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Abstract

Background Pulling from Self-Determination Theory (SDT; Deci & Ryan, 1985), this study examined whether individuals classified as 'nondependent-symptomatic' and 'nondependent-asymptomatic' for exercise dependence differed in terms of reported levels of exercise-related psychological need satisfaction, self-determined versus controlling motivation and exercise behavior. In addition, we examined the type of motivational regulations predicting exercise behavior among these different groups, and their role as mediators between psychological need satisfaction and behavioral outcomes.
Methods Participants ($N = 339$) completed measures of exercise-specific psychological need satisfaction, motivational regulations, exercise behavior and exercise dependence.
Results Nondependent-symptomatic individuals reported higher levels of competence need satisfaction and all forms of motivational regulation, compared to nondependent-asymptomatic individuals. Introjected regulation approached significance as a positive predictor of strenuous exercise behavior for symptomatic individuals. Identified regulation was a positive predictor of strenuous exercise, and completely mediated the relationship between competence need satisfaction and strenuous exercise behavior, for asymptomatic individuals.
Conclusions The findings reinforce the applicability of SDT to understanding the quantity and quality of engagement in exercise.

Keywords

- *exercise dependence*
- *motivational regulations*
- *physical activity*
- *psychological needs*

AN IMPRESSIVE body of evidence associates exercise with improved physical and psychological well-being (Biddle & Mutrie, 2001). Paradoxically however, it has also been suggested that if exercise becomes excessive, serious detrimental physical and psychological consequences may accrue (e.g. anemia, depressed immune response, menstrual irregularity, anxiety and depression; Hall, Kerr, Kozub, & Finnie, 2004; Hausenblas & Symons Downs, 2002a, 2002b; Ogden, Veale, & Summers, 1997; Szabo, 1998). Researchers examining the negative consequences of regular physical activity have focused primarily on the issue of exercise dependence (Hausenblas & Symons Downs, 2002a). Exercise dependence represents a condition in which moderate to vigorous physical activity becomes a compulsive behavior. Based on the *Diagnostic and statistical manual of mental disorders*-IV (DSM-IV) criteria for substance dependence (APA, 1994), it has been argued that exercise dependence has biomedical (e.g. withdrawal symptoms) and psychosocial (e.g. interference with social functioning) components (Veale, 1987, 1995).

At the present time, the prevalence of exercise dependence in the general population is not known. While some authors suggest that exercise dependence is a far more serious condition than many professionals currently recognize (e.g. Yates, 1996), others have criticized such claims and have pointed to an 'eagerness to pathologize exercise dependence' (e.g. Bamber, Cockerill, & Carroll, 2000; Bamber, Cockerill, Rodgers, & Carroll, 2003). Although it may be that only a very small percentage of regular exercisers are affected by exercise dependence (Morris, 1989; Veale, 1987), it has recently been argued that the pattern of exercise behavior observed among a more substantial number of exercisers may be considered both physically and psychologically debilitating (Hall et al., 2004). Thus, it seems important to examine the predictors of more maladaptive exercise engagement as reflected in reported dependence symptomatology.

There has been considerable work focused upon the measurement of exercise dependence. A recent literature review identified 12 instruments assessing various aspects of exercise dependence (Hausenblas & Symons Downs, 2002b), such as the Obligatory Exercise Questionnaire (Pasman & Thompson, 1988), the Commitment to Exercise Scale (Davis, Brewer, & Ratusny, 1993) and the Exercise Dependence Questionnaire (Ogden et al., 1997). However, many of the existent assessments have been criticized. For example, some measures define and measure exercise dependence as a unidimensional construct and conceptualize exercise dependence within a continuum. Thus, they are unable to identify or classify exercise-dependent individuals. Further, the majority of assessment tools fail to utilize the DSM-IV (APA, 1994) criteria for substance dependence (Hausenblas & Symons Downs, 2002b).

In an attempt to rectify these shortcomings, Hausenblas and Symons Downs (2002b) developed the Exercise Dependence Scale (EDS), a measurement instrument incorporating DSM-IV criteria for substance dependence (APA, 1994). The measure conceptualizes exercise dependence as a cluster of cognitive, behavioral and physiological symptoms (Hausenblas & Symons Downs, 2002a). The scale provides mean total and subscale scores, and allows individuals to be classified as 'at risk' (i.e. exercise dependent), those that show some signs of dependence (i.e. 'nondependent-symptomatic') and those that have no symptoms of exercise dependence (i.e. 'nondependent-asymptomatic'; Hausenblas & Symons Downs, 2002b).

Preliminary investigations utilizing the EDS provide evidence to suggest that at risk individuals are higher in perfectionism when compared to the nondependent groups (Hausenblas & Symons Downs, 2002b). Moreover, neuroticism, extraversion, conscientiousness and agreeableness (Hausenblas & Giacobbi, 2004), as well as the use of appearance imagery and energy imagery (Hausenblas & Symons Downs, 2002c) have been shown to positively predict symptoms of exercise dependence. Despite these recent advances however, research examining the precipitating and perpetuating factors of exercise dependence remains limited (Hausenblas & Symons Downs, 2002b, 2002c). Such work clearly has important implications for clinical practice (Loumidis & Roxborough, 1995). That is, if we can delineate the underlying factors that energize excessive exercise engagement we should be able to more easily recognize symptomatology and its etiology, and thus prevent the development of a more serious manifestation.

Motives for exercise have been proposed as key antecedents of exercise dependence (Ogles, Masters, & Richardson, 1995) and offer one avenue for potential exploration. However, researchers have yet to draw upon and test contemporary theoretical frameworks when attempting to delineate how at risk, non-dependent-symptomatic and nondependent-asymptomatic individuals differ motivationally in terms of exercise behavior.

One potential theory of human motivation applicable to the understanding of the quantity and quality of exercise engagement is Deci and Ryan's (1985) Self-Determination Theory (SDT). SDT proposes that human motivation varies in the extent to which it is autonomous/self-determined versus controlling. Behaviors and actions that are autonomous are freely initiated and emanate from within one's self (Reeve, 2002). In contrast, when controlled, behaviors are not chosen by the individual; they are regulated by an external force or internal pressure, and they are nonvolitional in nature. Based on these distinctions, SDT proposes that three distinct forms of motivation exist, namely, intrinsic motivation, extrinsic motivation and amotivation,[1] which, based on the level of autonomy inherent in them, lie on a continuum of high to low self-determination.

Intrinsic motivation is considered to be the most autonomous form of motivation and refers to an innate tendency possessed by all humans to seek out novelty and challenges, to extend and exercise one's capabilities, to explore and to learn (Ryan & Deci, 2000). It is encapsulated in the innate energy demonstrated when people pursue a goal or activity because it is enjoyable or interesting (Koestner & Losier, 2002). Individuals who are intrinsically motivated to exercise would do so because they consider it to be fun.

Not all human behaviors are intrinsically enjoyable however. To explain how such behaviors are regulated, SDT proposes extrinsic motivation, and a process called internalization. Extrinsic motivation refers to behaviors that are carried out to attain contingent outcomes outside the activity (Deci, 1971). Internalization refers to an inherent tendency possessed by all humans to integrate within themselves the regulation of extrinsically motivated activities that are useful for effective functioning in the social world, but are not inherently interesting (Deci, Eghrari, Patrick, & Leone, 1994). SDT proposes that the extent to which extrinsic motives are internalized can vary. Thus, four different forms of extrinsic regulation are proposed to exist, each reflecting a different level of internalization, and thus, experienced self-determination.

External regulation reflects the least autonomous of these regulations whereby the person engages in the activity to obtain external rewards or to avoid punishments (Deci & Ryan, 1985). An example of external regulation would be exercising because you have been told to do so by a health professional. Introjection refers to a regulation that is partially taken in, but is not fully accepted as one's own (Ryan & Deci, 2000). With introjection, behavior is undertaken in an attempt to avoid negative emotions (e.g. anxiety or guilt) or to support conditional self-worth and attain ego enhancement (Ryan & Deci, 2000). When guided by introjected regulation an internal demand pressures and coerces people to act (Ryan, Deci, & Grolnick, 1995). People who are guided by introjected regulation would exercise because of feelings of guilt or shame about not exercising. Identified regulation is an autonomous form of extrinsic motivation, and reflects participation in an activity because one holds certain outcomes of the behavior to be personally significant, although one may not enjoy the activity itself. Individuals guided by identified regulation would exercise because they value the benefits associated with exercise (e.g. improved health). Finally, the most autonomous form of extrinsic motivation is integrated regulation. Integrated regulation occurs when identified regulations are fully assimilated into the self and are brought into congruence with one's other values and needs (Deci & Ryan, 2000). Individuals guided by integrated regulation would exercise as it is an important aspect of how they perceive themselves.

As well as specifying the different types of regulation that may guide behavior, SDT also specifies their psychological antecedents. SDT postulates that the type of motivational regulation guiding behavior is dependent upon the satisfaction of three basic psychological needs. A need for *autonomy* reflects a desire to engage in activities of one's own choosing and to be the origin of one's own behavior (deCharms, 1968; Deci & Ryan, 1985). A need for *relatedness*

involves feeling connected, or feeling that one belongs in a given social milieu (Deci & Ryan, 1985). Finally, a need for *competence* implies that individuals have a desire to interact effectively with the environment and to experience a sense of competence in producing desired outcomes and preventing undesired events (Deci & Ryan, 1985). The greater the extent of need satisfaction derived in a given domain, the more self-determined the regulation of behavior should be (Deci & Ryan, 1985).

SDT further suggests that the extent to which the three psychological needs are satisfied will result in diverse cognitive, affective and behavioral consequences (Deci & Ryan, 1985). According to Vallerand (1997), the three needs give rise to such outcomes indirectly, via the promotion of different types of motivational regulation that mediate the relationships between need satisfaction, and behavior, cognitions and affect. Satisfaction of the three basic psychological needs, and ensuing self-determined motivation, is proposed to result in maintained/enhanced health, psychological growth and well-being, and an absence of pathology and ill-being (Ryan & Deci, 2000). In contrast, when the needs are thwarted, less autonomous regulations are hypothesized to guide behavior, and a variety of nonoptimal outcomes are likely to accrue.

Supporting these propositions, research has implicated inadequate need satisfaction in the etiology of numerous adjustment problems and mental illnesses (e.g. anorexia, bulimia, morbid obesity, obsessive-compulsive disorder; Ryan et al., 1995). Further, Shapiro (1981) suggested that autonomy deviations are common to many forms of psychopathology. For example, both bulimic and restrictive anorexics have been shown to exhibit more controlling forms of self-regulation, and to experience more pressure to conform to internal standards reflective of 'introjected' perfectionist strivings, than individuals showing no symptoms of an eating disorder (Strauss & Ryan, 1987).

To date, and in accordance with SDT's propositions (Deci & Ryan, 1985), research investigating the applicability of the basic tenets of SDT within the exercise domain has shown exercise behavior to be positively associated with intrinsic motivation and, to a greater extent, identified regulation (Edmunds, Ntoumanis, & Duda, 2006; Wilson, Rodgers, Blanchard, & Gessell, 2003; Wilson, Rodgers, & Fraser, 2002). Identified regulation has also been shown to partially mediate a relationship between competence need satisfaction and strenuous exercise behavior (Edmunds et al., 2006). In addition, and as evidenced in other domains (e.g. education and politics; see Koestner & Losier, 2002), introjected regulation has emerged as a positive predictor of physical activity engagement (Edmunds et al., 2006).

Despite the fact that the aforementioned work provides preliminary support for the basic theoretical propositions of SDT in the exercise domain, the majority of studies have considered the interplay between need satisfaction, motivational regulations and adaptive outcomes only. Limited consideration has been given to whether less autonomous regulatory styles and thwarting of the psychological needs relate to more maladaptive exercise perspectives/behaviors.

Pulling from the few studies that have targeted the less desirable facets of exercise engagement, it is evident that body image motives, which reflect introjected regulations for exercise involvement (Frederick & Ryan, 1993), have a major role to play in the genesis and maintenance of exercise addiction (Sewell, Clough, & Robertshaw, 1995). Further, Hamer, Karageorghis and Vlachopoulos (2002) examined the relationship between motivational regulations and exercise dependence among endurance athletes using an adaptation of the Running Addiction Scale (Chapman & DeCastro, 1990). Introjected and identified regulations emerged as positive predictors of exercise dependence. While these findings suggest that involvement in obligatory exercise involves some degree of self-determination (Hall et al., 2004), the fact that introjected regulation also predicted dependence supports the claims of Morgan (1979). That is, a perceived lack of volitional control over exercise may result in the greater occurrence of physically demanding practices.

Although the work of Hamer et al. (2002) revealed a correspondence between less autonomous forms of regulation and exercise dependence, it should be noted that the authors did not consider the impact of psychological need satisfaction. Consequently, the investigation of Hamer and colleagues does not allow

us to discern possible links between levels of psychological need satisfaction and reported exercise dependence. Further, neglecting to consider the psychological needs prevents a more complete examination of the relationships between the theoretical constructs embedded within SDT, and the mediating role played by the motivational regulations, as proposed by Vallerand (1997). Furthermore, the Hamer et al. (2002) study could be considered limited as it adopts a sport-specific, unidimensional measure of exercise dependence, which does not adopt the DSM-IV criteria (APA, 1994).

Addressing the aforementioned shortcomings, the current study aimed to further delineate the relationships between exercise dependence symptomatology, psychological need satisfaction and autonomous versus controlling forms of motivational regulation. Specifically, we aimed to examine whether, utilizing the classification system proposed by Hausenblas and Symons Downs (2002b), those individuals who are at risk of exercise dependence, those who are nondependent-symptomatic, and those who are nondependent-asymptomatic, differ in terms of the level of psychological need satisfaction they derive from exercise, their motivational regulations, and their exercise behavior. Further, this study also aimed to determine which psychological needs and motivational regulations predict the exercise behavior of at risk, nondependent-symptomatic and nondependent-asymptomatic individuals. We also intended to examine whether the motivational regulations mediate the relationship of psychological need satisfaction to behavioral outcomes, as specified by Vallerand (1997). However, despite multiple attempts to recruit a sufficient number of at risk, nondependent-symptomatic and nondependent-asymptomatic individuals, only 12 participants (3.4%) met the criteria for being classified 'at risk' of exercise dependence. This percentage, which is similar to that observed in previous studies utilizing the EDS (e.g. Hausenblas & Symons Downs, 2002a), was insufficient for the statistical analyses that were employed in this study (i.e. multivariate analysis of variance (MANOVA) and regression analysis; Tabachnick & Fidell, 2001). Thus, all of the hypotheses tested in this study relate to nondependent-symptomatic and nondependent-asymptomatic individuals only.

Hypotheses

Previous studies have shown that nondependent-symptomatic individuals report more self-efficacy for exercise than nondependent-asymptomatic individuals (Hausenblas & Symons Downs, 2002a). Such findings are likely to be attributable to the fact that nondependent-symptomatic individuals report engaging in exercise more often than nondependent-asymptomatics (Hausenblas & Symons Downs, 2002a) and, thus, are more likely to feel capable in this domain. Given conceptual similarities between self-efficacy and competence (Roberts, 2001), it was hypothesized that nondependent-symptomatic individuals would report higher competence need satisfaction via exercise than nondependent-asymptomatic individuals (Hypothesis 1). As nondependent-symptomatic individuals tend to exhibit higher levels of physical activity engagement than nondependent-asymptomatics (Hausenblas & Symons Downs, 2002a), and thus may have more opportunity to form relationships in the exercise domain, we also predicted that nondependent-symptomatic individuals will report more relatedness need satisfaction than nondependent-asymptomatics (Hypothesis 2). With regards to autonomy, it has been suggested that compulsive exercisers feel pressure and compulsion to engage in physical activity (Morgan, 1979). Thus, we further hypothesized that those showing signs of exercise dependence will report less autonomy need satisfaction, and consequently lower levels of self-determined regulation and higher levels of controlling motives (i.e. introjected and external regulation) than nondependent-asymptomatics (Hypothesis 3). In accordance with the findings of Hausenblas and Symons Downs (2002b), it was also expected that nondependent-symptomatic individuals will report higher levels of exercise behavior than nondependent-asymptomatic individuals (Hypothesis 4).

We further hypothesized that reported exercise behavior among nondependent-symptomatic individuals will be predicted by introjected regulation, due to the proposed thwarting of autonomy need satisfaction in this group. Based on the propositions of Vallerand (1997), it was expected that introjection will mediate the relationship between autonomy and exercise behavior among this group. In

contrast, for nondependent-asymptomatic individuals, we hypothesized that identified and integrated regulation, as well as intrinsic motivation, will emerge as significant predictors of exercise behavior. Further, we predicted that these types of motivational regulations will mediate the relationship between need satisfaction and exercise behavior (Hypothesis 5).

Method

Participants

A total of 373 participants, recruited from fitness, community and retail settings, provided informed consent to take part in the current study. Data were screened according to the recommendations of Tabachnick and Fidell (2001). Seventeen cases were removed due to missing data and five multivariate outliers were removed from the sample based on the Mahalonobis distance criterion (see Tabachnick & Fidell, 2001, p. 92), leaving a sample of 351 participants. Subsequent analysis revealed that only 12 participants (3.4%) met the criteria for being 'at risk' of exercise dependence. This number, which is similar to that observed in previous studies utilizing the EDS (e.g. Hausenblas & Symons Downs, 2002a), was insufficient for multivariate analysis of variance (MANOVA) and regression analysis (Tabachnick & Fidell, 2001). Therefore, data from these participants were also removed from the data set, leaving a final sample of 339 participants (47.5% male, 52.5% female; *M* age = 32.13, *SD* = 11.40).

From the final sample of 339 participants, 198 (58.4%) were classified as nondependent-symptomatic and 141 (40.6%) were classified as nondependent-asymptomatic. Those classified as nondependent-symptomatic ranged in age from 17–64 years (*M* = 30.49; SD = 10.84); 52.5 percent were male and 46.5 percent were female. Participants classified as nondependent-asymptomatic ranged in age from 16–60 years (*M* = 34.49; SD = 11.79); 39 percent were male and 59.6 percent were female.

Measures

Psychological need satisfaction Psychological need satisfaction was measured via the 21-item Basic Need Satisfaction at Work Scale (Deci et al., 2001), amended by the authors to make it relevant to the exercise domain. This 21-item scale is based on a 15-item measure developed by Kasser, Davey and Ryan (1992) to tap autonomy, relatedness and competence in the work domain. In the development of the original 15-item measure some items were taken from the Intrinsic Motivation Inventory (Ryan, 1982), a multidimensional measure of subjects' experience with experimental tasks, support for which has been garnered in the physical domain (McAuley, Duncan, & Tammen, 1989). The 21-item Basic Need Satisfaction at work scale has been shown to display alphas of .73 for competence, .84 for relatedness and .79 for autonomy in a sample of US workers (Deci et al., 2001).

Akin to the 21-item scale utilized by Deci et al. (2001), six items measured competence (e.g. 'Most days I feel a sense of accomplishment from exercising'), eight measured relatedness (e.g. 'People I exercise with take my feelings into consideration') and seven measured autonomy (e.g. 'I feel like I am free to decide for myself how to exercise') need satisfaction in the current study. Following the stem 'Please indicate how true each of the following statements is for you given your experiences of exercise', participants responded to each item on a seven-point scale ranging from 1 (*not true for me*) to 7 (*very true for me*).

Motivational regulations for exercise Participants completed the Behavioral Regulation in Exercise Questionnaire (BREQ; Mullan, Markland, & Ingledew, 1997), a 15-item self-report measure assessing the reasons why people exercise. The BREQ includes scales assessing external, introjected and identified regulation and intrinsic motivation. Following the stem 'Why do you exercise?', participants respond to each item on a five-point scale ranging from 1 (*not true for me*) to 5 (*very true for me*). Previous research provides support for the BREQ's factorial validity, the invariance of its factor structure across gender and the internal consistency of each subscale (α's ranged from .76 to .90; Mullan & Markland, 1997; Mullan et al., 1997). As the BREQ does not have a subscale tapping the construct of integrated regulation, we also included the integrated regulation subscale of Li's (1999) Exercise Motivation Scale (using the same 1–5 scale as that described earlier). Past research supports the internal consistency of this subscale (α's > .75; Li, 1999).

Exercise behavior Self-reported exercise behavior was measured via the Godin Leisure Time Exercise Questionnaire (GLTEQ; Godin & Shepard, 1985). The GLTEQ assesses the frequency of mild, moderate and strenuous exercise engaged in, for a minimum of 15 minutes, during a typical week. Exercise behavior scores are calculated by multiplying weekly frequencies of strenuous (e.g. running, vigorous gym workout), moderate (e.g. easy cycling) and mild activities (e.g. easy walking), by nine, five and three METS (Metabolic Equivalents), respectively. An overall exercise behavior score (units of metabolic equivalence) is calculated by summing the weighted product of each question as follows: (mild $\times$ 3) + (moderate $\times$ 5) + (strenuous $\times$ 9). The GLTEQ has been shown to be a reliable and valid measure with which to assess leisure time exercise behavior (Jacobs, Ainsworth, Hartman, & Leon, 1993).

Exercise dependence Exercise dependence was measured using the 21-item Exercise Dependence Scale (EDS-21; Hausenblas & Symons Downs, 2002b). Consistent with DSM-IV criteria (APA, 1994), the EDS-21 operationalizes exercise dependence as a multidimensional maladaptive pattern of exercise leading to clinically significant impairment or distress, as manifested by three or more of the following: (1) *tolerance*: a need for significantly increased amounts of exercise to achieve a desired effect, or the experience of diminished effect with the continued use of the same amount of exercise; (2) *withdrawal*: withdrawal symptoms for exercise (e.g. anxiety, fatigue) are evidenced, or exercise is undertaken to relieve or avoid withdrawal symptoms; (3) *intention effects*: exercise is often taken in larger amounts or over longer period than was intended; (4) *loss of control*: there is a persistent desire or unsuccessful effort to cut down or control exercise; (5) *time*: a great deal of time is spent in activities conducive to the obtainment of exercise; (6) *conflict*: important social, occupational or recreational activities are given up or reduced because of exercise; (7) *continuance*: exercise is continued despite knowledge of persistent or recurrent physical or psychological problems that are likely to have been caused or exacerbated by exercise.

EDS-21 items, based on the aforementioned criteria, refer to respondents' 'current exercise beliefs and behaviors that have occurred in the past three months' and are rated on a 1 (*never*) to 6 (*always*) point scale. Total and subscale scores can be calculated, with higher scores indicating more symptomatology. The scale is also accompanied by a scoring manual that consists of flowchart decision rules. These rules specify the items or combinations of items that determine if an individual is classified as at risk, nondependent-symptomatic or nondependent-asymptomatic on each of the previously defined criteria. Individuals who score in the dependent range (i.e. four or five on the Likert scale indicating string endorsement) on at least three of the seven criteria are classified as 'at risk' for exercise dependence. Individuals who endorse at least three criteria in the nondependent-symptomatic range (i.e. three on the Likert scale), or a combination of at least three criteria in the 'at risk' and nondependent-symptomatic range, but did not meet the criteria for dependence, are classified as nondependent-symptomatic. Finally, individuals who endorse at least three of the criteria in the nondependent-asymptomatic range (i.e. one or two on the Likert scale) are classified as nondependent-asymptomatic. Studies have shown the scale to possess acceptable test–retest ($r = 0.92, p = .001$) and internal reliability ($\alpha = .95$) while supporting its content and concurrent validity (e.g. Hausenblas & Symons Downs, 2002b).

Procedures

The current study was approved by the ethics subcommittee of a major university in the United Kingdom and constitutes a part of a larger data set reported elsewhere (Edmunds et al., 2006). Participants were recruited in a number of different settings (e.g. sports clubs, public leisure centers, private fitness clubs and retail outlets) in the West Midlands, UK. Participants were approached by the first author, who explained the purpose of the study, and asked if they were willing to complete a short questionnaire packet. Those who agreed to take part provided informed consent, responded to the multi-section inventory and returned the completed packet to the first author.

Results

Internal reliability, descriptive statistics and demographic differences

Internal consistency estimates (Cronbach's coefficient α) and descriptive statistics were computed for all variables (see Table 1). The results indicated that the assessment of relatedness need satisfaction, each of the motivational regulations and exercise dependence exhibited acceptable internal reliability. However, the alpha values for two of the psychological need satisfaction scales were marginal (autonomy α = .66; competence α = .63), and thus results based on these two variables should be interpreted with caution. The mean exercise dependence score was 57.50 (SD = 10.84) for symptomatic individuals and 33.70 (SD = 7.35) for asymptomatic individuals. For both symptomatic and asymptomatic participants, autonomy was the most highly satisfied psychological need, followed by relatedness and then competence. Intrinsic motivation was the most strongly endorsed exercise regulation for both groups, closely followed by identified regulation and integrated regulation.

An independent samples *t*-test revealed that males reported significantly higher exercise dependence scores ($M = 49.65$, SD = 15.25) than females ($M = 45.49$, SD = 14.67; $t(333) = 2.54$, $p = .01$). In addition, when participants were classified into three equal age groups (i.e. < 24, 25–34 and > 35), a one-way ANOVA revealed that exercise dependence scores decreased significantly with age ($F(2, 314) = 9.55$, $p = .00$). Post-hoc comparison using Tukey HSD test indicated that the mean exercise dependence score of participants below 24 years of age ($M = 51.46$, SD = 14.65), and those aged 25–34 ($M = 48.58$, SD = 16.04), were significantly higher than those over 35 years of age ($M = 42.90$, SD = 13.37).

Differences between symptomatic and asymptomatic participants on exercise need satisfaction, motivational regulations and exercise behavior

Separate one-way between-groups multivariate analyses of variance (MANOVA) were performed to investigate whether nondependent-symptomatic and asymptomatic exercise-dependent participants differed in terms of: (a) reported exercise-related psychological need satisfaction; (b) motivational regulations for exercise; and (c) exercise behavior. Prior to running these analyses, an examination of the assumptions associated with MANOVA (Tabachnick & Fidell, 2001) revealed no serious violations.

There was a significant difference between symptomatic and asymptomatic individuals in need satisfaction via exercise: $F(3, 335) = 5.55$, $p = .00$; Pillai's Trace = .05; partial eta squared = .05. As seen in Table 1, follow-up univariate tests showed that the only difference to reach statistical significance was competence need satisfaction. Symptomatic individuals ($M = 5.13$, SD = 0.90) reported significantly higher perceptions of competence need satisfaction via exercise than asymptomatic individuals ($M = 4.76$, SD = 0.94). A significant multivariate difference also emerged between symptomatic and asymptomatic individuals in terms of their motivational regulations: $F(5, 333) = 21.52$, $p = .00$; Pillai's Trace = .24; partial eta squared = .24. Follow-up univariate tests revealed that symptomatic individuals reported higher external, introjected, identified and integrated regulations and intrinsic motivation than asymptomatic individuals (Table 1). A significant difference also emerged between symptomatic and asymptomatic individuals in terms of their exercise behavior: $F(3, 335) = 5.55$, $p = .00$; Pillai's Trace = .05; partial eta squared = .05. Follow-up univariate tests revealed that symptomatic individuals reported higher total and strenuous exercise behavior than asymptomatic individuals (Table 1).

Predicting exercise behavior of symptomatic and asymptomatic participants

To determine which motivation-related variables predicted mild, moderate, strenuous and total self-reported exercise, separate hierarchical multiple regression analyses were conducted for both the nondependent-symptomatic and nondependent-asymptomatic groups. Again, examination of the assumptions associated with regression analyses (Tabachnick & Fidell, 2001) revealed no serious violations. Given their influence on exercise dependence,

Table 1. Reliability analyses (Cronbach's coefficient α), descriptive statistics and differences in exercise dependence, exercise behavior, psychological need satisfaction and motivational regulations for nondependent-symptomatic and nondependent-asymptomatic individuals

	Exercise dependence category									
	N = 399	*Symptomatic (n = 198)*			*Asymptomatic (n = 141)*					
Variable	*α*	*Range*	*M*	*SD*	*Range*	*M*	*SD*	*F*	*p*	*Partial eta square*
Exercise dependence	.90	37–91	57.50	10.84	21–49	33.70	7.35	–	–	–
Total exercise	–	5–196	64.31[a]	35.62	0–123	41.30[b]	27.23	0.36	.55	.00
Strenuous exercise	–	0–171	44.27[a]	30.58	0–81	18.38[b]	19.18	1.37	.24	.00
Moderate exercise	–	0–42	12.78	17.85	0–36	15.07	17.67	78.91	.00	.19
Mild exercise	–	0–100	7.26	8.96	0–85	7.85	9.15	41.51	.00	11
Autonomy	.66	3.43–7	5.49	0.83	2.86–7	5.47	0.82	.04	.83	.00
Relatedness	.85	1.75–7	5.15	1.14	1.75–7	4.97	1.21	2.07	.15	.01
Competence	.63	2.17–7	5.13[a]	0.90	2.17–7	4.76[b]	0.94	13.71	.00	.04
External regulation	.72	1–3.25	1.36[a]	0.52	1–3.5	1.25[b]	0.43	4.36	.04	.01
Introjected regulation	.69	1–4.33	2.09[a]	0.84	1–4	1.67[b]	0.73	23.32	.00	.07
Identified regulation	.79	1–5	3.73[a]	0.76	1–5	2.99[b]	0.90	66.21	.00	.16
Integrated regulation	.77	1–5	3.80[a]	0.80	1–5	2.27[b]	0.87	96.39	.00	.22
Intrinsic motivation	.92	1–5	3.81[a]	0.87	1–5	3.13[b]	1.06	41.50	.00	.11

Note: No α values are provided for total, strenuous, mild or moderate exercise as these are single-item variables. Means in the same row that do not share the same subscripts differ at $p < .05$ (competence need satisfaction and external regulation) or $p < .001$ (all other variables)

and the role they have been shown to play in predicting exercise behavior in previous studies (e.g. DoH, 2004), gender and age were entered in the first step. Next, each of the three psychological needs were entered, as they are postulated to affect behavioral outcomes indirectly via the motivational regulations (Vallerand, 1997), which were entered in the final step.

For symptomatic individuals, the regression model was not significant for mild and moderate exercise. However, the model was significant and explained 17 percent of the variability in strenuous exercise and 9 percent of the variability in total exercise. Strenuous exercise was negatively predicted by age and positively by competence need satisfaction. Introjected regulation was shown to be a marginal positive predictor of strenuous exercise (Table 2). Age was a significant negative predictor of total exercise (Table 2). With respect to asymptomatic individuals, the model was not significant for mild, moderate and total exercise. However, the model was significant and explained 22 percent of the variability in the strenuous exercise behavior of this group. Specifically, strenuous exercise was negatively predicted by age and positively by identified regulation (Table 3).

Results of the regression analyses suggest that for symptomatic and asymptomatic participants, introjected and identified regulation, respectively, may be mediating the relationship between competence need satisfaction and strenuous exercise. Thus we employed the regression procedures of Baron and Kenny (1986) to examine potential mediation effects. That is, to establish mediation, the predictor variable must have an effect on the criterion variable (step 1), the predictor variable must

Table 2. Summary of hierarchical regression analyses predicting total and strenuous exercise behaviors from gender, age, psychological need satisfaction and motivational regulations for individuals nondependent-symptomatic for exercise dependence

Total exercise				*Strenuous exercise*			
Independent variable	*Adj.* R^2	β	*t*	*Independent variable*	*Adj.* R^2	β	*t*
Step 1:	.04			Step 1:	.07		
$F(2, 184) = 4.61, p < .01$				$F(2, 184) = 7.82, p < .00$			
Gender		.01	.15	Gender		–.11	–1.45
Age		–.22	–3.03**	Age		–.25	–3.49**
Step 2:	.09			Step 2:	.15		
$F(3, 181) = 4.86, p < .00$				$F(3, 181) = 7.53, p < .00$			
Gender		.07	.99	Gender		–.04	–.53
Age		–.23	–3.10**	Age		–.23	–3.09**
Autonomy		.16	1.79	Autonomy		.01	.17
Relatedness		.01	.05	Relatedness		–.02	–.20
Competence		.16	1.76	Competence		.32	3.70**
Step 3:	.09			Step 3:	.17		
$F(5, 176) = 2.84, p < .00$				$F(5, 176) = 4.79, p < .00$			
Gender		.04	.48	Gender		–.09	–1.19
Age		–.22	–2.85**	Age		–.21	–2.87**
Autonomy		.15	1.67	Autonomy		.02	.20
Relatedness		–.03	–.27	Relatedness		–.04	–.42
Competence		.11	1.10	Competence		.25	2.55*
External regulation		–.05	–.63	External regulation		–.15	–1.91
Introjected regulation		.05	.61	Introjected regulation		.16	1.94[a]
Identified regulation		.11	1.10	Identified regulation		.03	.27
Integrated regulation		–.07	–.65	Integrated regulation		.03	.30
Intrinsic motivation		.07	.74	Intrinsic motivation		.06	.62

Note: $N = 187$. $^*p < .05$. $^{**}p < .01$. [a]Introjected regulation $p = .054$

Table 3. Summary of hierarchical regression analyses predicting strenuous exercise behavior from gender, age, psychological need satisfaction and motivational regulations for individuals nondependent-asymptomatic for exercise dependence

Independent variable	*Adj.* R^2	β	*t*
Step 1:			
$F(1, 127) = 8.92, p < .00$	.11		
Gender		–.06	–.66
Age		–.35	–4.22**
Step 2:			
$F(3, 124) = 5.16, p < .00$	.14		
Gender		–.06	–.73
Age		–.33	–4.03**
Autonomy		–.03	–.28
Relatedness		–.15	–1.60
Competence		.26	2.59*
Step 3:			
$F(5, 119) = 4.62, p < .00$	.22		
Gender		–.15	–1.74
Age		–.37	–4.55**
Autonomy		–.13	–1.36
Relatedness		–.07	–.69
Competence		.13	1.21
External regulation		–.14	–1.50
Introjected regulation		–.03	–.25
Identified regulation		.40	3.12**
Integrated regulation		–.05	–.47
Intrinsic motivation		.00	.01

Note: $N = 130$. *$p < .05$; **$p < .01$

have an effect on the mediator (step 2) and finally, the mediator must affect the criterion, after controlling for the predictor (step 3). To establish complete mediation, the effect of the predictor on the criterion should be zero in the third step of the analysis. Partial mediation occurs when this effect is reduced, but remains significant. We decided to control for the effects of the demographic variables of age and gender, as well as the other psychological need and motivational regulation constructs, in each respective regression equation required to establish mediation. We feel that it is unlikely that any demographic variable or psychological construct will operate in isolation in the real world. Thus, controlling for the effects of the aforementioned variables constitutes a more realistic test of what would be likely to occur in the exercise domain.

For symptomatic participants, introjected regulation was not a mediator of the relationship between competence need satisfaction and strenuous exercise. While competence did predict strenuous exercise ($\beta = .32$, $p < .01$) when controlling for the effects of gender and age and the other psychological need constructs (step 1), it did not predict introjected regulation $\beta = –.04$ ($p = .50$; i.e. step 2). For asymptomatic individuals, however, identified regulation was found to completely mediate the effect of competence need satisfaction on strenuous exercise behavior. Examining the effect of the predictor variables on the criterion and mediator variable (i.e. steps 1 and 2, respectively), and controlling for the effects of gender and age and the other psychological need constructs, competence need satisfaction predicted strenuous exercise ($\beta = .26$, $p < .01$; step 1) and identified regulation ($\beta = .39$, $p < .01$; i.e. step 2). Step 3 was also confirmed (Table 3), because identified regulation predicted strenuous exercise after controlling for the effect of competence need satisfaction $\beta = .40$ ($p < .01$). The standardized β coefficient for competence dropped from $\beta = .26$ ($p < .01$) to $\beta = .13$ ($p = .23$) when identified regulation was entered into the regression equation suggesting complete mediation (Table 3). The indirect effect size of competence need satisfaction on strenuous exercise, as mediated by identified regulation, was .16. The Aroian version of the Sobel test (as recommended by Baron & Kenny, 1986) confirmed that the indirect effect of the independent variable through the mediator was significantly greater than zero ($Z = 2.38$, $p = .02$).[2]

Discussion

The main purpose of the current study was to, first, examine whether individuals classified as 'at risk', 'nondependent-symptomatic' and 'nondependent-asymptomatic' for exercise dependence (Hausenblas & Symons Downs, 2002b) differed in terms of their degree of reported psychological need satisfaction, self-determined motivation and behavioral engagement. In addition, the present research aimed to determine whether the various motivational regulations assumed in SDT (Deci & Ryan, 1985) differentially predicted self-reported exercise behavior for each of the exercise groups under

investigation, and explored the mediating role of the motivational regulations between psychological need satisfaction and behavioral outcomes. However, substantiating claims that exercise dependence is a rare pathology (Morris, 1989; Veale, 1987), only 3.4 percent of our sample met the criteria to be defined as 'at risk' of exercise dependence. This prevented the inclusion of the at risk group in subsequent analyses. Supporting the suggestions of Hall and colleagues (2004), many more study participants were classified as showing symptomatology of dependence, and thus, comparisons could be made between symptomatic versus asymptomatic individuals.

Supporting the first hypothesis (Hypothesis 1), individuals classified as nondependent-symptomatic for exercise dependence reported higher levels of competence need satisfaction. As, aligned with our predictions (Hypothesis 4), the former group also reported greater exercise involvement, it makes sense that they would report feeling more competent in the physical domain. However, contrary to what was hypothesized, no differences were observed between symptomatic and asymptomatic individuals on the psychological needs for relatedness (Hypothesis 2) and autonomy (Hypothesis 3). Further, contrary to what was predicted (Hypothesis 3), symptomatic individuals displayed higher levels of autonomous motivation (i.e. identified and integrated regulation and intrinsic motivation) than asymptomatic participants.

In explicating these findings, it is important to consider the characteristics of the sample under investigation. Given that we were able to compare those individuals showing some, versus no symptomatology only, it remains possible that differences would have emerged if those individuals actually displaying this pathological behavior were compared to nondependent-asymptomatics. It would be most interesting if future studies could successfully secure larger numbers of 'at risk' individuals for such comparisons. However, it should be acknowledged that recruiting a sufficient sample of 'at risk' individuals is likely to prove extremely difficult. It has also been suggested that a random sample of habitual exercisers is likely to contain very few, if any, cases of exercise dependence (Morris, 1989). The fact that only 12 participants in our current investigation met the criteria for 'at risk' of exercise dependence, despite attempts to recruit participants from exercise settings where such individuals would most likely 'workout', gives credence to this proposition.

Contrary to our hypothesis (Hypothesis 3), it was notable that symptomatic individuals reported higher levels of not only autonomous motivation but also higher levels of more controlling motivational regulations (i.e. external and introjected regulations), compared to asymptomatics. Considering these seemingly incongruous findings, it is important to keep in mind that while an examination of mean differences allows greater awareness of the motivation-related characteristics that differentiate symptomatic versus asymptomatic groups, this does not provide insight into which regulations actually predict behavioral engagement for each group.

Indeed, results regarding which of the motivational regulations predicted exercise behavior among nondependent-symptomatic and asymptomatic groups did support our last hypothesis (Hypothesis 5). As predicted, asymptomatic individuals were guided by more autonomous, identified regulations. These findings indicate that the attachment of significant value to exercise (i.e. identified regulation) is not associated with problematic behavior (Robbins & Joseph, 1985). In contrast, for individuals reporting some symptomatology of exercise dependence, introjected regulation was found to be a marginally significant predictor of strenuous exercise behavior. This latter result is in line with the work of Hall et al. (2004), who suggested that perceptions of obligation to exercise may be a function of reduced self-determination. However, given that introjected regulation was found to be only a marginal predictor of strenuous exercise, this proposed mechanism should be interpreted with caution. Further, as the current study is cross-sectional in design, we should also be cautious in suggesting that exercise dependence symptomatology is a consequence of diminished self-determination. It remains possible that feelings of obligation may simply be concomitant with reduced self-determination. Further research which includes sufficient 'at risk' individuals and adopts experimental methodologies is warranted to begin

to tease out the interdependencies between controlling forms of motivational regulation and maladaptive exercise engagement.

The observed link between introjection and exercise behavior for those showing symptoms of exercise dependence, but not in the case of individuals who are asymptomatic, does seem to suggest that the quality of experience is likely to be very different for those guided by different regulatory styles (Ryan & Deci, 2000). To further elucidate and substantiate the negative effect of thwarted need satisfaction and less autonomous regulation on exercise engagement, future studies might consider investigating other affective and cognitive outcomes (e.g. enjoyment and commitment) associated with decreased self-determination in the exercise domain.

Consistent with previous research (Edmunds et al., 2006), intrinsic motivation was not a significant predictor of exercise behavior for either group. This finding supports the proposition that intrinsic motivation may not be the most important predictor of engagement in the exercise domain. With all the organization, commitment and often mundane/repetitive activities exercise engagement entails, individuals are probably not likely to maintain regular exercise behavior solely for the intrinsic reasons of fun or enjoyment (Mullan et al., 1997). However, previous research has shown that whereas new participants in physical activity programs report health benefits as their reason for exercise adoption, long-term participants report enjoyment as their principal reason for continuing (Perrin, 1979). Future longitudinal studies would allow researchers to determine the role of intrinsic motivation, and the internalization of extrinsic motivation, in predicting sustained exercise participation.

Competence need satisfaction emerged as a significant predictor of strenuous exercise behavior for nondependent-symptomatic individuals. Moreover, consonant with our hypothesis, competence need satisfaction impacted strenuous exercise behavior for asymptomatic individuals indirectly via an effect on identified regulation. The construct of competence can be compared to the concept of self-efficacy in that they both reflect an individual's beliefs about his/her capabilities to produce performances that will lead to anticipated outcomes (Bandura, 1997). Self-efficacy has been proposed to be the strongest cognitive determinant of exercise engagement (Sallis & Owen, 1998). The finding for the symptomatic group appears to corroborate this claim, as competence had a direct effect on reported behavioral outcomes. However, the observation that identified regulation mediated the effect of competence need satisfaction on exercise behavior in the present study also suggests an indirect mechanism by which this fundamental human need can impact adaptive behavioral engagement in the exercise domain.

It is interesting to point out that that none of the psychological needs or motivational regulations proposed by SDT predicted mild and moderate exercise behaviors in the current investigation. In explicating this finding, we should be cognizant that the majority of mild and moderate exercise reported by participants in this study was walking or cycling. Such activities could be considered more habitual in nature and may therefore require less cognitive processing than more structured and vigorous forms of exercise. Future SDT-based work examining the motivation-related determinants specific to different forms of physical activity and exercise (e.g. habitual physical activity, organized exercise classes, organized sport) is warranted.

We should also note that few studies have drawn a clear distinction between exercise dependence and commitment to physical activity (Bamber et al., 2000). In the present work, we explored differences in exercise dependence symptomatology as opposed to commitment to exercise. It has been suggested that the difference between the committed and dependent exerciser is that the former is invigorated and strengthened by exercise, while the latter has begun to see exercise as work rather than a source of enjoyment (Cockerill & Riddington, 1996). This description of the dependent exerciser reflects someone driven by introjected regulation, a marginally significant predictor of exercise behavior for symptomatic individuals in the current study.

As a final caveat, we acknowledge that research has yet to clarify why a sense of volitional control is diminished in individuals displaying obligatory exercise (Hall et al., 2004). Previous research has shown that the thwarting of autonomy and competence, and the accompanied ill-being, leads to poor coping and the

development of rigid behavioral patterns, such as anorexia nervosa (Deci & Ryan, 2000). However, in the present results, symptomatic and asymptomatic groups differed only in terms of reported levels of competence need satisfaction derived from exercise, with the former group actually reporting higher competence. In terms of this seemingly theoretically inconsistent finding, it remains possible that those showing symptoms of exercise dependence may still experience compromised need satisfaction at a wider, global level (Deci & Ryan, 2000). Thwarted need satisfaction experienced in other aspects of one's life (e.g. relationships) may result in feelings of a lack of control overall and, consequently, excessive exercise may represent an attempt to regain a sense of control and efficaciousness in one's life (Deci & Ryan, 2000).

In total, the findings of the current study suggest that key motivational variables embedded within the theoretical framework of SDT (Deci & Ryan, 1985) are linked to exercise dependence symptomatology. This study therefore appears to support the claims of Hamer and associates (2002), who suggested that the motivational regulations proposed by SDT could be considered in the development of inventories to assist the successful diagnosis of problematic exercise engagement. Interventions designed to support individuals displaying exercise dependence symptomatology may also benefit from being grounded in SDT (Deci & Ryan, 1985). For example, health and exercise professionals who focus upon the promotion of psychological need satisfaction and self-determined forms of motivation (e.g. via the creation of autonomy supportive environments) should be expected to promote more autonomous motivational regulations among individuals displaying dependence symptomatology. Subsequently, we would predict that these individuals will become less controlled toward their exercise involvement and display a more adaptive physical activity profile over time.

Notes

1. Amotivation has been defined as representing 'a state lacking of any intention to engage in behavior' and constitutes a completely nonself-determined form of motivation (Markland & Tobin, 2004). Given that all participants in the current study engaged in at least some form of exercise, amotivation is not discussed further in this study.
2. At the request of an anonymous reviewer, we re-ran each step of Baron and Kenny's (1986) strategy for establishing mediation with only the variables of interest (i.e. competence, identified regulation and/or strenuous exercise) included. The purpose of this analysis was to examine whether the effect of competence on strenuous exercise will still be nonsignificant in step 3 when not controlling for the demographic variables and the other two psychological needs. Competence predicted strenuous exercise ($\beta = .20$, $p = .02$; step 1) and identified regulation ($\beta = .35$, $p < .01$; step 2). Further, when controlling for the effect of competence, identified regulation predicted strenuous exercise ($\beta = .32$, $p < .01$; step 3). The β for competence need satisfaction dropped from .20 ($p < .01$) in step 1 to .09 ($p = .30$) in step 3, confirming complete mediation. In this instance the indirect effect size of competence need satisfaction on strenuous exercise, as mediated by identified regulation, was .11. Again, the Aroian version of the Sobel test (as recommended by Baron & Kenny, 1986) confirmed that the indirect effect of the independent variable through the mediator was significantly greater than zero ($Z = 3.08$, $p < .01$). These procedures also confirmed that, akin to the original analyses, introjected regulation did not mediate the effect of competence need satisfaction on strenuous exercise among the nondependent-symptomatic group.

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