Journal of Emotion and Psychopathology
2023, Vol 1, Issue 1, 302-312
https://doi.org/10.55913/joep.v1i1.24

The Role of Emotion Dysregulation in Problematic Exercise in those with Eating Disorders

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Abstract

Problematic exercise is common in eating disorders (EDs) and is associated with poor treatment prognosis; thus, understanding factors associated with problematic exercise may help improve treatment outcomes. In non-clinical samples, emotion dysregulation has been associated with problematic exercise; however, longitudinal associations between emotion dysregulation and problematic exercise have not been examined in clinical ED samples. This study examined if (1) emotion dysregulating was associated with problematic exercise symptom severity and frequency of problematic exercise, and (2) early changes in emotion dysregulation during treatment predicted problematic exercise symptom severity and frequency of problematic exercise in a clinical ED sample. ED patients ($N = 207$) completed the Difficulties in Emotion Regulation Scale (DERS), the Eating Disorder Examination-Questionnaire, and the Excessive Exercise subscale of Eating Pathology Symptoms Inventory at admission, 1-month post-admission, and discharge. DERS total score was correlated with symptom severity and frequency of problematic exercise at admission. Furthermore, early changes in DERS total score from admission to 1-month predicted problematic exercise symptom severity but not frequency of problematic exercise at discharge. Thus, emotion dysregulation may maintain symptoms of problematic exercise but not frequency in EDs, providing initial evidence that targeting emotion dysregulation may help reduce symptom severity of problematic exercise.

Keywords. eating disorders, emotion dysregulation, emotion regulation, problematic exercise, compulsive exercise

Eating disorders (EDs) are serious psychiatric conditions characterized by maladaptive behaviors to control weight, including problematic exercise (American Psychiatric Association, 2013). Furthermore, EDs are associated with serious medical complications (Mehler et al., 2018) and increased mortality (Arcelus et al., 2011). Despite evidence-based treatments for EDs, up to 50% of individuals do not recover from EDs (Keel & Brown, 2010). Due to the serious health consequences associated with EDs, it is critical to understand factors that may be maintaining weight control behaviors in patients with EDs to help improve outcomes.

Exercise in EDs can be problematic in multiple ways, including being compulsive (i.e., driven or compelled), and/or excessive (i.e., high frequency or long duration) that interferes with occupational, social, and other responsibilities (Allegre et al., 2009; Berczik et al., 2012; Terry et al., 2004). Problematic exercise can be physically and interpersonally harmful, as individuals may continue to exercise despite a medical injury, and/or exercise despite impaired social relationships (Allegre et al., 2009; Berczik et al., 2012; Landolfi, 2012; Terry et al., 2004). Data support that up to 80% of individuals with anorexia nervosa restricting type (Dalle Grave et al., 2008) and 66% of those with bulimia nervosa engage in problematic exercise (Stiles-Shields et al., 2015). While problematic exercise is most common in anorexia nervosa restricting type compared to other ED diagnoses, problematic exercise is still present across the ED spectrum and is associated with symptom severity (Dalle Grave et al., 2008).

*Corresponding Author: Taylor R. Perry ✉ tperry2@albany.edu
Received: 13 April 2022 | Revision Received: 19 October 2022 | Accepted: 7 November 2022
Handling Editor: David A. Preece
Published by Black Swan Psychological Assessments Pty Ltd
www.emotionandpsychopathology.org

Problematic exercise has also been associated with poorer treatment outcomes (Carter et al., 2004; Caspe & Jabine, 1996; Dalle Grave et al., 2008; Solenberger, 2001; Stiles-Shields et al., 2015). Further, problematic exercise is one of the most common weight control behavior in EDs, and researchers have suggested that problematic exercise may lead to other compensatory behaviors such as self-induced vomiting and laxative abuse (Stiles-Shields et al., 2012). Taken together, studies demonstrate that problematic exercise is a common weight control behavior in EDs that may lead to worse treatment prognosis. Therefore, it is critical to understand factors that might maintain problematic exercise.

One factor that may maintain problematic exercise is emotion dysregulation (i.e., difficulty regulating negative emotions). Previous research has documented that individuals with EDs have difficulties with emotion regulation (Anderson et al., 2018; Haynos & Fruzzetti, 2011; Lavender et al., 2015). Affect regulation theory postulates that problematic exercise may be both positively reinforced (e.g., evoking positive emotion from exercise) and negatively reinforced (e.g., to alleviate negative feelings) (Meyer et al., 2011). Consistent with this theory, previous cross-sectional research highlights that individuals with EDs are more likely to engage in exercise to cope with negative emotions, and to manage stress compared to healthy controls (Bratland-Sanda et al., 2010; Long et al., 2009; Shroff et al., 2006).

While research to date has not examined if there is a relationship between difficulties in emotion regulation and problematic exercise in a clinical ED sample, it is plausible to assume that this relationship may exist given findings from non-clinical samples (Goodwin et al., 2012, 2014). In a cross-sectional non-clinical sample of adolescents, internal dysfunctional emotion regulation (e.g., dealing with situations by engaging in negative behaviors such as harming or punishing oneself) was uniquely associated with problematic exercise (Goodwin et al., 2012). Longitudinal studies have also demonstrated that emotion dysregulation predicts problematic exercise at one-year follow-up in a non-clinical sample (Goodwin et al., 2014). Taken together, these studies support that emotion dysregulation may maintain problematic exercise. Furthermore, while previous research highlights that emotion dysregulation may be associated with problematic exercise symptom severity (e.g., exercising despite an injury, planning one's days around exercise, being bothered by missing a day of exercise) it is unclear if emotion dysregulation is associated with problematic exercise frequency. To date, research has not examined if emotion dysregulation is associated with symptom severity and frequency of problematic exercise in a clinical ED sample. A better understanding of the relationship between emotion dysregulation and both problematic exercise severity and frequency could help inform interventions, as exercise frequency is often a more common treatment target than symptom severity.

While previous research highlights that there is a link between emotion dysregulation and problematic exercise, it is critical to examine whether improvements in emotion dysregulation predict improvement in problematic exercise, to refine theoretical models of problematic exercise and identify potential treatment targets. Previous research has demonstrated that emotion regulation improves throughout ED treatment and that improvements are associated with reductions in ED cognitions (Brown et al., 2020). While these findings suggest that improvements in emotion regulation may be important for ED symptom reduction, it remains unclear if improvements in emotion dysregulation are associated with decreased problematic exercise, as previous research has demonstrated that exercising to improve mood may be a motivator to exercise (Silberstein et al., 1988). Furthermore, previous research has demonstrated that improvements in the first month of ED treatment predict better treatment outcomes at discharge (Vall & Wade, 2015). Thus, it may be important to examine if early changes in emotion dysregulation in the first month of treatment predict problematic exercise at discharge from treatment.

Therefore, the present study sought to examine associations between problematic exercise and emotion dysregulation in a clinical ED sample. This study aimed to examine if 1) emotion dysregulation was associated with problematic exercise symptom severity and frequency of problematic exercise, and 2) if early changes in emotion dysregulation predicted problematic exercise symptom severity and frequency of problematic exercise. As problematic exercise is theorized to have a bidirectional relationship with emotion dysregulation (Meyer et al., 2011), this study also had an exploratory aim, which sought to determine if early changes in problematic exercise symptom severity and frequency of problematic exercise predicted changes in emotion dysregulation. For Aim 1, we hypothesized that emotion dysregulation would be associated with greater problematic exercise symptom severity and frequency of problematic exercise sessions at admission. For Aim 2, due to prior research demonstrating that early improvements in treatment are associated with treatment response (Vall & Wade, 2015), we hypothesized that early improvements in emotion dysregulation would be associated with decreased problematic exercise

symptom severity and frequency of problematic exercise at discharge.

Materials & Methods

Participants & Procedures

Participants were adults (n = 125) and adolescents (n = 82) seeking treatment for an ED at a partial hospitalization program (PHP), that follows the structure of Dialectical Behavioral Therapy (DBT), for adults, and Family-Based Therapy (FBT) and DBT skills for adolescents. Participants were included if they had a length of stay for 60 days or greater, to ensure that there was sufficient time to capture associations between early change and outcomes. Data for the current study were derived from a larger treatment outcome study (see Brown et al., 2018; Reilly et al., 2020). The sample comprised primarily White (n = 172, 83.1%), female (n = 178, 86.0%), young adults (M_{age} = 21.79 ± 8.77, range = 11.92 – 64.06). The most common diagnosis was Anorexia Nervosa-Restricting type (n = 85, 41.1%) and the average body mass index at admission was 19.96 (SD = 4.21, range = 13.75 – 41.49). Over half the sample engaged in at least one problematic exercise episode 28 days before treatment (n = 118, 570%). Full demographic characteristics are displayed in Table 1.

All procedures for the current study were approved by the Institutional Review Board. Written and informed consent was provided by participants prior to completion of self-report assessments within two weeks of program admission. Additional assessments were administered 1-month post-admission and at discharge. The average length of treatment was 109.57 days (SD = 42.10; range = 60 – 246 days).

Participants completed a semi-structured clinical interview within two weeks of admission by trained bachelor's level research assistants or doctoral-level trainees. All interviewers completed rigorous assessment training conducted by clinical psychologists with extensive clinical assessment experience and conducted all interviews under observation until two clinical psychologists approved their competency. Interviewers were required to participate in an hour of weekly group supervision, where each case was presented, and diagnoses were determined based on group consensus.

Measures

Diagnostic Interviews.

Adult participants were assessed using the Structured Clinical Interview for the DSM-5, clinician version (SCID-5; First et al., 2015) or the Mini Neuropsychiatric Interview (MINI: Sheehan et al., 1997). Adolescent participants were assessed using the Schedule for Affective Disorders and Schizophrenia for School-Age Children (KSADS; (Kaufman et al., 1997), or the Mini International Neuropsychiatric Interview for Children and Adolescents (MINI-KID; Sheehan et al., 2010). During the diagnostic interviews participants reported how old they were when their ED began, and age of onset was subtracted from their current age to determine length of illness.

Table 1. Sample Demographic Information at Admission

Variable	*n* (%)	Variable	*n* (%)
Race		**ED Diagnosis**	
Caucasian	172 (83.1%)	AN-R	85 (41.1%)
Asian	10 (4.8%)	AN-P	22 (10.6%)
Blac	4 (1.9%)	AN-BP	9 (4.3%)
Native Hawaiian/Pacific Islander	2 (1.0%)	BN-P	28 (13.5%)
Native American/Alaskan Native	1 (0.5%)	BN-NP	7 (3.4%)
Other	18 (8.7%)	ARFID	14 (6.8%)
Gender Identity	-	OSFED	-
Male	16 (7.7%)	Atypical AN	25 (12.1%)
Female	178 (86.0)	Subthreshold BN	4 (1.9%)
Other Identity	12 (5.8%)	Purging Disorder	10 (4.8%
Missing	1 (0.5%)	Other OSFED	2 (1.0%)
Ethnicity	-	USFED	1 (0.5%)
Non-Hispanic/Latinx	168 (81.2%)		
Hispanic/Latinx	39 (18.8%)		

Note. AN-R, anorexia nervosa, restricting subtype; AN-P, anorexia nervosa, purging subtype; AN-BP, anorexia nervosa, binge/purge subtype; BN-P, bulimia nervosa, purging subtype; BN-NP, bulimia nervosa, nonpurging subtype; ARFID, avoidant/restrictive food intake disorder; OSFED, other specified feeding/eating disorder; USFED, unspecified feeding or eating disorder.

Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004).

The DERS is a 36-item self-report questionnaire that assesses emotion dysregulation. Items are rated on a scale from 1 (almost never, 0 – 10%) to 5 (almost always, 91 – 100%), with higher scores indicating greater emotion dysregulation. The DERS has six dimensional subscales and one total score; the total score was used for this study. Internal consistency for the present study was good for all time points (α = .87 – .90).

Eating Pathology Symptoms Inventory (EPSI; Forbush et al., 2013).

The EPSI is a 45-item, self-report questionnaire that assesses both cognitive and behavioral dimensional symptoms associated with EDs over the most recent 4-week period. Items are rated on a scale from 0 (never) to 4 (very often). The dimensional subscales for the EPSI have displayed good to excellent internal consistency, good convergent validity, and reliability across a variety of settings (Forbush et al., 2013; Forbush et al., 2014; Richson et al., 2021). For the current study, we utilized the 5-item *Excessive Exercise* subscale to quantify the symptom severity of problematic exercise frequently observed in EDs. The Excessive Exercise subscale measures symptoms of compulsive exercise e.g., "I planned my days around exercise" and excessive exercise e.g. "I engaged in strenuous exercise at least 5 days per week". Thus, we will use the true scale name *Excessive Exercise* throughout the results section, although it measures both symptoms of excessive and compulsive exercise (i.e., problematic exercise). *Excessive Exercise* scores can range from 0 to 20, and our sample had good to excellent internal consistency at each time point throughout treatment (α = .87 – .93).

Eating Disorder Examination Questionnaire (EDE-Q; Fairburn & Beglin, 1994; 2008).

The EDE-Q is an adapted 41-item, self-report version of the Eating Disorder Examination that requests participants endorse any disorder eating symptoms over the past 28 days. To measure problematic exercise frequency, we used item 18 from the EDE-Q (hereinafter referred to as EDE-Q 18), which assesses frequency of compulsive exercise, "*Over the past 28 days how many times have you exercised in a "driven" or "compulsive" way as a means of controlling your weight, shape, or amount of fat, or to burn off calories*". For the current study, this measure was used in addition to the EPSI, as the EDE-Q provides behavioral frequencies for compulsive exercise (which is referred to as problematic exercise in this study), whereas the EPSI provides a dimensional score that provides a severity index.

Statistical Analysis Plan

Data analyses were run in IBM SPSS, version 27, and were screened for assumptions of normality. The EPSI Excessive Exercise subscale violated the assumption of normality and was positively skewed at admission, thus a square root transformation was conducted. All other variables conformed to assumptions of normality. Little's MCAR test supported that data were missing completely at random *p*s > .83; thus, multiple imputation was used to impute missing values for the DERS and EPSI Excessive Exercise. Data was not imputed for the EDEQ-18, given that this variable was zero-inflated. For Aim 1, to examine the association between DERS and EPSI Excessive Exercise and EDE-Q item 18 at admission Pearson's *r* correlations were conducted For Aim 2, to examine if early changes in DERS predicted EPSI Excessive Exercise at discharge, a linear regression was conducted. At step 1, admission EPSI Excessive Exercise and DERS were entered into the model. At step 2, DERS at 1-month (to evaluate early change) was entered into the model. To examine if early change in DERS predicted EDE-Q 18 at discharge, a zero-inflated negative binomial regression was conducted. Zero-inflated models are suitable for count data in which there is an overrepresentation of zero (i.e., absence of behavior). To correct for over dispersion resulting from the overrepresentation of zero in a dataset, zero-inflated models first generate a logistic regression predicting zero (i.e., patients who are behaviorally abstinent), and a count model (i.e., negative binomial regression) only examining the frequency of an occurrence (e.g., problematic exercise) among participants who engage in a behavior. Zero-inflated negative binomial regression models were generated using Rstudio *pscl* and *AER* packages (Jackman, 2010; Kleiber & Zeileis, 2008).

For the exploratory aims, linear regression analyses examined if early changes in EPSI Exercise predicted improvements in DERS at discharge (Step 1: admission EPSI Excessive Exercise (or EDE-Q-18), DERS; Step 2: 1-month EPSI Excessive (or EDE-Q-18). The EDE-Q 18 was positively skewed at admission and 1-month; thus, a square root transformation was conducted for exploratory analyses.

Results[1]

Associations between Emotion Dysregulation and Problematic Exercise

Results from descriptive statistics and correlation analyses are presented in Table 2.

DERS scores at admission were moderately correlated with severity of EPSI Excessive Exercise at admission, $r = .23$, $p = .001$. Furthermore, DERS scores at admission were moderately correlated with number of problematic exercise episodes in the past 28 days $r = .23$, $p < .001$. Thus, higher DERS scores were associated with higher EPSI Excessive Exercise severity and frequency of problematic exercise.

Changes in Emotion Dysregulation Predicting Problematic Exercise

Age, BMI, length of illness, and length of stay were examined as potential covariates, given that lower BMI and younger age have been associated with problematic exercise in previous studies (Shroff et al., 2006), and that length of treatment stay could influence symptom severity and problematic exercise frequency at discharge. Furthermore, length of illness was examined as potential covariate, due to shorter duration of illness being associated with better treatment outcomes (Vall & Wade, 2015). However, these variables were not associated with EPSI Excessive Exercise severity or EDE-Q exercise frequency at discharge and therefore, were not included in the final models. Results from linear regression analyses predicting severity of problematic exercise are presented in Table 3. After controlling for admission DERS and EPSI Excessive Exercise scores, DERS at 1-month predicted increases EPSI Excessive Exercise symptom severity at discharge above and beyond admission DERS and EPSI scores ($p = .042$).

Zero-inflated negative binomial regression results predicting the frequency of problematic exercise episodes are presented in Table 4. For the logistic regression model predicting abstinence from problematic exercise (i.e., predicting zero), early changes in DERS scores were not associated with abstinence of problematic exercise at discharge. Similarly, in the count model early changes in DERS scores were not significantly associated with frequency of problematic exercise at treatment discharge.

Changes in Problematic Exercise Predicting Emotion Dysregulation

Results from exploratory linear regression analyses predicting difficulties in emotion regulation are presented in Table 3. After controlling for admission DERS and EPSI Excessive Exercise scores, higher EPSI Excessive Exercise at 1-month predicted increases in DERS symptom severity at discharge $p = .004$ (see Table 3). After controlling for admission DERS and EDE-Q- 18 problematic exercise frequency, problematic exercise frequency at 1-month predicted increases in DERS symptom severity at discharge $p = .005$ (see Table 3).

Discussion

This study sought to examine the relationship between emotion dysregulation and problematic exercise in a clinical ED sample at admission to treatment, and if changes in emotion dysregulation early in treatment predicted problematic exercise at discharge. Results were consistent with previous research demonstrating that problematic exercise is a common behavior in those with EDs (Dalle Grave et al., 2008; Stiles-Shields et al., 2015). Results from the present study demonstrate that emotion dysregulation is associated with symptom severity of problematic exercise and frequency of problematic exercise in a treatment-seeking ED sample. Specifically, those who had greater emotion dysregulation had more severe symptoms of problematic exercise and greater number of problematic exercise episodes at admission. Consistent with our hypotheses, results from regression models demonstrated that greater early decreases in emotion dysregulation predicted decreases in problematic exercise symptom severity. However, contrary to our hypothesis, early changes in emotion dysregulation did not predict likelihood of abstinence from, or frequency of, problematic exercise at discharge. Additionally, greater early reductions in problematic exercise symptom severity and frequency of problematic exercise predicted decreased emotion dysregulation at discharge.

[1] Sensitivity analyses were run to determine if there were differences in the association between changes in emotion dysregulation and problematic exercise at discharge in adolescents and adults. In the adolescent sample emotion dysregulation did not predict problematic exercise (B = .04, $p = .10$). Furthermore, in the adult sample, emotion dysregulation also did not predict problematic exercise (B = .04, $p = .17$). The beta values for the sensitivity analyses were equivalent to the beta values of analyses with the full sample (i.e., adolescents and adults combined). Due to having multiple R^2 values, from multiple imputation we calculated post-hoc power analyses from largest to smallest effect for both the adolescent and adult samples. In the adolescent sample power ranged from .2-.6, and in the adult sample power ranged from .1 – .7. Due to the beta values being identical for all analyses (i.e., adolescent, adult, and full sample), it is likely the reason, that early changes in difficulties in emotion regulation did not predict problematic exercise was due to being under powered in the sub samples.

Table 2. Descriptive Statistics and Correlations for Problematic Exercise

Variable	*n*	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. Age	207	21.8 (8.8)												
2. BMI	207	.33***	20 (4.2)											
3. Length of Illness	200	.86***	.41***	7.3 (8.4)										
4. Treatment Duration	207	.20**	-.02	.16*	109.6 (42.1)									
5. EPSI Exercise (Admit)	200	.12	.10	.07	.13	8.2 (6.8)								
6. EPSI Exercise (1-month)	190	.12	.14	.11	.06	.67***	5.7 (5.9)							
7. EPSI Exercise (Discharge)	180	.13	.14	.11	.03	.56***	.69***	4.3 (4.8)						
8. EDE-Q Exercise[a] (Admit)	200	.07	.04	-.007	.15*	.60***	.59***	.37***	7 (11)					
9. EDE-Q Exercise[a] (1-month)	192	.03	.05	.03	.03	.44***	.68***	.50***	.64***	4.5 (8.9)				
10. EDE-Q Exercise[a] (Discharge)	180	.01	-.02	.05	.07	.25***	.43***	.59***	.23***	.55***	2.1 (.6)			
11. DERS Total (Admit)	198	.19**	.24***	.27***	.20**	.23***	.26***	.24***	.23***	.21**	.15*	114 (27.9)		
12. DERS Total (1-month)	172	.16*	.10	.18*	.16*	.22**	.35***	.29***	.27***	.24***	.20*	.69***	109.5 (25.7)	
13. DERS Total (Discharge)	152	.03	.03	.10	-.03	.09	.26**	.41***	.09	.25**	.26***	.47***	.50***	97.3 (24.7)

Note. EPSI, Eating Pathology Symptom Inventory; DERS (Admit), Difficulties in Emotion Regulation Scale at treatment admission; EDE-Q 18; Eating Disorder Examination-Questionnaire question 18. Descriptive statistics (*M*[*SD*]) are presented on the diagonal.

*$p < .05$, **$p < .01$, ***$p < .001$

[a] EDE-Q item 18 assesses the frequency of problematic exercise episodes

Table 4. Linear Regression Analyses Predicting Excessive Exercise and Emotion Regulation Across Treatment

DV = Excessive Exercise (Discharge)						
	Adj. R^2	B	*se*	*t*	*p*	95% CI
Step 1	.268-.323		F = 38.618 – 52.038, *ps* < .001			
EPSI Excessive Exercise (Admit)		.37	.05	8.14	<.001	.278, .456
DERS Total (Admit)		.03	.01	1.73	.085	-.002, .038
Step 2	.280-.350		F = 34.276 – 38.021, *ps* < .001			
EPSI Excessive Exercise (Admit)		.36	.05	8.09	<.001	.274, .451
DERS Total (Admit)		-.006	.02	-.40	.687	-.036, .024
DERS (1-month)		.04	.02	2.09	.042	.001, .072
DV = Emotion Dysregulation (Discharge) [a]						
	Adj. R^2	B	*se*	*t*	*p*	95% CI
Step 1	.186-.263		F = 24.585 – 37.747, *ps* < .001			
EPSI Excessive Exercise (Admit)		-.02	.27	-.09	.933	-.552, .507
DERS Total (Admit)		.44	.07	6.33	<.001	.296, .574
Step 2	.235-.315		F = 21.906 – 32.590, *ps* < .007			
EPSI Excessive Exercise (Admit)		-.66	.32	-2.03	.044	-1.297, -.017
DERS Total (Admit)		.42	.07	5.94	<.001	.269, .547
EPSI Excessive (1-Month)		1.19	.40	2.95	.004	.383, 1.987
DV = Emotion Dysregulation (Discharge) [a]						
	Adj. R^2	B	*se*	*t*	*p*	95% CI
Step 1	.167-.255		F = 20.62 – 33.528, *ps* < .001			
EDE-Q-18 (Admit)		.06	.17	.37	.714	-.283, .410
DERS Total (Admit)		.44	.08	5.58	<.001	.276, .598
Step 2	.198-.269		F = 16.618 – 27.615, *ps* < .005			
EDE-Q-18 (Admit)		-.29	.20	-1.44	.153	-.685, .108
DERS Total (Admit)		.42	.08	5.46	<.001	.263, .581
EDE-Q-18 (1-Month)		.71	.25	2.83	.005	.215, 1.213

Notes. EPSI, Eating Pathology Symptom Inventory; DERS, Difficulties in Emotion Regulation Scale.
[a] denotes exploratory analysis

Table 3. Zero-Inflated Negative Binomial Regression Model for Problematic Exercise at Discharge

DV = Absence of Problematic Exercise at Discharge						
Zero-Inflated Model	B	*SE*	*z*	*p*	Exp(B)	95% CI for Exp(B)
Intercept	4.04	1.71	2.36	.02	56.84	1.98, 1633.66
EDE-Q 18 (Admit)	-.37	.17	-2.13	.03	.69	.49, .97
DERS Total (Admit)	-.005	.02	-.22	.83	.99	.96, 1.04
DERS Total (1-month)	-.03	.02	-1.10	.27	.98	.93, 1.02
DV = Frequency of Problematic Exercise at Discharge						
Count Model	B	*SE*	*z*	*p*		
Intercept	.05	1.08	.05	.96		
EDE-Q 18 (Admit)	.02	.02	1.0	.31		
DERS Total (Admit)	-.007	.01	-.51	.61		
DERS Total (1-month)	.02	.02	1.08	.28		
Log-likelihood = -889, *df* = 9						

Notes. DERS, Difficulties in Emotion Regulation Scale; EDE-Q 18, Eating Disorder Examination-Questionnaire (problematic exercise frequency); CI, confidence interval.

While this is the first study to demonstrate associations between problematic exercise and emotion dysregulation in a clinical ED sample, these results extend previous findings in non-clinical samples that have demonstrated an association between problematic exercise and emotion dysregulation (Goodwin et al., 2012; 2014). Overall, our results are consistent with findings that individuals with EDs may exercise to cope with negative emotions (Bratland-Sanda et al., 2010; Long et al., 2009; Shroff et al., 2006). Our results suggest that improving emotion dysregulation may decrease the symptom severity, but not frequency, of problematic exercise. While early changes in emotion dysregulation did not predict frequency of problematic exercise at discharge, this could be because individuals may still be engaging in driven exercise, but their exercise may not be as strenuous or excessive, which is captured by the EPSI, but not EDE-Q18.

The findings from this study support the affect regulation theory for exercise, which posits that individuals with EDs may engage in problematic exercise to regulate their emotions (Meyer et al., 2011). Previous research has suggested that high levels of positive and negative affect are associated with weight loss behaviors (e.g., problematic exercise) and may be maintained by positive affect (Selby et al., 2015), which has led to a new theoretical model of problematic exercise in those with anorexia nervosa (Coniglio et al., 2021). Coniglio and colleagues (2021) theorize that problematic exercise may be maintained through reward (i.e., weight loss) and the escape from negative emotions. While the current study suggests that emotion dysregulation and problematic exercise may maintain one another, future research is needed to determine the influence of emotion dysregulation and positive affect on problematic exercise.

Our results also suggest that decreasing symptoms of problematic early in treatment may improve emotion dysregulation, which supports the theory that the relationship between emotion dysregulation and problematic exercise may be bidirectional and potentially maintain one another (Meyer et al., 2011). While problematic exercise may be used as an emotion regulation strategy prior to or early on in treatment, acquisition of adaptive skills to regulate emotions during treatment may in turn reduce problematic exercise and has been shown to significantly reduce other ED symptoms (Brown et al., 2019). Alternatively, as patient treatment plans often included prescriptions to abstain from exercise, reductions may also reflect treatment compliance. Additional research is needed to understand if individuals are alleviating negative feelings in general, or feelings specific to ED cognitions when they engage in problematic exercise.

This study benefited from several strengths, including the use of a transdiagnostic clinical sample of EDs and validated self-report measures. This study also benefited from measuring both symptom severity of problematic exercise and frequency of problematic exercise to understand whether emotion dysregulation was related to both dimensional and behavioral constructs. Despite these strengths, our findings should be considered in light of several limitations. First, our assessment of problematic exercise did not purely measure symptoms of compulsive exercise, but rather symptoms of compulsive and excessive exercise, although excessive exercise often accompanies compulsive exercise (Wyatt, 1997). Furthermore, using a single retrospective item for frequency problematic exercise episodes may lack reliability. Our sample was also comprised of patients in PHP; thus, our findings may be indicative of the limited opportunity to engage in exercise given the duration of the program (6-10 hours/day up to six days a week). Furthermore, since participants in this study were receiving Dialectical Behavioral Therapy-based treatment, which targets emotion dysregulation and self-damaging behaviors, it is unclear to what extent these results can be generalized to other levels of care and other treatment modalities. Our sample was comprised of predominately white, non-Hispanic, girls and women; thus, our results may not be generalizable to other demographics. Furthermore, this study lacked a control group. Thus, it is unclear if improvements in emotion dysregulation are associated with a reduction in problematic exercise in individuals who do not have an ED. Finally, while we were unable to detect if emotion dysregulation predicted problematic exercise in adolescents and adults separately due to insufficient power, beta values were equivalent across age groups and the full sample. Thus, it is plausible that there is a relationship between emotion dysregulation and problematic exercise in adolescent and adult samples. Future research should examine if age is a moderator between emotion dysregulation and problematic exercise in clinical ED samples.

In sum, results are consistent with the idea that emotion dysregulation may play a role in symptoms of problematic exercise in those with EDs. Given that problematic exercise has been associated with increased ED severity (Dalle Grave et al., 2008) and poor treatment prognosis (Carter et al., 2004; Caspe& Jabine, 1996; Dalle Grave et al., 2008; Solenberger, 2001; Stiles-Shields et al., 2015), results from this study help clarify the clinical relevance of emotion dysregulation in maintaining symptoms of problematic exercise in patients with EDs. Results from this study demonstrate the importance of factors related to problematic exercise in patients with EDs. Results

suggest that targeting emotion dysregulation in ED treatment may help to decrease symptom severity of problematic exercise. However, results do not indicate that targeting emotion regulations will reduce frequency of problematic exercise. Future research is needed to examine processes that may be maintaining the frequency of problematic exercise. Given that improvements in emotion regulation skills are associated with decreased ED cognitions (Brown et al., 2020), these skills may also address symptoms of problematic exercise.

Future research should examine which emotion regulation skills specifically contribute to decreased problematic exercise, to help inform future treatment development. Furthermore, future research should examine if early improvements in emotion dysregulation predict sustained decreases in problematic exercise symptom severity exercise episodes following discharge from treatment.

Additional Information

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. TAB is supported by the Arlene and Michael Rosen Foundation and CEW is supported by the National Institute of Mental Health (R01MH113588, R21MH118409).

Conflict of Interest

The authors have no conflict to declare.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author CRediT Statement

Taylor Perry: Conceptualization; writing-original draft; writing- review and editing. Dominic Denning: writing-original draft; writing- review and editing. Walter Kaye: reviewing and editing: Christina Wierenga: reviewing and editing; Tiffany Brown: Conceptualization; reviewing and editing; supervision.

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