6 items that didn't meet the criterion of $\geq .7$ resulted in the deletion of 2 subscales (time and reductions in other activities). Deletion of these subscales resulted in an increase in the total variance explained (from 67.6% with 21 items to 69.5% with 15 items). Each of the five factors retained comprised three items and were identical to five of the subscales (intention effects, continuance, tolerance, withdrawal, and lack of control) found by Symons Downs et al. (2004).

After the EFA, an internal consistency analysis was conducted to determine the reliability of each of the remaining five factors. Alpha coefficients for the five factors were as follows: withdrawal (N = 3) $\alpha = .83$, continuance (N = 3) $\alpha = .89$, tolerance (N = 3) $\alpha = .85$, lack of control (N = 3) $\alpha = .81$, and intention effects (N = 3) $\alpha = .91$. These alpha coefficients were similar to those found by Symons Downs et al. (2004) in Studies 1 and 2, respectively, for the same five factors: withdrawal (N = 3) $\alpha = .93$ and $\alpha = .90$, continuance (N = 3) $\alpha = .89$ and $\alpha = .90$, tolerance (N = 3) $\alpha = .78$ and $\alpha = .78$, lack of control (N = 3) $\alpha = .82$ and $\alpha = .82$, and intention effects (N = 3) $\alpha = .92$ and $\alpha = .89$.

Confirmatory factor analysis

Given that data from the asymptomatic sample was used to generate the EFA solution, the 15 items from the EFA were subjected to confirmatory factor analysis (CFA) using data from the symptomatic sample (n = 125). Three CFA models were analyzed using AMOS (Arbuckle, 1993; Arbuckle & Wothke, 1995). Model 1 (Figure 2) was based on the results of the EFA. Model 2 (Figure 3) was based on the seven-factor structure proposed by Symons Downs et al. (2004). Model 3 (Figure 4) used exercise

dependence as the only factor in order to test whether an unhealthy dependence on exercise could be better conceptualized as a single factor rather than having discrete components.

The X^2 statistic assesses the amount of discrepancy between the original and estimated covariance matrices. Although a nonsignificant X^2 is preferable, this result is seldom met in practice because the X^2 is a product of sample size (Byrne, 2001). Due to the sensitivity the X^2 has to sample size, many other fit indices were used to evaluate model fit, including a ratio of X^2/df, or relative chi-square. Byrne suggested that this ratio provides a better assessment of the magnitude of the X^2 statistic. Conservative use of relative chi-square requires rejection of models with X^2/df greater than 2 or 3. However, since the X^2 is still affected by sample size, this ratio may also reflect a poor fit when the sample size is large. Byrne noted that the researcher who originally proposed X^2/df as a measure of goodness of fit later advocated that the ratio not be used. A second fit index, Root Mean Square Error of Approximation (RMSEA) is an alternative overall goodness of fit index. The RMSEA takes into account model complexity and answers the question, "How well would the model, with unknown, but optimally chosen, parameter values fit the population covariance matrix if it were available?" (Browne & Cudeck, 1993, p. 137-138). RMSEA values less than .06 indicate a relatively good fit to the data (Hu & Bentler, 1999). The next three fit indices, Normed Fit Index (NFI), Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI), are examples of incremental fit indices. They are derived from comparing the sample's model fit to a null model that assumes the observed variables are uncorrelated. Values for these indices range from 0 to 1, with values greater than .95 indicating a superior fit (Hu & Bentler). A final fit index, the

Parsimony Comparative Fit Index (PCFI), penalizes for lack of parsimony and has the same cutoffs as its CFI counterpart. When comparing parsimony indices, a higher index suggests a better fit. The fit indices for the three models are shown in Table 2. They are shown for both the symptomatic data set and the asymptomatic data set.

The CFA results for the symptomatic sample indicated that the single-factor solution demonstrated a poor fit to the data as X^2/df = 5.564, NFI = .509, TLI = .503, CFI = .553, PCFI = .498, and RMSEA = .192. Compared to the seven-factor model, the EFA (five-factor) model demonstrated an improved fit. The X^2/df ratio was lower for the EFA model than for the seven-factor model (1.446 and 1.504, respectively). The NFI was greater for the EFA model than for the seven-factor model (.919 and .882, respectively), and the TLI was greater for the EFA model than for the seven-factor model (.964 and .945, respectively). The CFI was also greater for the EFA model than for the seven-factor model (.973 and .956, respectively). The RMSEA for the EFA model was slightly less than the RMSEA for the seven-factor model (.060 and .064, respectively). The only fit index that supported a better fit for the seven-model factor was the PCFI, which was smaller for the EFA model than for the seven-factor model (.741 and .765, respectively). As shown in Table 2, results demonstrated by the asymptomatic sample were similar to those demonstrated by the symptomatic sample. Overall, the EFA model (Model 1, Figure 5) demonstrated a better fit when compared to the seven-factor model (Model 2, Figure 6). The single-factor model (Model 3, Figure 7) demonstrated a poor fit.

Given that the five-factor EFA model provided the best fit to the data, a final reliability analysis was conducted for these five factors with the symptomatic data. The alpha coefficients for the subscales were as follows: withdrawal (N = 3) α = .86,

continuance (N = 3) α = .86, tolerance (N = 3) α = .91, lack of control (N = 3) α = .89, and intention effects (N = 3) α = .89.

Discriminant function analyses

Direct discriminant function analysis (DISCRIM) was performed in SPSS (2008) using the seven EDS-R factors as predictors of membership in three groups (i.e., at risk for exercise dependence, symptomatic, and asymptomatic). DISCRIM was also performed using the five factors derived from the factor analyses (described above) as predictors of membership in these three groups. For the former analysis, predictors were tolerance, withdrawal, continuance, lack of control, reductions in other activities, time, and intention effects. For the latter analysis, predictors were tolerance, withdrawal, continuance, lack of control, and intention effects. Results for these two analyses were compared for both the symptomatic (in terms of disordered eating) and asymptomatic samples.

For the asymptomatic sample, the seven EDS-R factors correctly predicted group membership with regard to exercise dependence for 169 (96.6%) of the 175 individuals. The five EDS-R factors correctly predicted group membership for 158 (90.3%) of the 175 asymptomatic individuals. For the symptomatic sample, the seven EDS-R factors correctly predicted group membership for 114 (91.2%) of the 125 individuals. In this sample, the five EDS-R factors correctly predicted group membership for 110 (88%) of the 125 individuals.

The seven-factor model correctly classified 4 (80.0%) of the 5 individuals who were at risk for exercise dependence, while the five-factor model correctly classified 0 (0%) of the 5 at risk individuals. In the symptomatic sample, a similar pattern of results

emerged. The seven-factor model correctly classified 11 (73.3%) of the 15 at risk individuals, while the five-factor model correctly classified 7 (46.7%) of the 15 at risk individuals.

Correlational analyses using the EDS-R five-factor model

The 90 women identified as symptomatic demonstrated the following pathogenic eating behaviors: maintenance of a BMI ≤ 20 (12); use of strict dieting and/or appetite pills to prevent weight gain, and no binging (26); use of vomiting, laxatives, enemas, diuretics, fasting for at least 24 hours, and/or chewing food and spitting it out to prevent weight gain, and no binging (19); binging described as "out of control" and use of strict dieting and/or appetite pills to prevent weight gain (14); binging described as "out of control" with compensation by vomiting, laxatives, enemas, diuretics, fasting for at least 24 hours, and/or chewing food and spitting it out (12); binging described as "in control," and use of strict dieting and/or appetite pills to prevent weight gain (3); binging described as "in control," with compensation by vomiting, laxatives, enemas, diuretics, fasting for at least 24 hours, and/or chewing food and spitting it out (4).

The 35 men identified as symptomatic demonstrated the following pathogenic eating behaviors: use of strict dieting and/or appetite pills to prevent weight gain, and no binging (10); use of vomiting, laxatives, enemas, diuretics, fasting for at least 24 hours, and/or chewing food and spitting it out to prevent weight gain, and no binging (4); binging described as "out of control" and use of strict dieting and/or appetite pills to prevent weight gain (7); binging described as "out of control" with compensation by vomiting, laxatives, enemas, diuretics, fasting for at least 24 hours, and/or chewing food and spitting it out (0); binging described as "in control," and use of strict dieting and/or

appetite pills to prevent weight gain (13); binging described as "in control," with compensation by vomiting, laxatives, enemas, diuretics, fasting for at least 24 hours, and/or chewing food and spitting it out (1).

Means and standard deviations for amount of exercise, the five EDS-R subscales derived from the EFA and CFA, total EDS-R scores (based on the reduced set of subscales), obsessive-compulsiveness, addictiveness, and weight dissatisfaction are shown in Table 3 for men, women, and the combined sample. The following correlational analyses were conducted: EDS-R subscale scores correlated with addictiveness, obsessive-compulsiveness, amount of exercise, and weight dissatisfaction; total EDS-R scores correlated with addictiveness, obsessive-compulsiveness, amount of exercise, and weight dissatisfaction; amount of exercise correlated with addictiveness, obsessive-compulsiveness, and weight dissatisfaction; and weight dissatisfaction correlated with addictiveness and obsessive-compulsiveness. These correlations are shown in Table 4 for the symptomatic women, Table 5 for the symptomatic men, and Table 6 for the combined symptomatic sample. Given that only five factors of the EDS-R were used to calculate total EDS-R scores for the symptomatic sample, total EDS-R scores were recalculated for the previously studied asymptomatic sample using the same reduced set of factors. Based on this new set of total EDS-R scores, some correlations were recalculated for the previously studied asymptomatic sample. For ease of comparison, all of the aforementioned correlations for the asymptomatic women, the asymptomatic men, and the combined asymptomatic sample are shown in Tables 4, 5, and 6, respectively.

For the symptomatic sample of women, addictiveness was not significantly correlated with any of the newly derived EDS-R subscales. The correlation between

addictiveness and total EDS-R scores was also not significant. Likewise, these correlations were not significant for the symptomatic sample of men or the combined symptomatic sample.

The correlation between obsessive-compulsiveness and intention effects ($r = .254$, $p<.05$) was significant for the symptomatic sample of women. The correlations between obsessive-compulsiveness and the other newly derived EDS-R subscales and between obsessive-compulsiveness and total EDS-R scores were not significant. For the symptomatic sample of men, the correlations between obsessive-compulsiveness and the newly derived EDS-R subscales were not significant. In addition, the correlation between obsessive-compulsiveness and total EDS-R scores was not significant for the symptomatic men. For the combined symptomatic sample, the correlations between obsessive-compulsiveness and lack of control ($r = .189$, $p<.05$) and between obsessive-compulsiveness and intention effects ($r = .227$, $p<.05$) were significant. The correlation between obsessive-compulsiveness and total EDS-R scores and ($r = .195$, $p<.05$) was also significant.

In the symptomatic sample of women, amount of exercise was significantly correlated with tolerance ($r = .261$, $p<.05$), lack of control ($r = .234$, $p<.05$), intention effects ($r = .252$, $p<.05$), and total EDS-R scores ($r = .289$, $p<.01$). In the symptomatic sample of men, amount of exercise was significantly correlated with lack of control ($r = .443$, $p<.05$), intention effects ($r = .432$, $p<.05$), and total EDS-R scores ($r = .554$, $p<.01$). For the combined symptomatic sample, amount of exercise was significantly correlated with continuance ($r = .206$, $p<.05$), tolerance ($r = .298$, $p<.01$), lack of control ($r = .302$, $p<.01$), intention effects ($r = .316$, $p<.01$), and total EDS-R scores ($r = .366$, $p<.01$).

Amount of exercise was not significantly correlated with addictiveness in the symptomatic sample of women, the symptomatic sample of men, or the combined symptomatic sample. Likewise, amount of exercise was not significantly correlated with obsessive-compulsiveness in the symptomatic sample of women, the symptomatic sample of men, or the combined symptomatic sample.

The mean weight dissatisfaction for women was 12.1 pounds, and the mean weight dissatisfaction for men was -3.3 pounds. Thus, on average, women desired to lose weight, and men desired to gain weight. Weight dissatisfaction was not significantly correlated with any of the EDS-R subscales, total EDS-R scores, addictiveness, obsessive-compulsiveness, or amount of exercise in the symptomatic sample of women. Weight dissatisfaction was negatively and significantly correlated with intention effects (r = -.341, p<.05), total EDS-R scores (r = -.362, p<.05), and addictiveness (r = -.383, p<.05) in the symptomatic sample of men. Weight dissatisfaction was not significantly correlated with the other EDS-R subscales, obsessive-compulsiveness, or amount of exercise for symptomatic men.

Using z-tests, comparisons were made between correlations in the symptomatic versus asymptomatic samples of women. Specifically, the correlations between addictiveness and the EDS-R subscales and between obsessive-compulsiveness and the EDS-R subscales were analyzed. In addition, correlations between total EDS-R scores and both addictiveness and obsessive-compulsiveness were examined. None of these correlations were found to be significantly different between the two samples. Z-tests were used to make the same comparisons between correlations in the symptomatic

sample versus asymptomatic samples of men. None of these correlations were significantly different.

CHAPTER IV

Discussion

EFA, CFA, and DISCRIM

EFA demonstrated that five of the seven EDS-R subscales may be sufficient for operationalizing exercise dependence. Previous research by Symons Downs et al. (2004) indicated that seven factors, based on the *DSM-IV-TR* criteria for Substance Dependence, are necessary to identify individuals as at-risk for exercise dependence. In the present study, the most parsimonious factor structure was revealed after six iterations using the asymptomatic sample. Six iterations resulted in deletion of six items belonging to two EDS-R subscales (time and reductions in other activities). Deleting these six items resulted in an increase in the total variance explained, which suggested that the more parsimonious structure is a more efficient way to understand exercise dependence.

The five-factor model was evaluated, along with a single-factor model and the original seven-factor model, for goodness of fit using CFA. The X^2/df ratio, NFI, and CFI, TLI, and RMSEA indicated that the EFA model was a better fit to the data compared to both the single-factor model and the seven-factor model. This superior fit was demonstrated for both the symptomatic and the asymptomatic sample.

Thus, exploratory and confirmatory factor analyses indicated that the five-factor model of the EDS-R was sufficiently reliable and more parsimonious when compared to the seven-factor model proposed by Symons Downs et al. (2004). DISCRIM did not provide support for the use of the five-factor model over the seven-factor model. DISCRIM was used to determine how well the factors from the five-factor model, compared to factors from the seven-factor model, predicted group membership with

regard to exercise dependence (i.e. at risk, symptomatic, or asymptomatic). In the asymptomatic (with regard to disordered eating) sample, the five-factor model did not predict group membership as well as the seven-factor model, particularly in terms of the at risk classification.

Correlational analyses using the EDS-R five-factor model

Based on the Davis et al. (1999) model (Figure 1) for exercise attitudes and behavior, it was hypothesized that correlational analyses would indicate which EDS-R subscales most strongly account for the relations between addictiveness and exercise dependence and between obsessive-compulsiveness and exercise dependence. In addition, it was expected that correlational analyses would indicate which EDS-R subscales most strongly account for the relations between amount of exercise and exercise dependence. The Davis et al. model was developed using a sample of patients with Anorexia Nervosa and subsequently validated using a sample of "non-clinical" college females (Thome & Espelage, 2007). Based on research reported by Davis et al. and Thome and Espelage, significant positive correlations were expected between some of the five EDS-R factors and both addictiveness and obsessive-compulsiveness in the symptomatic sample of women. Given this previous research, significant positive correlations were also expected between total EDS-R scores and both addictiveness and obsessive-compulsiveness.

In the present study, no significant correlations were found between addictiveness and the five EDS-R factors or between addictiveness and total EDS-R scores for the symptomatic sample of women. (Likewise, none of these correlations were significant for the asymptomatic sample of women.) Thus, the results from the present study do not

seem consistent with those reported by Davis et al. (1999) and Thome and Espelage (2007). However, it should be noted that Thome and Espelage utilized different measures of exercise attitudes than the EDS-R. Additionally, they used a sample of 599 women and obtained correlations between addictiveness and exercise attitudes that were relatively low (r = .13 for the Commitment to Exercise Scale and r = .11 for the Obligatory Exercise Questionnaire).

For women in the present study, correlational analyses for obsessive-compulsiveness reflected greater consistency with results reported by Davis et al. (1999) and Thome and Espelage (2007). For the symptomatic sample of women, obsessive-compulsiveness was significantly correlated with intention effects. For the asymptomatic sample of women, obsessive-compulsiveness was significantly correlated with lack of control and total EDS-R scores. Thome and Espelage utilized three different measures of obsessive-compulsiveness and reported correlations ranging from r = .19 to r = .22 for the Commitment to Exercise Scale and from r = .19 to r = .24 for the Obligatory Exercise Questionnaire. As shown in Table 4, correlations between obsessive-compulsiveness and total EDS-R scores in the current study were r = .19 and r = .28 for the symptomatic and asymptomatic women, respectively.

Based on results reported by Thome and Espelage (2007), amount of exercise was hypothesized to correlate positively and significantly with some of the five EDS-R subscales in the symptomatic sample of women. Also amount of exercise was expected to correlate positively and significantly with total EDS-R scores in this sample. However, addictiveness and obsessive-compulsiveness were not expected to correlate significantly with amount of exercise. Results in the present study confirmed these hypotheses.

Amount of exercise was significantly correlated with tolerance, lack of control, intention effects, and total EDS-R scores. Amount of exercise was not significantly correlated with either addictiveness or obsessive-compulsiveness. (In the asymptomatic sample of women, amount of exercise was not significantly correlated with any of the EDS-R subscales, total EDS-R scores, addictiveness, or obsessive-compulsiveness.)

It should be noted that correlations between amount of exercise and total EDS-R scores were lower than expected in both the symptomatic and asymptomatic samples of women. Thome and Espelage (2007) utilized four different measures of exercise behavior and obtained correlations ranging from $r = .49$ to $r = .53$ for the Commitment to Exercise Scale and from $r = .52$ to $r = .58$ for the Obligatory Exercise Questionnaire. As shown in Table 4, correlations between amount of exercise and total EDS-R scores in the current study were $r = .29$ and $r = .08$ for the symptomatic and asymptomatic women, respectively. Given that measures of exercise attitudes and exercise behavior were highly correlated in previous research, it seems likely that the measure of exercise behavior used in the present study has limitations related to validity (see further discussion of limitations below).

The Davis et al. (1999) model has not yet been tested on men. Results from the present study indicated that it would likely provide a better fit for men who are asymptomatic, as opposed to symptomatic, in regard to disordered eating. For the symptomatic sample of men, addictiveness was not significantly correlated with any of the EDS-R subscales or with total EDS-R scores. In this sample, lack of significance was also found for correlations between obsessive-compulsiveness and the EDS-R subscales and between obsessive-compulsiveness and total EDS-R scores. For the symptomatic

sample of men, amount of exercise was positively and significantly correlated with lack of control, intention effects, and total EDS-R scores. For the asymptomatic sample of men, addictiveness was positively and significantly correlated with withdrawal, continuance, and total EDS-R scores. In addition, obsessive-compulsiveness was positively and significantly correlated with withdrawal, and amount of exercise was positively and significantly correlated with lack of control and intention effects. Again, the measure of exercise behavior used in the present study seemed to have limitations in terms of its validity.

It was hypothesized that correlations between obsessive-compulsiveness and both the EDS-R subscales and total EDS-R scores would be positive and greater for the symptomatic samples compared to the asymptomatic samples. Similarly, correlations between addictiveness and both the EDS-R subscales and total EDS-R scores were expected to be positive and greater for the symptomatic samples compared to the asymptomatic samples. As shown in Tables 4 and 5, results provided minimal support for these hypotheses. The correlation between obsessive-compulsiveness and intention effects was significant in the symptomatic sample of women and greater than the same correlation in the asymptomatic sample of women. However, the difference between this correlation in the two samples was not significant. *Z*-tests comparing other correlations relevant to these hypotheses were not significant.

Based on a presumed underlying motivation to control weight through control of eating and exercise behaviors, weight dissatisfaction was hypothesized to correlate positively with all of the other variables (addictiveness, obsessive-compulsiveness, EDS-R subscales, total EDS-R scores, and amount of exercise) in the symptomatic sample. For

women, none of the correlations between weight dissatisfaction and the other variables were significant. For men, there were negative and significant correlations between weight dissatisfaction and three other variables, intention effects, total EDS-R scores, and addictiveness. In other words, as these three variables increased, desire to lose weight decreased and reached the point of weight satisfaction (i.e., weight dissatisfaction was equal to zero). As these three variables continued to increase, the point of weight dissatisfaction was passed, and desire to gain weight steadily increased.

In the asymptomatic sample of men, weight dissatisfaction was not significantly correlated with any of the other variables. In the asymptomatic sample of women, the correlation between addictiveness and weight dissatisfaction was positive and significant. That is, as addictiveness scores increased, desire to loss weight also increased. Thus, there is some evidence that addictiveness is associated with weight dissatisfaction for symptomatic men and asymptomatic women. For symptomatic men, addictiveness may increase one's desire to be at a higher weight. For asymptomatic women, addictiveness may increase one's desire to be at a lower weight.

None of the newly derived five EDS-R subscales fit the Davis et al. (1999) model well in terms of their correlations with addictiveness, obsessive-compulsiveness, and amount of exercise. For symptomatic women, intention effects were positively and significantly correlated with obsessive-compulsiveness and amount of exercise. For asymptomatic men, withdrawal was positively correlated with both addictiveness and obsessive-compulsiveness. When considering the samples of men and women separately, other EDS-R subscales were correlated with one or fewer of the personality and amount of exercise variables.

In terms of a subclinical population of women, the results of the present study provided limited support for the Davis et al. (1999) model. No significant correlations were found between addictiveness and the EDS-R subscales or total EDS-R scores. Only intention effects were significantly correlated with obsessive-compulsiveness. Amount of exercise was correlated with three of the EDS-R subscales and total EDS-R scores. Likewise, results for the asymptomatic sample of women provided limited support for the Davis et al. model. Neither addictiveness nor amount of exercise was significantly correlated with any of the EDS-R subscales or total EDS-R scores. Obsessive-compulsiveness was significantly correlated with lack of control and total EDS-R scores. Regarding the sample of men, the subclinical sample was small, and correlational analyses provided no support for the Davis et al. model. Results from the asymptomatic sample of men provided limited support.

Limitations and suggestions for future research

The present investigation was limited in several ways. First, the minimum level of activity for inclusion in the sample may have been too low. The ranges, in terms of amount of exercise per week, were wide (i.e., 1.3 to 26.0 hours per week for symptomatic women and 1.2 to 19.2 hours per week for symptomatic men). A higher cutoff would likely have resulted in a larger number of individuals demonstrating traits of exercise dependence, and results may have been more robust. Utilizing individuals involved in competitive sports (e.g., collegiate athletes) is recommended for future investigations of exercise dependence. Second, the measure used for exercise behavior may have used an inappropriately extensive time interval in that it required participants to estimate the number of weeks they had exercised over the past year. Given that the EDS-R requires

individuals to report on their exercise beliefs and behaviors over the past three months, it would have been adequate to inquire about amount of exercise during the same three-month time period. Other measures that could have been utilized include the Godin Leisure-Time Exercise Questionnaire (Godin & Shephard, 1985) and the Aerobics Center Longitudinal Study Physical Activity Questionnaire (ACLS; Kohl, Blair, Paffenbarger, Macera, & Kronenfeld, 1988).

Further examination of the psychometric properties of the five-factor model of the EDS-R should involve cross-validation confirmatory factor analyses with multiple samples. This would provide information regarding the variance of the structure in clinical and non-clinical populations, across ethnic groups, among different age groups, and for both men and women.

It is recommended that future tests of the Davis et al. (1999) structural equation model utilize exercise dependence, as measured by the five-factor EDS-R, in place of exercise attitudes. This would help to determine whether addictiveness and/or obsessive-compulsiveness predict exercise attitudes, as measured by the EDS-R. In addition, it would help to determine whether addictiveness and/or obsessive-compulsiveness indirectly predict exercise behavior through their direct effects on exercise attitudes, as measured by the EDS-R.

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Table 1

Total Variance Explained

Factor	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**
	Total	% of Var	Cum Var	Total	% of Var	Cum Var	Total
1	4.788	31.921	31.921	4.505	30.036	30.036	3.416
2	2.246	14.974	46.895	1.972	13.145	43.180	2.676
3	1.898	12.650	59.546	1.616	10.771	53.951	2.941
4	1.630	10.866	70.412	1.285	8.565	62.516	2.374
5	1.338	8.919	79.331	1.056	7.039	69.555	2.512

Table 2

Goodness-of-Fit Statistics and Indices for CFA Models

	df	X^2	X^2/df	NFI	TLI	CFI	PCFI	RMSEA
Symptomatic EFA Model	80	115.694	1.446	.919	.964	.973	.741	.060
Symptomatic Seven-factor Model	168	252.743	1.504	.882	.945	.956	.765	.064
Symptomatic Single-factor Model	189	1051.678	5.564	.509	.503	.553	.498	.192
Asymptomatic EFA Model	80	108.177	1.352	.928	.974	.980	.747	.045
Asymptomatic Seven-factor Model	168	271.749	1.618	.874	.934	.947	.757	.060
Asymptomatic Single-factor Model	189	1259.416	6.664	.417	.391	.452	.406	.180

Note. NFI: Normed Fit Index; TLI: Tucker Lewis Index; CFI: Comparative Fit Index; PCFI: Parsimony Comparative Fit Index; RMSEA: Root Mean Square Error of Approximation (n = 125).

Table 3

Means, Ranges, and Standard Deviations for EDS-R Subscales, Total EDS-R Scores, Obsessive-Compulsiveness, Addictiveness, Amount of Exercise, and Weight Dissatisfaction (Symptomatic)

	Women (n = 90)	Men (n = 35)	Combined (n = 125)
Withdrawal	12.0 (3-18, 3.4)	10.5 (3-18, 4.3)	11.6 (3.7)
Continuance	9.2 (3-18, 4.5)	10.4 (3-18, 4.3)	9.5 (4.4)
Tolerance	11.7 (3-18, 3.7)	13.4 (5-18, 3.9)	12.2 (3.8)
Lack of Control	8.3 (3-16, 3.6)	9.3 (3-18, 4.2)	8.6 (3.7)
Intention Effects	8.9 (3-18, 3.7)	10.2 (3-18, 3.9)	9.3 (3.8)
Total EDS-R Score	50.1 (15-88, 13.7)	53.9 (31-80, 12.9)	51.2 (13.5)
Obsessive-Compulsiveness	13.5 (1-20, 3.8)	12.1 (4-20, 4.1)	13.1 (3.9)
Addictiveness	13.8 (5-24, 4.5)	12.8 (3-26, 4.2)	13.5 (4.4)
Amt of Exercise (hrs/wk)	6.6 (1.3-26.0, 5.1)	8.2 (1.2-19.2, 5.2)	7.0 (5.1)
Weight Dissatisfaction	12.1 (-20-115, 15.2)	-3.3 (-30-13, 11.0)	7.8 (15.7)

Table 4

EDS-R Subscales, Total EDS-R Scores (based on reduced number of subscales), Amount of Exercise (AMT), and Weight Dissatisfaction (WD) Correlated with Addictiveness (AD), Obsessive-Compulsiveness (OC), AMT, and WD for Symptomatic and Asymptomatic Women

	Symptomatic (n = 90)				Asymptomatic (n = 93)			
	AD	OC	AMT	WD	AD	OC	AMT	WD
Withdrawal	.047	.071	.168	-.071	.114	.078	-.099	-.072
Continuance	.111	.088	.149	-.011	.003	.162	.092	-.038
Tolerance	-.075	.069	.261*	-.056	-.030	.176	.108	-.057
Lack of Control	.034	.203	.234*	-.091	.058	.313**	.058	.040
Intention Effects	-.074	.254*	.252*	-.055	.003	.147	.096	.000
Total EDS-R Scores	.017	.186	.289**	-.075	.047	.276**	082	-.043
AMT (hrs/wk)	.076	.049	1.0	.018	.047	.107	1.0	.049
WD	.191	.055	.018	1.0	.271**	-.037	.049	1.0

*$p<.05$, **$p<.01$

Table 5

EDS-R Subscales, Total EDS-R Scores (based on reduced number of subscales), Amount of Exercise (AMT), and Weight Dissatisfaction (WD) Correlated with Addictiveness (AD), Obsessive-Compulsiveness (OC), AMT, and WD for Symptomatic and Asymptomatic Men

	Symptomatic (n = 90)				Asymptomatic (n = 93)			
	AD	OC	AMT	WD	AD	OC	AMT	WD
Withdrawal	.102	.286	.235	-.119	.218*	.220*	-.157	-.077
Continuance	.050	.041	.316	-.083	.378**	.092	.214	-.120
Tolerance	-.159	.141	.331	-.287	.139	.094	.052	-.038
Lack of Control	-.068	.232	.443*	-.320	.129	.048	.289*	-.133
Intention Effects	.020	.268	.432*	-.341*	.170	.151	.240*	.029
Total EDS-R Scores	-.014	.308	.554**	-.362*	.332**	.193	.189	-.104
AMT (hrs/wk)	-.158	.222	1.0	-.067	.094	-.067	1.0	.059
WD	-.383*	-.267	-.067	1.0	.022	.151	.059	1.0

*$p<.05$, **$p<.01$

Table 6

EDS-R Subscales, Total EDS-R Scores (based on reduced number of subscales), Amount of Exercise (AMT), and Weight Dissatisfaction (WD) Correlated with Addictiveness (AD), Obsessive-Compulsiveness (OC), AMT, and WD for the Combined Sample

	Symptomatic (n = 90)				Asymptomatic (n = 93)			
	AD	OC	AMT	WD	AD	OC	AMT	WD
Withdrawal	.079	.169	.162	.007	.159*	.177*	-.157*	.036
Continuance	.081	.052	.206*	-.079	.185*	.105	.169*	-.114
Tolerance	-.115	.056	.298**	-.182*	.055	.118	.084	-.074
Lack of Control	-.008	.189*	.302**	-.180*	.093	.180*	.193*	-.075
Intention Effects	-.062	.227*	.316**	-.174	.088	.099	.211**	-.093
Total EDS-R Scores	-.003	.195*	.366**	-.174	.189*	.215**	.154*	-.101
AMT (hrs/wk)	.005	.076	1.0	-.055	.074	-.027	1.0	-.049
WD	.109	.055	-.055	1.0	.099	.169*	-.049	1.0

*$p<.05$, **$p<.01$

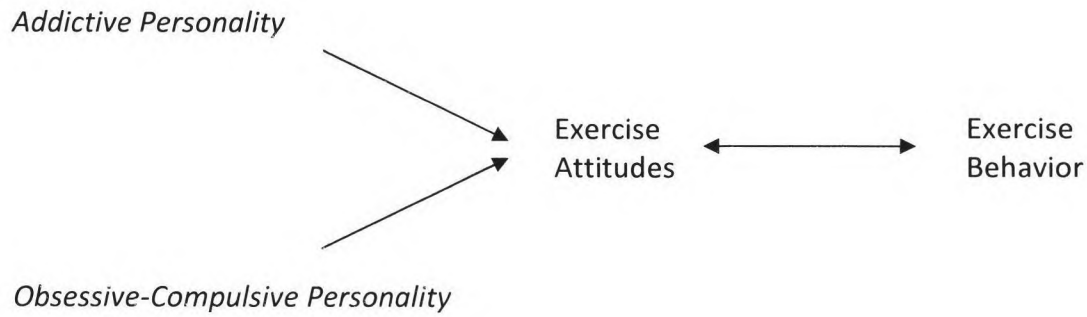

Figure 1. Structural-equation model for exercise attitudes and excessive exercise status. *Note*. From "Compulsive physical activity in adolescents with Anorexia Nervosa: A psychobehavioral spiral of pathology," by C. Davis, D. K. Katzman, and C. Kirsh, 1999, *The Journal of Nervous and Mental Disease, 187*, p 338.

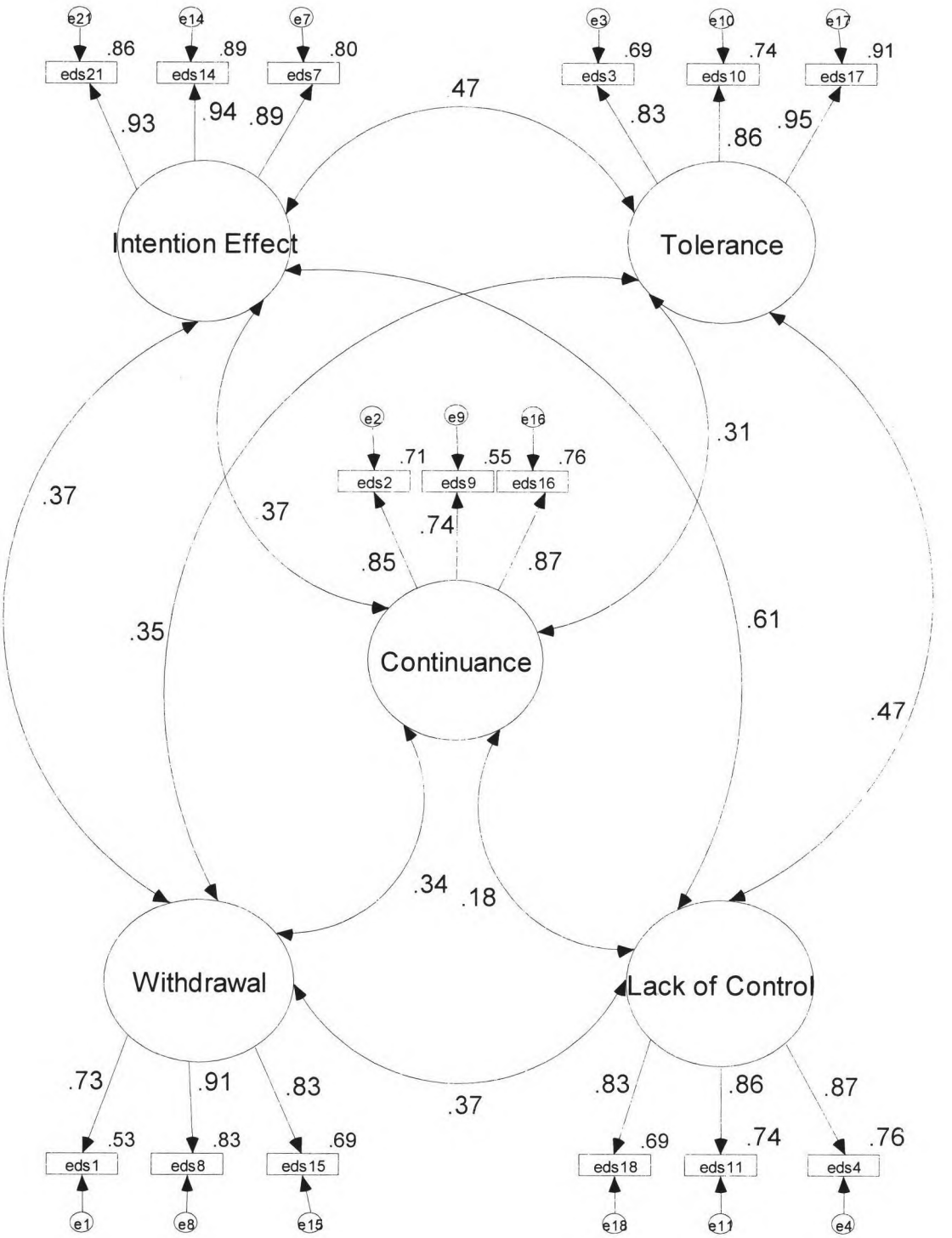

Figure 2. Model 1 using the symptomatic sample (EFA model).

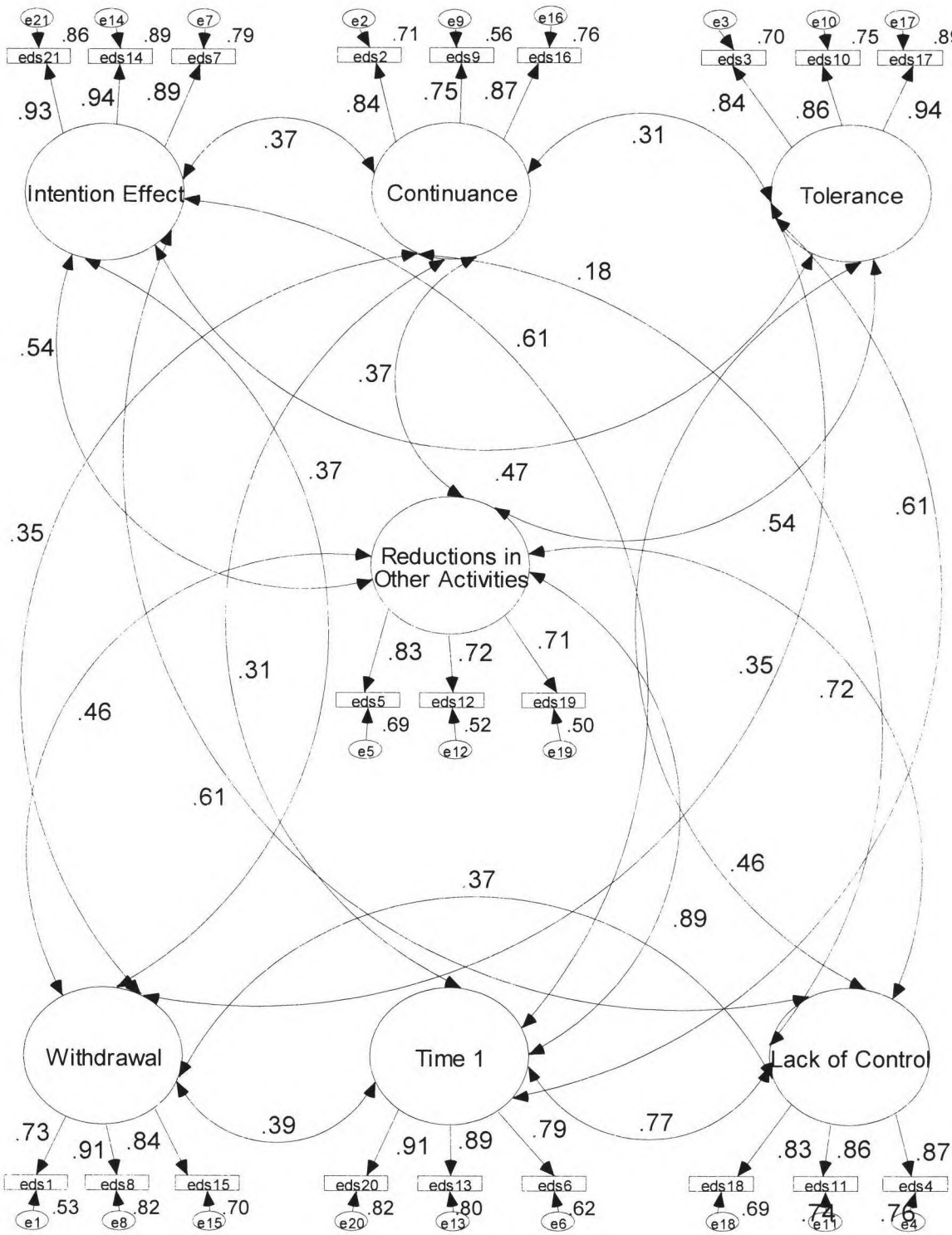

Figure 3. Model 2 using the symptomatic sample (seven-factor model).

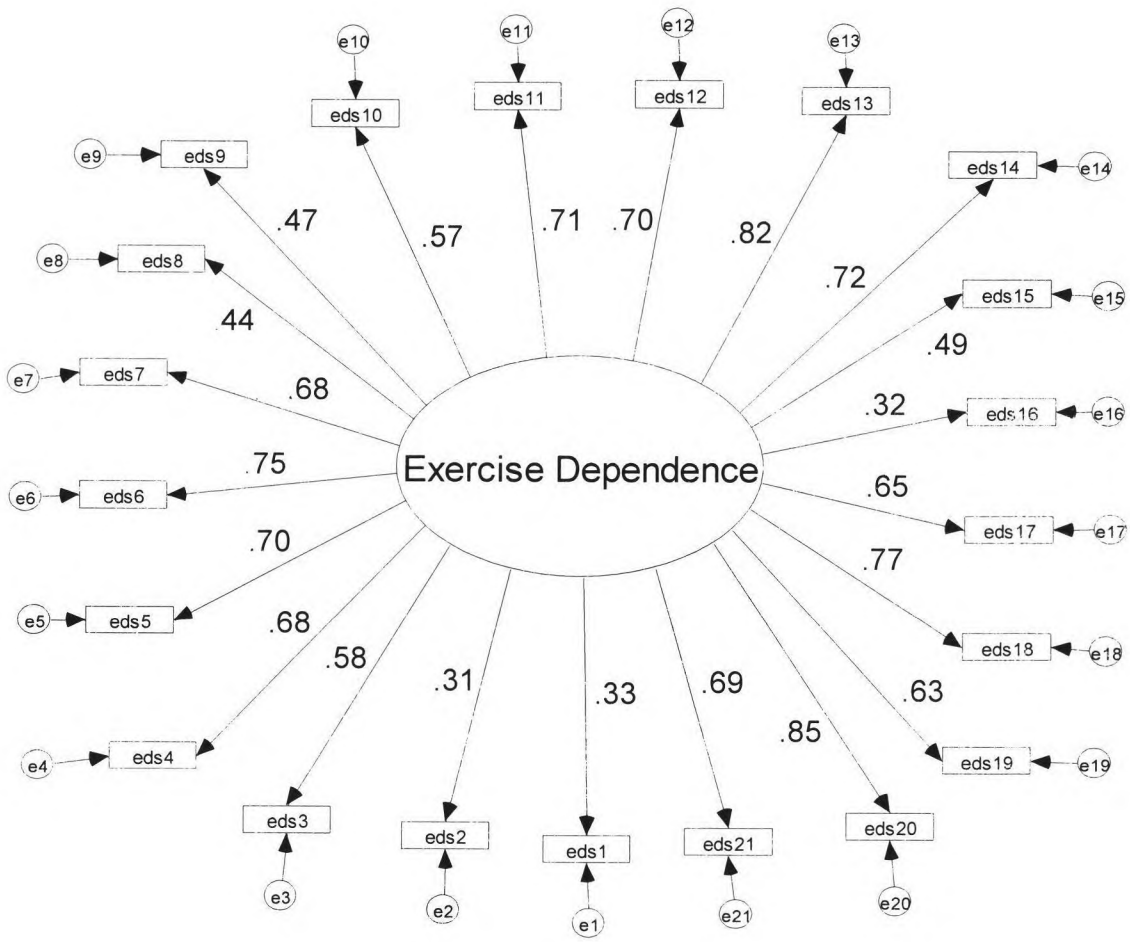

Figure 4. Model 3 using the symptomatic sample (single-factor model).

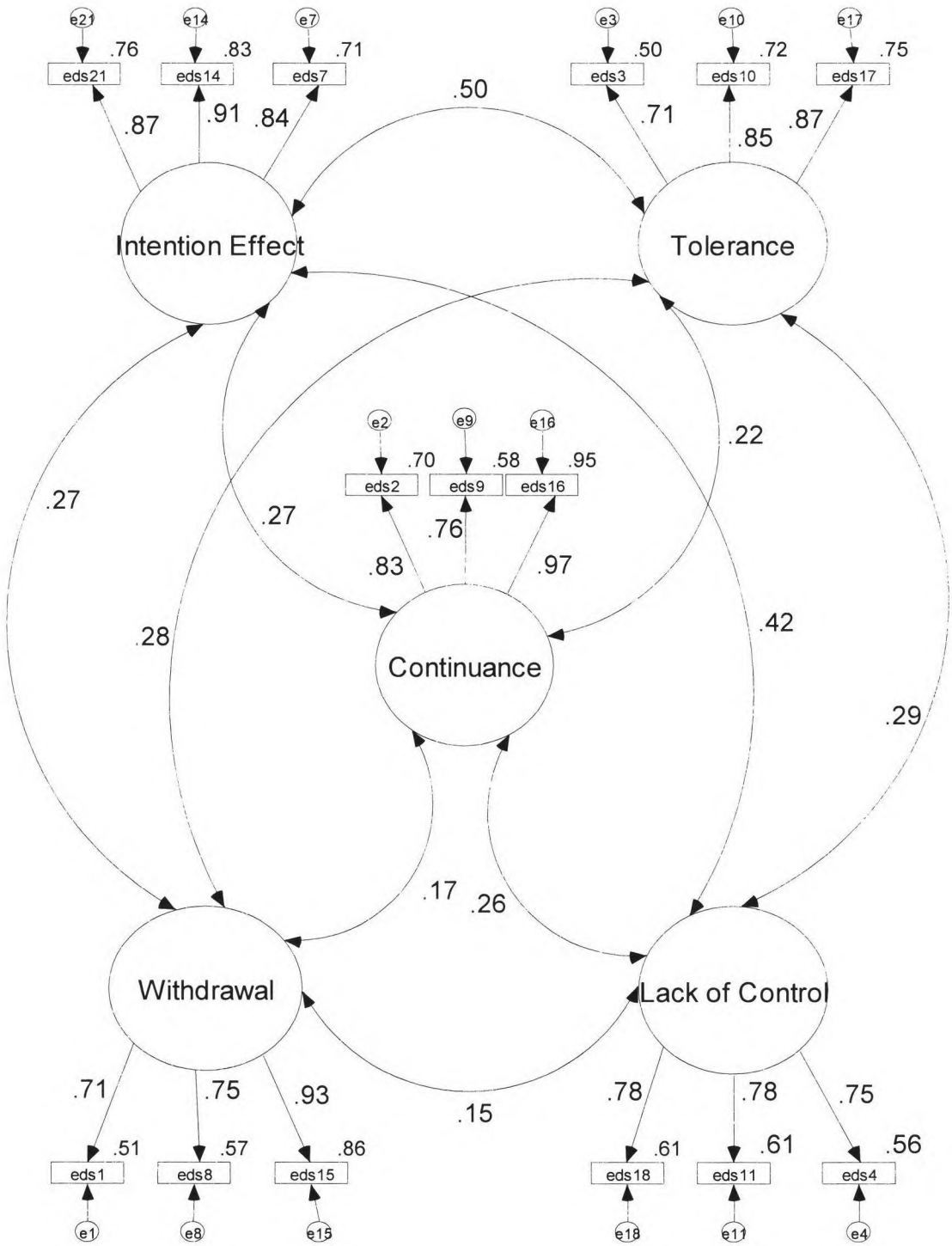

Figure 5. Model 1 using the asymptomatic sample (EFA model).

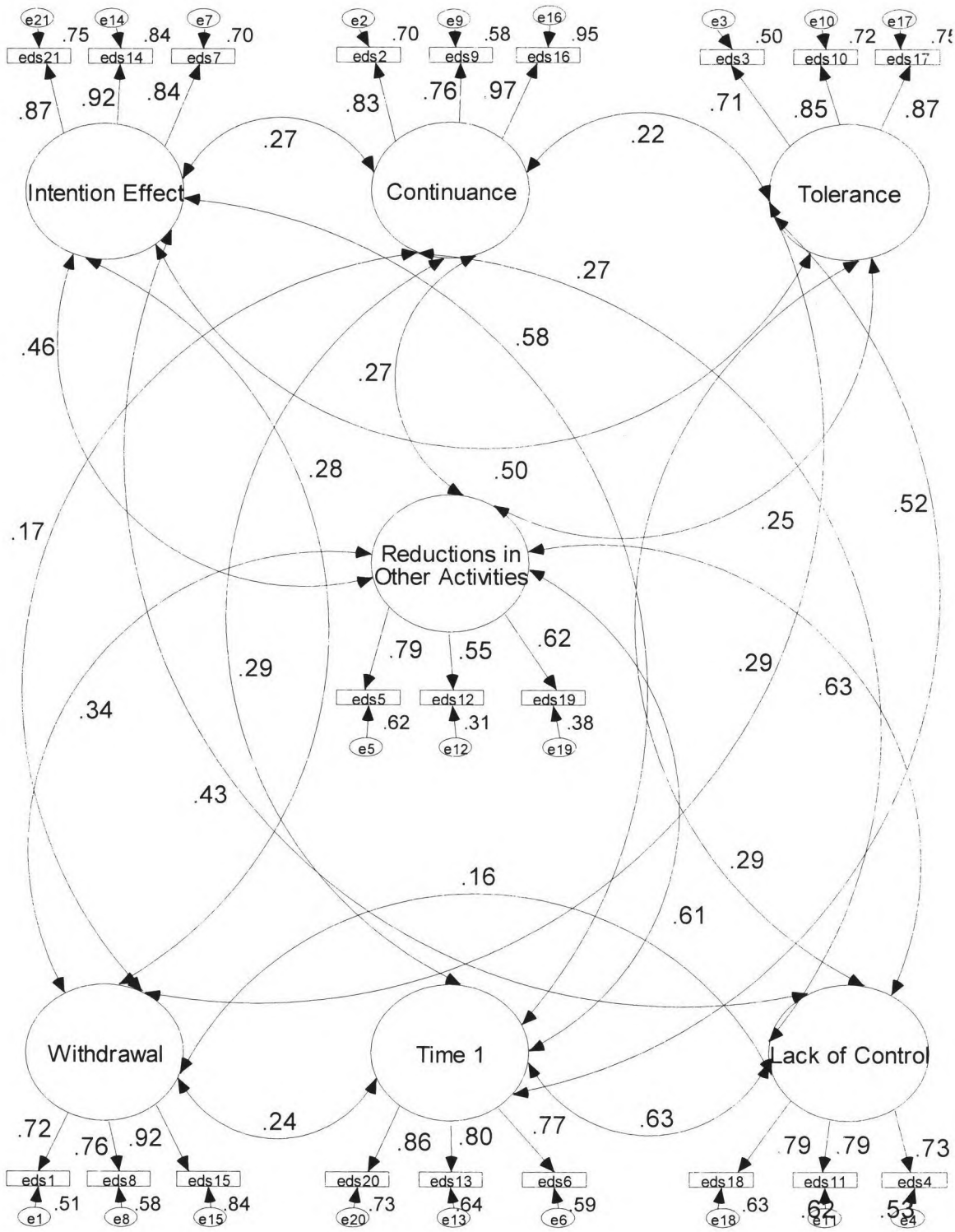

Figure 6. Model 2 using the asymptomatic sample (seven-factor model).

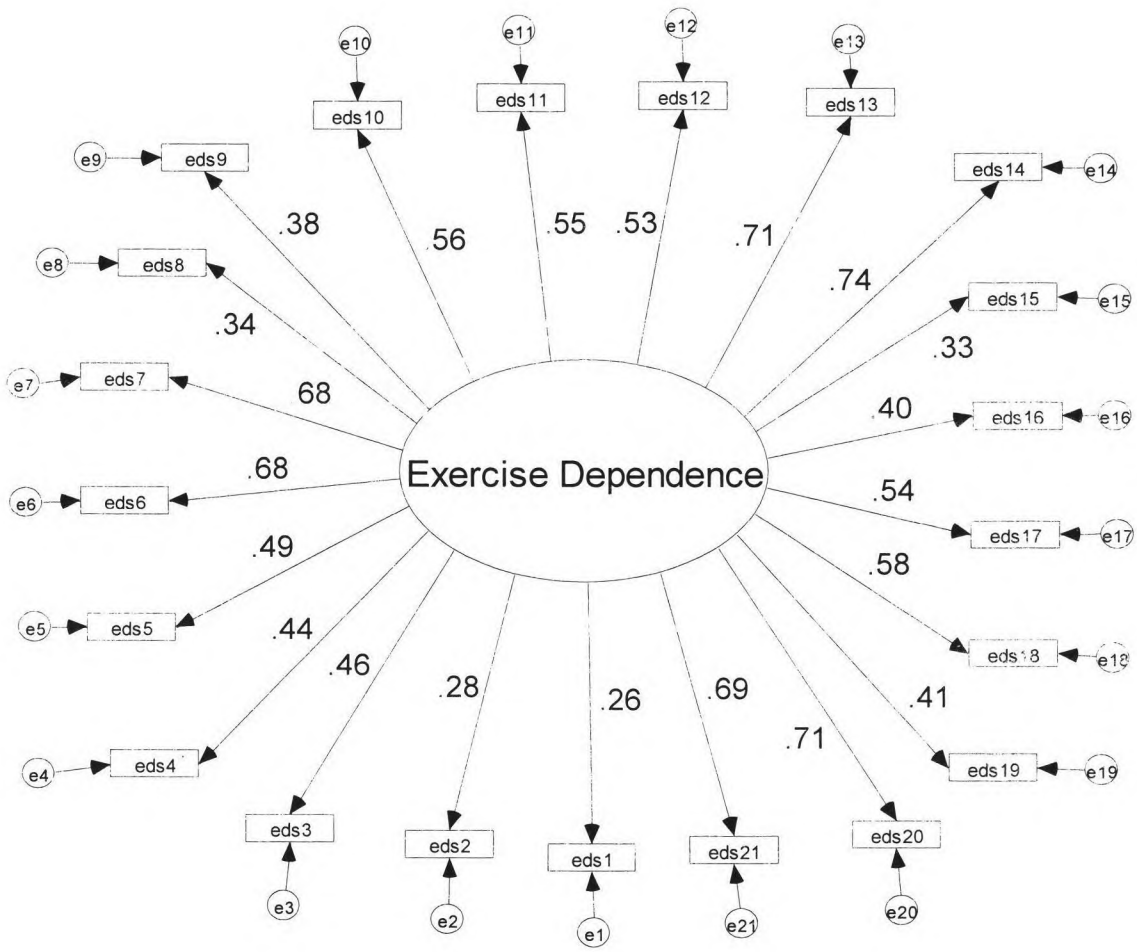

Figure 7. Model 3 using the asymptomatic sample (single-factor model).