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## Defining Features of Unhealthy Exercise Associated with Disordered Eating and Eating Disorder Diagnoses

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### Abstract

**Objectives**—The current study sought to compare different features of unhealthy exercise on associations with disordered eating and their ability to identify individuals with eating disorders. A secondary aim of the study was to compare prevalence and overlap of different aspects of unhealthy exercise and potential differences in their gender distribution.

**Design**—Cross-sectional epidemiological study.

**Methods**—A community-based sample of men (n=592) and women (n=1468) completed surveys of health and eating patterns, including questions regarding exercise habits and eating disorder symptoms.

**Results**—Compulsive and compensatory features of exercise were the best predictors of disordered eating and eating disorder diagnoses compared to exercise that was excessive in quantity. Further, compulsive and compensatory aspects of unhealthy exercise represented overlapping, yet distinct qualities in both men and women.

**Conclusions**—Including the compulsive quality among the defining features of unhealthy exercise may improve identification of eating disorders, particularly in men. Results suggest that the compensatory aspect of unhealthy exercise is not adequately captured by the compulsive aspect of unhealthy exercise. Thus, interventions that target unhealthy exercise behaviors among high-risk individuals, such as athletes, may benefit from addressing both the compulsive and compensatory aspects of unhealthy exercise. Future prospective longitudinal studies will aid in determining the direction of the association between these features of unhealthy exercise and the onset of eating pathology.

### Keywords

unhealthy exercise; disordered eating; eating disorders; exercise; men

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#### Conflict of Interest

The authors have no Conflicts of Interest to disclose.

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## Introduction

Exercise is an important component of a healthy lifestyle. However, when associated with a maladaptive body image, exercise can become an unhealthy behavioral feature of eating disorders (Brehm & Steffen, 1998; Lipsey, Barton, Hulley, & Hill, 2006; Meyer, Taranis, Goodwin & Haycraft, 2011; Vartanian, Wharton, & Green, 2012). Problematic exercise is common in eating disorders, occurring in approximately 80% of anorexia nervosa (AN) patients and 55% of bulimia nervosa (BN) patients in the acute phase of the disorders (Davis et al., 1997). Thus, a comprehensive understanding of the construct of unhealthy exercise is necessary for its assessment as well as eating disorder prevention and intervention.

Past research provides strong support that the construct of unhealthy exercise is multifaceted (e.g., Taranis & Meyer, 2011; Steffen & Brehm, 1999), such that both quantitative and qualitative aspects of exercise contribute to its pathological nature. Specifically, a multidimensional conceptualization of unhealthy exercise encompasses quantitative aspects, such as frequency and intensity of exercise (e.g., Davis & Kaptein, 2006) as well as qualitative aspects of unhealthy exercise, such as exercise preoccupation, compulsivity, and weight and shape regulation (e.g., Polivy, 1994; Thome & Espelage, 2004; Adkins & Keel, 2005; Meyer & Taranis, 2011; LePage, Crowther, Harrington, & Engler, 2008).

The terms used to describe unhealthy exercise can be grouped into three domains: “excessive” - exercise characterized by excessive frequency, duration, and intensity (Davis & Fox, 1993); “compulsive” - exercise to prevent or reduce feelings of distress, exercise despite illness or injury, and preoccupation with exercise (also termed “obligatory” or “exercise addiction” in some papers) (Adkins & Keel, 2005; Meyer & Taranis, 2011; Mond, Hay, Rodgers, Owen, & Beumont, 2004; Monok et al., 2012); and “compensatory” - exercise to compensate for the effects of food intake on weight or shape (APA, 1994; LePage et al., 2008).

While researchers agree that excessive, compulsive, and compensatory forms of exercise are unhealthy, there remains ambiguity regarding the extent to which each of these aspects impact eating pathology. Seigel and Hetta (2001) found that high levels of exercise were associated with compulsive exercise, but only compulsive attitudes toward exercise were associated with significant body image and eating disturbances in a community sample of young-adult women. In a larger community-based sample women, Mond and colleagues (Mond et al., 2004; Mond, Hay, Rodgers, & Owen, 2006) reported that feelings of guilt following the postponement of exercise was significantly associated with elevated levels of eating pathology and reduced quality of life whereas frequency of exercise was not. Similarly, Taranis and Meyer (2011) found no significant associations between exercise frequency and EDE-Q scores in young women. Adkins and Keel (2005) examined whether excessive or compulsive is a better descriptor of unhealthy exercise in both college men and women. Results from their investigation indicated that among individuals exercising to influence their appearance, compulsive exercise was a significant positive predictor of disordered eating, whereas duration of exercise was a significant negative predictor in multivariate models. Thus, previous studies that have investigated both the excessive and compulsive aspect of unhealthy exercise have consistently indicated that although these aspects are related, the compulsive quality of exercise, rather than excessive quantity, may be a better predictor of eating pathology.

Although several studies have examined the compulsive aspect of exercise, relatively few have specifically examined exercise that is compensatory in nature. Further, to our knowledge, no studies have examined if the compensatory aspect of exercise is distinct from the compulsive aspect of exercise. LePage and colleagues (2008) examined associations

between individuals who used vigorous exercise to control weight or shape or to counteract the effects of eating and/or fasted to influence their weight or shape with eating pathology in undergraduate women. Findings indicated that individuals who endorsed vigorous exercise reported significantly greater body dissatisfaction and dietary restraint than the control group. While this study did show associations between exercise as a compensatory behavior and disordered eating, it did not examine other aspects of unhealthy exercise. Thus, it is unclear whether the compensatory aspect of unhealthy exercise is distinct from the compulsive aspect of unhealthy exercise. Additionally, Taranis, Touyz, and Meyer (2011) posited that negative emotion when one is unable to exercise, exercise for weight or shape reasons, and rigidity of one's exercise routine are defining components of compulsive exercise. These authors found that among the hypothesized primary factors to maintain unhealthy exercise, weight control exercise (e.g., exercise for weight or shape reasons) consistently showed the strongest associations with eating pathology. Importantly, this definition does not specifically address whether exercise is used to compensate for food intake. Similarly, Mond and colleagues (2004, 2006) and Adkins and Keel (2005) did not directly examine the compensatory aspect of exercise. Thus, little attention has been directed to the compensatory aspect of unhealthy exercise despite description of exercise as an inappropriate compensatory behavior in BN since the Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV; APA, 1994).

One might argue that the compensatory quality of exercise described in the DSM-IV-TR (APA, 2000) is captured by examinations of its compulsive quality. In the context of an individual who binges but fears weight gain, unhealthy exercise may reflect a compulsion to reduce anxiety about the effects of binge eating and to prevent dreaded weight gain. However, unhealthy exercise is not limited to those with BN, as it is a feature of AN without binge-eating and can occur in eating disorder not otherwise specified (EDNOS) in the absence of binge-eating episodes. The latter example may be particularly true for men who are more likely to be diagnosed with EDNOS than with AN or BN. In these instances, unhealthy exercise may be used to reduce anxiety, consistent with the definition of compulsions in the DSM-IV-TR, without being used to compensate for specific food intake. In addition, exercise could be compulsive without being related to the effects of exercise on weight or shape as supported in analyses by Adkins and Keel (2005) and Mond et al. (2006). Thus, "compulsive" exercise may capture aspects of "compensatory" exercise without being synonymous.

Importantly, previously reported findings on the quantitative and qualitative features of unhealthy exercise come from studies that predominantly examined women. Given that men are more likely to use exercise to control weight than other means, such as dieting, purging, or fasting, it is important to extend the examination of these different aspects of unhealthy exercise to men (Lewinsohn, Seeley, Moerk, & Streigel-Moore, 2002). In addition, previous studies have focused on continuous measures of disordered eating rather than examining the ability of different forms of unhealthy exercise to predict eating disorder diagnoses. To date, no study has adequately examined the unique contributions of excessive, compulsive, *and* compensatory aspects of unhealthy exercise for predicting disordered eating and eating disorder diagnoses using multivariate analyses in community-based samples of both men and women. Finally, previous studies have not examined the overall prevalence and gender distribution of different aspects of unhealthy exercise in a large community sample of men and women.

Thus, the purpose of the current study was to compare different aspects of unhealthy exercise (excessive, compulsive, and compensatory) on associations with disordered eating and to examine which aspect of unhealthy exercise best discriminates individuals with eating disorder diagnoses from non-eating disorder controls in a large community sample of

men and women. Based on prior findings (Adkins & Keel, 2005; Mond et al., 2004, 2006; Seigel & Hetta, 2001; Taranis & Meyer, 2011), we predicted that compulsive exercise would demonstrate greater associations with disordered eating than excessive exercise. Given that compensatory exercise is contingent upon concerns about the effects of eating on weight, we further predicted that compensatory exercise would be more closely associated with elevated bulimia scores compared to excessive and compulsive exercise. Finally, we predicted that participants engaging in compulsive and/or compensatory exercise would be more likely to meet criteria for an eating disorder diagnosis than participants engaging in excessive exercise or no aspect of unhealthy exercise. A secondary aim of the study was to compare different aspects of unhealthy exercise on prevalence, overlap, and gender distribution.

## Methods

### Participants

Data were drawn from a previously established epidemiological study in a sample of three cohorts of men ( $n = 592$ ) and women ( $n = 1468$ ) originally selected at random from the same college population in the springs of 1982, 1992, and 2002 (see Keel et al. 2006, 2010, 2007 for details, respectively). Participants completed a survey of health and eating behaviors and were followed prospectively at 10-year intervals. Data come from the third assessment wave in 2002, reflecting baseline assessment of the 2002 cohort ( $n = 783$ ), 10-year follow-up of the 1992 cohort ( $n = 622$ ), and 20-year follow-up of the 1982 cohort ( $n = 655$ ), representing 72% of those sought. Detailed information about the sampling procedures for baseline assessment of the 2002 cohort, 10-year follow-up of the 1992 cohort, and 20-year follow-up of the 1982 cohort has been reported elsewhere (Keel et al. 2006, 2010, 2007). Participants had a mean (SD) age of 29.39 (8.57) years, and had a mean (SD) body mass index (BMI) of 23.17 (3.59)  $\text{kg}/\text{m}^2$ . Most participants (70.8%) were Caucasian, and ethnic/racial distribution in remaining participants was 14.2% Asian, 6.8% African American, 5.8% Hispanic, 0.4% Native American, 0.4% Native Hawaiian, and 1.6% biracial/other. This study was reviewed and approved by the Institutional Review Board.

### Measures

**Eating Disorders Inventory (EDI) (Garner, Olmsted, & Polivy, 1983)**—The EDI is a self-report, 6-point forced choice measure of behavioral and psychological traits in anorexia nervosa and bulimia nervosa. The EDI is a well-validated inventory with excellent support for its internal consistency and discriminant validity (Nevonen, Clinton, & Norring, 2006) as well as test-retest reliability in both individuals with and without eating disorders (Thiel & Paul, 2006). In the current study, items from the Bulimia and Drive for Thinness subscales of the EDI were included to measure disordered eating attitudes and behaviors. Cronbach's  $\alpha$  for the Bulimia and Drive for Thinness subscales of the EDI were  $\alpha = 0.84$  and  $\alpha = 0.91$ , respectively.

**Revised Restraint Scale (RS) (Herman & Polivy, 1980)**—Dietary restraint was assessed by the Concern for Dieting subscale of the RS. The Concern for Dieting subscale of the RS consists of 5 self-report items and has well-established reliability and validity (Gorman & Allison, 1995). Cronbach's  $\alpha$  for the Concern for Dieting subscale of the RS in the current sample was  $\alpha = 0.83$ .

**Eating Disorder Diagnoses**—Eating disorder diagnoses were determined based on eating disorder diagnostic information provided in survey data (see Keel et al. (2002) for eating disorder diagnostic criteria). Diagnoses were made for participants who met criteria for AN, BN, or EDNOS (e.g., partial AN, partial BN, purging disorder, or binge eating

disorder). Specifically, diagnoses were operationalized as follows: (1) full or partial AN: BMI below 5<sup>th</sup> percentile for sex and EDI Drive for Thinness scores  $\geq$  25<sup>th</sup> percentile for AN patients; (2) full or partial BN: recurrent binge-eating episodes with use of inappropriate compensatory behavior, and worry over binge-eating episodes occurring at frequency or below threshold; (3) purging disorder (PD): vomiting, fasting, laxative and/or diuretic use at least twice a week to control weight or shape; or (4) full or partial binge-eating disorder (BED): binge-eating at least once per week, loss of control over episodes and worry over episodes without use of inappropriate compensatory behavior. Participants who did not meet criteria for any eating disorder and provided adequate information to determine the absence of an eating disorder were classified as non-eating disorder controls. Of note, a subset of participants completed structured clinical interviews (SCID-I; First, Spitzer, Gibbon, & Williams, 1995) in the second stage of this two-stage epidemiological and longitudinal study (Keel et al., 2006). Specificity and sensitivity of the survey-based diagnoses were .89 and .91, respectively, and overall agreement between survey and interview-based diagnoses was high ( $\kappa = .80$ ), and no significant differences were found between cohorts. In consideration of the high level of agreement between survey-based and interview-based diagnoses and because survey data were available for the full sample, survey-based diagnoses were used in the current study.

**Forms of Unhealthy Exercise**—The assessment of unhealthy exercise was included as part of a survey that assessed a broad spectrum of health and eating behaviors, which was distributed to a large number of randomly selected participants. Thus, there were constraints on the number of items that could be devoted to each construct and it was necessary for the assessment of unhealthy exercise to be brief. For each form of unhealthy exercise (excessive, compulsive, and compensatory), a dichotomous variable was created indicating the presence or absence of that feature based on responses to survey items.

**Excessive exercise**—Based on criteria used to define excessive exercise in previous studies (Davis et al., 1997, 1999; Davis & Kaptein, 2006; Seigel & Hetta, 2001), as well as current US guidelines for the recommended amount of exercise needed per week for adults to maintain health (Centers for Disease Control and Prevention [CDC], 2011), excessive exercise was defined as engaging in exercise at least once a day for more than 60 minutes per session. Specifically, excessive exercise was assessed by two survey items that asked participants to rate how often they exercised (1 = never; 7 = more than once per day) and to rate the duration of their average workout (1 = 10 minutes; 7 = more than 60 minutes). Current US guidelines for adults suggest engaging in between two hours and thirty minutes of *moderate* aerobic exercise per week, 2 or more days of muscle strengthening activities per week, and *up to* five hours per week of *moderate* aerobic exercise or two hours and thirty minutes of *intense* aerobic exercise and 2 or more days of muscle strengthening activities per week (CDC, 2011). Thus, engaging in greater than 1 hour of exercise at least once daily exceeds current US recommendations for a healthy amount of exercise.

*Compulsive exercise* was defined as present for ratings of 3 or lower on a survey item that asked participants to rate levels of distress when they missed planned exercise (1 = miserable; 7 = happy), consistent with definitions validated in previous research (Mond et al., 2004, 2006, 2008). In order to establish the validity of the single-item measure of compulsive exercise used in the current study, a separate college sample of men and women (n=936) was administered the single-item measure of compulsive exercise, as well as the Commitment to Exercise Scale (CES; Davis, Brewer, & Ratsuny, 1993). The CES is a well-validated, eight-item measure that specifically addresses the compulsive element of exercise (e.g., continuing to exercise despite illness or injury, turning down important social events to exercise, maintaining a rigid exercise schedule). In the separate college sample used to validate our single-item assessment, items from the CES were rated on a 0–10 scale, with



higher scores representing greater compulsive exercise attitudes. The association between the CES and the single-item measure of compulsive exercise was of a large effect size ( $r=.51$ ; Cohen, 1992), providing support for the validity of our single-item measure of compulsive exercise.

*Compensatory exercise* was assessed from the relevant item of the Eating Disorder Diagnostic Scale (EDDS; Stice, Telch, & Rizvi, 2000). Participants rated how many times per week on average over the past 3 months they engaged in excessive exercise specifically to counteract the effects of overeating episodes, regardless of the actual reported duration or frequency of exercise. Compensatory exercise was defined as present if the participant reported engaging in compensatory exercise an average of at least one time per week. Previous community-based studies have found that similar single-item measures of exercise intended to avoid feelings of guilt and exercise to control weight or shape and/or compensate for the effects of eating (Ackard, Brehm, & Steffen, 2002; Mond et al., 2004, 2006, 2008; LePage et al., 2008) have demonstrated significant associations with eating disorder psychopathology.

## Data Analyses

Bivariate associations between different forms of unhealthy exercise (excessive, compulsive, and compensatory) and dependent measures of disordered eating (EDI Bulimia, EDI Drive for Thinness, and the Restraint Scale) were calculated, and Hotelling's t-tests were used to compare exercise variables on the magnitude of their associations with disordered eating variables. In addition, multiple regression analyses were conducted to examine the independent contributions of each definition of unhealthy exercise to predict variance in dependent measures of disordered eating. Analyses controlled for sex as well as cohort (to account for possible differences between age groups). Separate multiple regression analyses were conducted with EDI Bulimia, EDI Drive for Thinness, and the Restraint Scale as dependent variables. For each regression model, cohort, sex, and exercise variables that had shown significant bivariate associations with the dependent variable and the interactions of sex by the exercise variables were entered into the equation.

To address the third hypothesis, a logistic regression was performed to evaluate associations between the different forms of unhealthy exercise and likelihood of meeting criteria for an eating disorder diagnosis. All diagnoses were included together, given inadequate power to examine associations between different forms of unhealthy exercise and specific diagnoses separately. Finally, descriptive analyses were conducted to assess the prevalence for each aspect of unhealthy exercise, and chi-square analyses were used to explore possible gender differences among exercise variables.

## Results

### Descriptive Analyses

Estimates of prevalence and overlap of excessive, compulsive, and compensatory aspects of unhealthy exercise in men and women are presented in Table 1. Overall, 6.8% of participants reported engaging in excessive exercise, 3.3% reported engaging in compulsive exercise, and 7.3% reported engaging in compensatory exercise. Prevalence in men ranged from 2.7% for compulsive exercise to 8.3% for excessive exercise, whereas prevalence in women ranged from 4.0% for excessive exercise to 10.4% for compensatory exercise. Results indicated that women were significantly more likely to report engaging in exercise to compensate for overeating than men (10.4% in women vs. 4.4% in men;  $\chi^2(1)=18.50, p<.001$ ). Conversely, men were more likely to report excessive exercise than women (8.3% in men vs. 5.4% in women;  $\chi^2(1)=5.94, p=.015$ ). Finally, there was no significant difference

between men and women on the likelihood of engaging in compulsive exercise (2.7% in men vs. 3.9% in women;  $\chi^2(1)=1.80, p = .19$ ). Among the two forms of unhealthy exercise that were significantly associated with eating disorder diagnoses (compulsive and compensatory), the proportion of men (6.1%) and women (11.6%) reporting engaging in compulsive and/or compensatory aspects of unhealthy exercise differed significantly ( $\chi^2(1) = 20.37, p < .001$ ). There were no significant differences in the proportion of overlap between excessive, compulsive, and compensatory features of unhealthy exercise in men and women.

### Correlational Analyses

Correlations between different forms of unhealthy exercise and scores on the EDI Bulimia subscale, EDI Drive for Thinness subscale, and the Restraint Scale are presented in Table 2. Results supported significant correlations between all forms of unhealthy exercise and dependent measures of disordered eating, with the exception of nonsignificant correlations between excessive exercise and the EDI Drive for Thinness subscale and the Restraint Scale. Hotelling's *t*-tests were used to compare the magnitudes of correlations. As predicted, compulsive exercise (all *r*'s  $\geq 0.20$ ) outperformed excessive exercise (all *r*'s  $\leq 0.06$ ) in its associations with EDI Bulimia ( $t(2015)= 5.28; p<.001$ ), EDI Drive for Thinness ( $t(2014)=7.49; p<.001$ ), and the Restraint Scale ( $t(1979)= 8.28; p<.001$ ). In addition, compensatory exercise was more closely associated with elevated EDI Bulimia subscale scores than either excessive ( $t(2015)= 9.45; p<.001$ ) or compulsive exercise ( $t(2011)= 5.87; p<.001$ ). As shown in Table 1, there were significant positive correlations among all forms of unhealthy exercise, demonstrating non-independence. However, the magnitude of associations did not suggest problems with multicollinearity (*r*-values ranged from .13 to .34, all *p*-values  $<.01$ ), and exercise variables demonstrated sufficient distinctiveness in analyses of multicollinearity.

### Multivariate Analyses

**EDI Bulimia**—Table 3 presents the results of multivariate regression analyses in which scores on the EDI Bulimia subscale were regressed on excessive exercise, compulsive exercise, compensatory exercise, cohort, sex, and their interactions. Results indicated that the overall model was significant ( $R^2=.183, F(8,1965)=54.92, p<.001$ ). As expected, compulsive exercise and compensatory exercise were significant predictors of EDI Bulimia scores. In contrast to the significant correlation between excessive exercise and EDI Bulimia scores, there was no significant main effect of excessive exercise in the multivariate model that controlled for positive associations between excessive exercise and compulsive and compensatory exercise. Finally, there were no significant sex by unhealthy exercise variable interactions (all *p*-values  $>.33$ ).

**EDI Drive for Thinness**—Table 3 presents the results of multivariate regression analyses in which scores on the EDI Drive for Thinness subscale were regressed on compulsive exercise, compensatory exercise, cohort, sex, and their interactions. Results indicated that the overall model was significant ( $R^2=.245, F(6,1977)=106.72, p<.001$ ). As expected, the exercise variables that significantly predicted variance in scores on the EDI Drive for Thinness subscale were compulsive exercise and compensatory exercise. There were no significant sex by unhealthy exercise variable interactions (all *p*-values  $>.25$ ).

**Restraint Scale**—Table 3 presents the results of multivariate regression analyses in which scores on the Restraint Scale were regressed on compulsive exercise, compensatory exercise, sex, and their interactions. Results indicated that the overall model was significant ( $R^2=.234, F(6,1940)=98.76, p<.001$ ). As expected, compulsive exercise and compensatory exercise significantly predicted higher scores. Additionally, the interaction between sex and

compulsive exercise approached significance ( $\beta=.04$ ,  $t(1940)=1.85$ ,  $p=.064$ ). Specifically, compulsive exercise was more strongly associated with RS scores in women compared to men at a trend level.

**Eating Disorder Diagnoses**—Results from the logistic regression assessing the impact of different aspects of unhealthy exercise on the likelihood that participants would meet criteria for an eating disorder are presented in Table 4. The full model containing all predictors was statistically significant ( $\chi^2(8)=84.17$ ,  $p<.001$ ), indicating that the model was able to distinguish between individuals who did ( $n=135$ ) and did not ( $n=1847$ ) meet criteria for an eating disorder. As shown in Table 4, of the three exercise variables, only compulsive and compensatory exercise made a unique statistically significant contribution to the model. Results suggest that individuals who engaged in compulsive exercise were almost 4 times more likely to meet criteria for an eating disorder, and that individuals who endorsed compensatory exercise were over 3 times more likely to meet criteria for an eating disorder, compared to those who did not endorse these features, respectively. In contrast, those endorsing excessive exercise demonstrated no significant increase in risk for having an ED diagnosis in the multivariate model. Finally, there were no significant sex by exercise variable interactions, indicating that associations between defining features of unhealthy exercise and ED diagnosis did not differ between men and women.

## Discussion

The current study examined the relative ability of excessive, compulsive, and compensatory aspects of unhealthy exercise to predict disordered eating and likelihood of meeting criteria for an eating disorder diagnosis. Consistent with previous findings (Adkins & Keel, 2005; Mond et al., 2004; Seigel & Hetta, 2001; Taranis & Meyer, 2011), the compulsive element of unhealthy exercise was a better predictor of disordered eating than excessive quantity of exercise. Results extend prior findings by demonstrating that the compensatory quality of unhealthy exercise significantly predicted scores on the EDI Bulimia and Drive for Thinness subscales and the Restraint Scale, independent of the contribution of compulsive exercise. Finally, both compulsive and compensatory aspects of unhealthy exercise were predictive of meeting criteria for an eating disorder diagnosis in both men and women.

Findings confirm that compulsive and compensatory qualities are distinct from each other (only 16.7% of men and 20.4% of women reporting either compulsive or compensatory exercise engaged in both), and both contribute to identifying unhealthy exercise that is linked to eating disorders. Results support that exercise specifically to compensate for episodes of overeating (compensatory exercise) is not adequately captured by only assessing whether individuals exercise to influence weight/shape or body definition because only half of individuals engaging in compensatory exercise reported exercising primarily to influence weight/shape or body definition. Thus, previous studies that assessed only whether individuals exercise to influence weight/shape or body definition and did not ask questions directly related to the compensatory aspect of unhealthy exercise (e.g., Adkins & Keel, 2005; Mond et al., 2004, 2006, 2008; Taranis & Meyer, 2011) might have missed an important defining feature of unhealthy exercise. In addition to the low amount of overlap observed among the compulsive and compensatory aspects of unhealthy exercise, overlap between both compulsive and excessive aspects and compensatory and excessive aspects of unhealthy exercise were less than 12% for both men and women. Overall, this underscores the importance of developing and expanding measures that detect differential links between specific aspects of exercise and eating pathology (Taranis & Meyer, 2011).

A secondary aim of the study was to compare different forms of unhealthy exercise as they relate to prevalence, overlap, and gender distribution. Gender differences were observed for



excessive exercise and compensatory exercise, such that significantly more men reported engaging in excessive exercise and significantly more women endorsed compensatory exercise. However, no differences in gender distribution were observed for compulsive exercise, consistent with results from Matheson and Crawford-Wright (2000) who reported that a similar number of men and women were classified as obligatory (compulsive) exercisers. This highlights the importance of assessing compulsive exercise in both males and females when attempting to identify disordered eating. Despite differences in prevalence of excessive and compensatory aspects of unhealthy exercise, no gender differences were observed for overlap of each aspect of unhealthy exercise. Given that compulsive exercise did not demonstrate gender differences in prevalence or overlap and was a robust predictor of disordered eating and eating disorder diagnoses in both men and women, these findings suggest that expanding the definition of unhealthy exercise to include compulsive features may be particularly useful in capturing eating disorder cases that could otherwise be missed in men. In contrast, relying less on the excessive aspect on unhealthy exercise may minimize false positives, particularly among men. Importantly, this does not mean that excessive exercise is a healthy or normative behavior, but that it was not indicative of an eating disorder after accounting for the compulsive and compensatory aspects of exercise in this sample.

These findings have important implications for the identification of disordered eating behaviors in different populations for intervention. For instance, conceptualizing unhealthy exercise in terms of its compulsive and/or compensatory quality may help aid in the detection of unhealthy eating attitudes and behaviors in athletes, who can be at increased risk for eating-related pathology (Stirling & Kerr, 2012). Exercising at high frequencies is a typical, and often necessary, behavior among athletes. While excessive exercise may be present among athletes (e.g., exercising above and beyond an already demanding training schedule) and represent one way to detect unhealthy exercise in this population, our results suggest that it may be useful to assess the presence of compulsive and/or compensatory aspects of exercise in male and female athlete populations. Specifically, identifying compulsive and compensatory aspects of unhealthy exercise in athletes may help identify those who may have eating disorders and benefit from cognitive-behavioral interventions. Future research should consider peer-led, group-based interventions (e.g., Becker et al., 2010), which may provide particular benefits as they can be disseminated more broadly than individual interventions and are designed to work within peer groups that share values.

The present study has several strengths. Data came from a randomly selected college-based population, including men and women sampled from late adolescence to mid-life and represent the first study to extend the examination of the multi-dimensional nature of unhealthy exercise to men. Measures demonstrated strong psychometric properties, and data were collected with self-report measures. Self-report assessments have been associated with greater self-disclosure compared to interview-based assessments, potentially due to the greater anonymity associated with self-report in larger survey studies of potentially stigmatizing behaviors (Keel et al., 2002). The size of the study sample provided adequate power for detecting differences in relationships between various exercise variables and measures of disordered eating. This further allowed for the first head-to-head comparisons of the excessive, compulsive, and compensatory aspects of exercise in their associations with dimensional measures of disordered eating and eating disorder diagnoses.

While the present study possesses several strengths, there are also limitations worth discussing. First, participants from the study came from a selective northeastern university; thus, results may not generalize to individuals with dissimilar demographic features. In addition, each aspect of unhealthy exercise was measured based on responses to single-item assessments, which are associated with lower reliability and may provide less robust

information than psychometrically validated multi-item scales (Taranis, Touyz, & Meyer, 2011). Data came from a large epidemiological study examining a range of health and eating behaviors; thus, the number of items devoted to examining dimensions of unhealthy exercise was limited. However, given the desire to distinguish between different aspects that characterize exercise as pathological, it was important to avoid existing multi-item assessments that potentially blur distinctions or do not directly assess the compensatory aspect of unhealthy exercise. Further, examining unhealthy exercise within a large community-based sample is essential to avoid bias inherent in treatment-seeking samples of patients with eating disorders. Thus, items used in the current study aimed to directly measure distinct aspects of unhealthy exercise while also limiting participant burden in this comprehensive community-based study. Finally, the threshold for “excessive” used in the current study may not have been stringent enough to adequately capture pathology in that group. While the definition of excessive exercise used in the current study included aspects of excessive duration and frequency, it did not measure intensity of exercise. Thus, it is possible that the items used may have been less sensitive than multi-item measures of excessive exercise that have included high intensity as an important component of its definition. There is no clear cut-off used across studies for what is considered exercise that is in excess of duration, frequency, and intensity of what is normally required for physical health and thresholds vary considerably across studies. Difficulty defining what threshold of exercise makes it unhealthy may undermine evaluation of this aspect of the definition and have influenced prevalence of this aspect of unhealthy exercise and its associations with disordered eating. However, the definition used in the current study was similar to or exceeded most thresholds used to define an “excessive” amount of exercise in previous studies and also exceeded current US guidelines for healthy exercise for adults.

In addition, the single-item measure of the compulsive aspect of unhealthy exercise largely focused on the affective component of compulsive exercise and did not measure other components of the compulsive aspect of unhealthy exercise included in existing multi-item measures (e.g., exercising despite illness or injury, preoccupation with thoughts of exercise, and engaging in exercise that significantly interferes with important activities). Importantly, although there are problems with assessing compulsive exercise with one item, the associations between compulsive exercise and disordered eating in this study were similar to those reported in previous studies that have utilized validated multi-item measures of compulsive exercise. In addition, our single-item measure showed a strong association with the CES in a separate sample, supporting the validity of our assessment of compulsive exercise. Thus, despite the clear limitations in how we were able to assess our three constructs, we were still able to discern meaningful patterns in the study’s results.

Our cross-sectional design permitted examination of concurrent associations between exercise variables and disordered eating, which is important for addressing our central question regarding what aspects of unhealthy exercise are most strongly associated with eating pathology. However, the cross sectional design does not permit temporal conclusions. Thus, it remains unclear whether compulsive and compensatory features of unhealthy exercise may increase risk for eating disordered behavior or whether eating disordered behaviors may increase risk for unhealthy exercise. Previous research shows some evidence that unhealthy exercise may be more likely to occur in individuals recovering from use of more extreme weight control behaviors, such as self-induced vomiting or laxative abuse (Hubbard, Gray, & Parker, 1998). Prospective longitudinal studies would allow researchers to determine the direction of the association.

Because unhealthy exercise may serve to maintain eating pathology, several treatment programs have been developed that incorporate targeting unhealthy exercise attitudes and behaviors into the treatment. For example, Thien, Thomas, Markin, and Birmingham (2000)

examined the effectiveness of adding a graded exercise program in the treatment of AN in an outpatient setting. Patients randomized to the graded exercise program reported significantly higher quality of life three months later. Importantly, the graded exercise program was associated with higher quality of life but did not compromise the rate of weight gain in the patients, consistent with results from a similar study which examined the effects of including an anaerobic exercise program in inpatient settings on weight restoration (Touyz, Lennerts, Arthur, & Beumont, 1993). More recently, Hay and colleagues have developed the LEAP program for treatment-seeking individuals with AN and BN, which educates patients to relearn non-compulsive attitudes towards exercise (Hay, Arcelus, & Touyz, 2011). Incorporation of such programs in eating disorder treatment settings could increase treatment compliance in eating disorder treatment programs and aid in preventing relapse into unhealthy eating and exercise behaviors. Similar programs aimed at the prevention of unhealthy exercise behaviors may be beneficial in community-based settings to educate individuals on healthy motivations for exercise (e.g., general health, enjoyment) and the prevention of unhealthy motivations for exercise (e.g., to reduce guilt, to compensate for over-eating). In particular, future community-based prevention efforts may benefit from targeting individuals at higher risk for developing unhealthy exercise and disordered eating behaviors, such as athletes.

In summary, the current study suggests that among the excessive, compulsive, and compensatory aspects of unhealthy exercise, compulsive and compensatory forms of exercise show the strongest associations with disordered eating and eating disorder diagnoses. Importantly, although compulsive and compensatory forms of unhealthy exercise are related, they may also exist independent of each other. Prevalence estimates of the different aspects of unhealthy exercise from the current study indicate that these exercise behaviors are surprisingly common, underscoring the importance of identifying and addressing such behaviors.

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### Highlights

- Forms of unhealthy exercise are compared on associations with eating pathology
- Compulsive and compensatory forms of exercise best predict eating disorder status
- Compulsive and compensatory exercise represent overlapping, yet distinct qualities
- Compulsive exercise may improve identification of eating disorders, particularly in men

Table 1

Gender Differences in Prevalence and Overlap of Excessive, Compulsive, and Compensatory Aspects of Unhealthy Exercise

Aspect of Unhealthy Exercise	Prevalence (%)			$\chi^2$ (1)	<i>p</i>
	Men	Women			
Excessive	8.3%	5.4%	5.94	.01	
Compulsive	2.7%	4.0%	1.79	.11	
Compensatory	4.4%	10.4%	18.50	<.001	
Excessive & Compulsive	1.0%	1.0%	0.02	.54	
Excessive & Compensatory	0.8%	1.6%	1.89	.12	
Compulsive & Compensatory	1.0%	2.4%	4.11	.03	
Excessive, Compulsive, & Compensatory	0.5%	0.6%	0.08	.53	
	Overlap (%)				
	Men	Women	$\chi^2$ (1)	<i>p</i>	
Excessive & Compulsive	10.2%	11.4%	0.01	.57	
Excessive & Compensatory	7.1%	11.8%	0.73	.27	
Compulsive & Compensatory	16.7%	20.4%	0.37	.36	
Excessive, Compulsive, & Compensatory	3.9%	4.1%	0.01	.58	

**Table 2**  
 Correlations Among Definitions of Unhealthy Exercise and Dependent Measures of Disordered Eating (N = 2060)

Variable	1	2	3	4	5	6
1. Excessive Exercise	--	0.17***	0.13***	0.06**	0.02	0.03
2. Compulsive Exercise		--	0.34***	0.21***	0.24***	0.25***
3. Compensatory Exercise			--	0.32***	0.35***	0.35***
4. EDI Bulimia				--	0.68***	0.70***
5. EDI Drive for Thinness					--	0.84***
6. Restraint Scale						--

\*\*  
*p* < .01

\*\*\*  
*p* < .001

Table 3

Regression Analysis Predicting Score on EDI Bulimia, EDI Drive for Thinness, and RS Concern for Dieting Subscales<sup>a</sup>

Variable	Bulimia			Drive for Thinness			Restraint		
	$\beta$	S.E.	<i>t</i>	$\beta$	S.E.	<i>t</i>	$\beta$	S.E.	<i>t</i>
Sex	0.22	0.03	10.73***	0.32	0.04	16.20***	0.30	0.02	14.93***
Cohort	0.16	0.02	7.39***	0.08	0.02	3.92***	-0.01	0.01	-0.07
Excessive Exercise	-0.01	0.05	-0.46	0.00	0.00	0.00	0.00	0.00	0.00
Compulsive Exercise	0.11	0.07	5.07***	0.13	0.10	6.17***	0.13	0.06	6.13***
Compensatory Exercise	0.23	0.05	9.95***	0.26	0.07	11.73***	0.28	0.04	12.50***
Sex*Excessive Exercise	0.00	0.11	0.13	0.00	0.00	0.00	0.00	0.00	0.00
Sex*Compulsive Exercise	0.00	0.17	-0.20	0.02	0.23	1.16	0.04	0.15	1.85
Sex*Compensatory Exercise	0.02	0.13	0.98	-0.003	0.17	-0.14	-0.02	0.11	-1.05

<sup>a</sup> Analyses utilized square-root transformed values to correct for positive skew.\*\*\*  
 $p < .001$

**Table 4**  
 Logistic Regression Analysis Predicting Likelihood of Meeting Criteria for ED Diagnosis

	<b>B</b>	<b>S.E.</b>	<b>Wald</b>	<b>df</b>	<b>p</b>	<b>Odds Ratio</b>	<b>95% CI Lower</b>	<b>95% CI Upper</b>
Sex	1.23	0.30	16.31	1	<.001	3.41	1.90	6.18
Cohort	0.05	0.12	0.15	1	.697	1.05	0.84	1.31
Excessive Exercise	0.06	0.42	0.02	1	.891	1.06	0.46	2.42
Compulsive Exercise	1.36	0.38	13.17	1	<.001	3.90	1.87	8.14
Compensatory Exercise	1.15	0.28	16.99	1	<.001	3.17	1.83	5.49
Sex*Excessive Exercise	1.47	1.22	1.45	1	.229	4.34	0.40	47.41
Sex*Compulsive Exercise	0.23	1.04	0.05	1	.829	1.25	0.16	9.66
Sex*Compensatory Exercise	-1.25	0.75	2.79	1	.100	0.29	0.07	1.24
Constant	-3.96	0.37	112.43	1	<.001	0.02		