



Associations among eating disorder symptoms and the Minnesota Multiphasic Personality Inventory-2-Restructured Form (MMPI-2-RF) in college students

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Abstract

Purpose To identify associations between eating disorder (ED) attitudes and behaviors and scores on the MMPI-2-RF in college students.

Methods The study included 425 undergraduate students (38.5% males and 61.5% females) with a mean age of 19.13 (SD = 1.77). Measures included the MMPI-2-RF and the Eating Disorder Examination Questionnaire. Correlations and relative risk ratios were computed between MMPI-2-RF scores and ED variables.

Results Scores on several MMPI-2-RF Scales were associated with the presence of subthreshold ED symptoms. Manifestations of emotional/internalizing dysfunction were associated with all ED symptom presentations.

Conclusions The results of this study identified narrowly defined personality and psychopathology constructs relevant to, and found across college students experiencing various subthreshold ED symptoms. Considering this additional information in ED screening or treatment planning could reduce the likelihood of subthreshold symptoms worsening and increase the effectiveness of ED interventions with at-risk college student populations.

Level of evidence Level III, evidence obtained from well-designed cohort or case–control analytic studies.

Keywords Eating disorders · MMPI-2-RF · Personality assessment · College students

Introduction

Over the last half-century, there has been an increase in the prevalence rates of eating disorders (EDs), which represent high-risk disorders and a major public health concern owing to elevated mortality rates found in individuals with these conditions [1–3]. Research has found that ED symptoms are present in a significant percentage of college students. For example, Lipson and Sonnevile examined the prevalence of ED symptoms in students from 12 universities, who were classified into 3 groups: at-risk for an ED, a binge eating group, and a compensatory behavior group [4]. Participants could belong to more than one group depending on the ED

symptoms endorsed (e.g., elevating a subscale of the EDE-Q and engaging in binge eating). ED risk was determined by a score at or above 3 on the Global subscale of the Eating Disorder Examination Questionnaire (EDE-Q). The Global subscale of the EDE-Q is the average of the participants' scores on the other four EDE-Q subscales (Restraint, Eating Concern, Shape Concern, and Weight Concern). Binge eating was defined as one or more episodes of a loss of control over eating in the past 4 weeks. Compensatory behaviors were defined as one or more times in the past 4 weeks, vomiting, taking laxatives, diuretics, or diet pills, and/or exercising in a compulsive way as a means of weight control. This study demonstrated that subthreshold ED symptoms were present in a significant amount of college students, with 11.9% found to be at-risk for an ED, 40.2% reported at least one episode of binge eating in the past month, and 30.2% reported engaging in at least one compensatory behavior in the past month [4]. Given the significant rates of ED symptoms among college students, research aimed at identifying and better understanding ED symptoms that may be subthreshold is needed, as these individuals may be at an elevated risk for

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developing an ED and/or experiencing distress and impairment associated with their symptoms.

A considerable number of individuals with an ED experience comorbid psychological symptoms and disorders. Swinbourne and colleagues found that 65% of women with an ED also met criteria for a comorbid anxiety disorder [5]. Research has found significant rates of comorbid personality disorders (PDs) among women with anorexia nervosa (AN) or bulimia nervosa (BN), with borderline, obsessive–compulsive, and avoidant PDs being the most common [6]. Avoidant and obsessive–compulsive PDs are most commonly diagnosed in people with the restricting subtype of AN (AN-R) while borderline and avoidant PDs are more commonly diagnosed in people with the binge eating/purging subtype of AN (AN-BP) and BN [6, 7]. De Bolle and colleagues found that global functioning was significantly impaired among people diagnosed with AN or BN who also experienced comorbid internalizing or externalizing personality pathology [8]. In general, individuals diagnosed with an ED have been found to experience higher levels of emotional/internalizing psychopathology marked by negative emotionality and perfectionism [9–12]. There has also been some research examining behavioral/externalizing psychopathology and EDs, with findings that increased levels of impulsivity and alcohol use were associated with BN symptoms [13, 14]. In addition, individuals with BN have been found to have higher levels of impulsivity compared to non-ED controls and those with AN [11, 15]. In particular, those diagnosed with AN-B demonstrated higher levels of negative and positive urgency compared to those diagnosed with AN-R, highlighting that impulsivity may be more related to the binge eating or purging behaviors associated with EDs [10, 11, 15]. Individuals diagnosed with AN-BP or BN were found to be lower on self-directedness than those diagnosed with AN-R [11, 16]. Personality traits associated with ED diagnoses have also been examined. For example, Garrido and colleagues found that participants diagnosed with AN had higher scores on neuroticism and openness to experience and lower scores on agreeableness, conscientiousness, and extraversion compared to non-ED controls. Additionally, participants diagnosed with BN had higher scores on neuroticism, extraversion, and conscientiousness compared to non-ED controls [17]. Taken together, these findings suggest that assessment of psychopathology and personality may assist in tailoring ED interventions to target comorbid disorders, maladaptive personality traits, and problematic behaviors.

Current study

Elucidating associations between personality and psychopathology and ED symptoms may improve our understanding of EDs, contribute to their early detection, guide interventions, and improve treatment outcomes. Moreover,

examining associations between more narrowly defined personality and psychopathology constructs and specific ED attitudes and behaviors, rather than focusing on full-syndrome ED diagnoses, can advance our understanding of commonly shared and/or differentiating personality constructs across various manifestations of ED symptoms and behaviors. The current study seeks to contribute to this effort by examining associations between ED symptoms and scores on a commonly used broadband measure of personality and psychopathology, the Minnesota Multiphasic Personality Inventory-2-Restructured Form (MMPI-2-RF) [18].

The MMPI-2-RF is a self-report measure of personality and psychopathology which is comprised of 338 true–false items. The items are scored on 9 Validity Scales and 42 Substantive Scales. The Substantive Scales of the MMPI-2-RF are organized into a hierarchical framework with broad substantive domains, in line with contemporary theories of personality and psychopathology [18, 19]. Within this framework, there are three broad higher-order scales measuring emotional/internalizing dysfunction, behavioral/externalizing dysfunction, and thought dysfunction. There are nine Restructured Clinical (RC) Scales measuring the psychological constructs of demoralization, somatic complaints, low positive emotions, cynicism, anti-social behavior, ideas of persecution, dysfunctional negative emotions, aberrant experiences, and hypomanic activation. Furthermore, there are 23 Specific Problems Scales (5 Somatic/Cognitive, 9 Internalizing, 4 Externalizing, and 5 Interpersonal Scales), 2 Interest Scales (aesthetic-literary and mechanical-physical), and 5 scales assessing the Personality Psychopathology-Five (PSY-5) model [20]. The Specific Problems and Interest Scales are used to augment the higher order and RC Scales by assessing narrower, distinctive constructs and the PSY-5 Scales are measures of personality pathology. The MMPI-2-RF Technical Manual and scoring material include a college student comparison group, which can be used to facilitate use of the test when assessing this population [19].

We sought to investigate the ability of the MMPI-2-RF scores to identify associations with and risk for subthreshold ED attitudes and behaviors in college students. As discussed earlier, individuals experiencing these symptoms may be at an elevated risk for developing an ED and/or experiencing distress and impairment associated with their symptoms. Identifying more narrowly defined, specific facets of personality and psychopathology associated with ED symptom presentations can further our understanding of factors that may be contributing to the maintenance of subthreshold ED symptoms. Considering this information during screening and/or intervention may help to alleviate an individual's current distress and decrease the likelihood of subthreshold ED symptoms developing into a clinical ED.

Hypotheses

It was hypothesized that engaging in binge eating or compensatory behaviors would be associated with higher scores on the Behavioral/Externalizing Scales of the MMPI-2-RF, as previous research has demonstrated that people engaging in binge eating or compensatory behaviors are more likely to experience behavioral problems such as impulsivity or alcohol misuse [13–15]. It was also hypothesized that being at overall risk for an ED would be associated with higher scores on the Emotional/Internalizing Scales of the MMPI-2-RF, as previous research has demonstrated generally higher levels of internalizing psychopathology across ED presentations [8–11].

Materials and methods

Participants

Participants were selected from among 519 undergraduate students who consented to participate in a broader study at a large Midwestern University. The students received extra credit in their General Psychology course in exchange for completing a large number of measures including the ones used in the current investigation. Participants attended one session in which they completed a series of self-report measures administered by computer, including the MMPI-2-RF and EDE-Q. Participants were included in this study if they produced a valid and interpretable MMPI-2-RF protocol as recommended in the MMPI-2-RF Technical Manual (i.e., Cannot Say [CNS] < 18, Variable Response Inconsistency [VRIN-r] < 80, True Response Inconsistency [TRIN-r] < 80, Infrequent Responses [F-r] < 120, or Infrequent Psychopathology Responses [Fp-r] < 100) [19]. Of those who consented to participate, 425 students produced a valid MMPI-2-RF protocol. Within this sample, participants were composed of 38.5% males and 61.5% females with a mean age of 19.13 (SD = 1.77). 84.8% were Caucasian, 10.8% were African-American, 2.7% were Hispanic, and 1.7% were of another ethnicity. There was a significant difference in ethnic composition between those who produced a valid MMPI-2-RF protocol and those who produced an invalid MMPI-2-RF protocol. Specifically, African-American participants produced a significantly greater than expected proportion of invalid protocols $\chi^2(1) = 11.81, p = .001$. Although this resulted in a modest underrepresentation of African-American college students (12.7% in the original sample and 10.8% meeting inclusion criteria), our sample does represent the population of college students who would produce interpretable results on the MMPI-2-RF.

Measures

MMPI-2-RF

As previously detailed, the MMPI-2-RF is a self-report measure of personality and psychopathology comprising 9 Validity Scales and 42 Substantive Scales organized into a hierarchical framework with broad substantive domains [18]. Studies have demonstrated good reliability, validity, and generalizability for the MMPI-2-RF Scale scores in a variety of contexts, including medical, inpatient, and outpatient mental health, forensic, and non-clinical settings [20–26].

EDE-Q

The EDE-Q is a 28-item self-report measure that assesses the occurrence of attitudes, feelings, and behaviors associated with eating pathology over the past 28 days [27]. Twenty-two of the items are scored into four subscales: Restraint (Cronbach's alpha = .76), Eating Concern (Cronbach's alpha = .80), Shape Concern (Cronbach's alpha = .91), and Weight Concern (Cronbach's alpha = .86), as well as a Global score, which is an average of the subscale scores. The other six items are behavioral frequency questions measuring the number of times a person has engaged in binge eating or compensatory behaviors over the past 28 days. Adequate reliability and validity were found for the EDE-Q in this study and have been previously established for the EDE-Q in both clinical and non-clinical settings [28–30].

Statistical analyses

Subthreshold ED symptoms were determined from participants' scores on the EDE-Q subscales and their reported number of compensatory behaviors in the past 28 days. For the EDE-Q subscales, a score of 4 on each subscale was considered clinically elevated [31, 32]. Each subscale score at or above 4 was coded as a 1, and a score below 4 was coded as 0. Engagement in compensatory behaviors was captured by items asking the number of times in the past 28 days participants had vomited or taken laxatives as a means to control their weight or shape. The number of reported episodes for taking laxatives or vomiting as a means to control their weight was summed into one total compensatory behavior variable. This variable was then dichotomized so that engaging in at least one or more compensatory behaviors was coded as 1 and engaging in no compensatory behaviors was coded as 0. An overall subthreshold ED score was calculated by summing the dichotomized EDE-Q subscale variables and the dichotomized compensatory behavior variable (maximum score of 5). This score was then dichotomized, with a total score at or above 1 being considered a subthreshold ED ($n = 47$).

(12.8%) and a score of 0 being considered no subthreshold ED ($n = 320$) (87.2%). These rates are similar to Lipson and Sonnevile's study in which 11.9% of their sample was classified as at-risk for an ED [4]. While a Global subscale score can be calculated for the EDE-Q (average of the four EDE-Q subscale scores), this was not used to identify subthreshold EDs because it does not account for compensatory behaviors, which are important transdiagnostic ED behaviors. Therefore, we also included engaging in compensatory behaviors with the EDE-Q subscale scores to identify subthreshold EDs to create a more comprehensive and transdiagnostic ED variable.

Episodes of binge eating were captured by an EDE-Q item asking the number of times in the past 28 days a participant experienced an episode of overeating with a sense of loss of control over eating. The proportion of participants engaging in at least one self-reported episode of binge eating (40%) was considerably larger than that of those elevating at least one subscale of the EDE-Q (10%) or engaging in at least one compensatory behavior (4%). Although 40% is similar to the rate of binge eating reported by Lipson and Sonnevile, some investigators have questioned the reliability and validity of the binge eating frequency item on the EDE-Q [4, 33]. Therefore, to avoid inflating the risk variable, the binge eating frequency item was not included when creating the overall risk variable.

Independent sample *t* tests were first calculated to examine differences in MMPI-2-RF Substantive Scale scores between participants who were considered to have a subthreshold ED and those who did not. Effect sizes were calculated for MMPI-2-RF Scales with significant differences between the groups using Cohen's *d* to identify small (.20), medium (.50), and large (.80) mean differences. To control for Type 1 error, mean differences were considered significant if $p \leq .001$ and Cohen's *d* was of a medium magnitude difference or larger.

Pearson's product-moment correlations were then computed between the MMPI-2-RF Scale scores and the subthreshold ED variable, the individual EDE-Q subscale scores, the total number of reported binge eating episodes, and the total number of reported compensatory behaviors in the past 28 days. To control for Type 1 error, correlations were considered statistically significant at the $p \leq .001$ level.

Finally, relative risk ratios (RRRs) were computed for multiple MMPI-2-RF Substantive Scale score cutoffs (65 T, 70 T, and 75 T) to determine which MMPI-2-RF Scales predict increased risk for a subthreshold ED. RRRs were computed by dividing the risk of being classified as having a subthreshold ED for participants who scored at or above the designated MMPI-2-RF Scale score cutoff by the risk among the participants who scored below the MMPI-2-RF Scale score cutoff. RRRs are considered statistically significant if the 95% confidence interval did not include 1.

Results

Results of the independent sample *t* tests indicated significant mean differences between participants classified as having a subthreshold ED and those not classified as having a subthreshold ED on several of the MMPI-2-RF Substantive Scales (Table 1). The groups exhibited medium-to-large magnitude differences between scores on several Emotional/Internalizing and Somatic Dysfunction Scales (e.g., emotional/internalizing dysfunction, self-doubt, dysfunctional negative emotions, somatic complaints, low positive emotions, and gastrointestinal complaints).

Pearson's product-moment correlations indicated a number of significant associations between MMPI-2-RF Substantive Scale scores and the subthreshold ED variable, scores on the individual EDE-Q subscales, binge eating episodes in the past 28 days, and compensatory behaviors in the past 28 days (Table 2). The subthreshold ED variable was positively associated with scores on MMPI-2-RF Scales measuring emotional/internalizing dysfunction and somatic/cognitive dysfunction (e.g., emotional/internalizing dysfunction, gastrointestinal complaints, and self-doubt). Scores on the Weight Concerns subscale of the EDE-Q were positively associated with MMPI-2-RF Scales measuring emotional/internalizing dysfunction (e.g., dysfunctional negative emotions and self-doubt). Scores on the Shape Concerns subscale of the EDE-Q were positively associated with MMPI-2-RF Scales measuring emotional/internalizing and somatic/cognitive dysfunction (e.g., demoralization and gastrointestinal complaints). Binge eating was positively associated with MMPI-2-RF Scales measuring emotional/internalizing dysfunction (e.g., dysfunctional negative emotions and stress/worry). Lastly, engaging in compensatory behaviors was positively associated with the MMPI-2-RF Scale measuring anxiety.

The RRR analyses indicated that varying elevations (i.e., scores at or above 65 T, 70 T, and 75 T) on a number of the Substantive Scales of the MMPI-2-RF indicated an increased risk (2.00–4.05 times the risk) of subthreshold ED symptoms (Table 3). For example, a score at or above 65T on the scale measuring self-doubt was associated with a 4.05 times increased risk of subthreshold ED symptoms. Additionally, elevations on emotional/internalizing dysfunction, demoralization, somatic complaints, low positive emotions, dysfunctional negative emotions, malaise, gastrointestinal complaints, head pain complaints, cognitive complaints, suicide/death ideation, helplessness/hopelessness, inefficacy, stress/worry, anxiety, anger proneness, behavior-restricting fears, multiple specific fears, family problems, interpersonal passivity, negative emotionality/neuroticism, and introversion/low positive emotions were associated with an increased risk for a subthreshold ED.

Table 1 MMPI-2-RF Scale score differences between the subthreshold ED group and non-ED group

	At-risk (<i>n</i> =47)		Not at-risk (<i>n</i> =320)		<i>p</i>	Cohen's <i>d</i>
	Mean	SD	Mean	SD		
EID	63.67	11.46	54.48	10.79	< .001	.83
THD	58.23	9.37	56.36	11.69		
BXD	52.36	9.33	52.69	10.39		
RCd	65.68	10.89	57.66	10.32	< .001	.76
RC1	64.42	10.83	58.65	10.38	< .001	.54
RC2	57.16	12.21	50.88	10.98	< .001	.54
RC3	58.40	9.54	55.65	9.07		
RC4	53.77	8.12	52.90	9.99		
RC6	61.52	11.17	58.09	11.64		
RC7	65.31	11.36	55.92	11.22	< .001	.83
RC8	60.22	9.90	58.13	12.14		
RC9	55.61	9.90	55.43	11.11		
MLS	62.18	8.31	57.62	8.64	.001	.54
GIC	63.19	16.22	54.88	13.24	.001	.56
HPC	61.06	13.49	55.02	10.94		
NUC	60.04	12.50	59.10	10.72		
COG	65.89	13.52	59.69	11.09	.001	.50
SUI	57.85	20.90	51.89	14.19		
HLP	58.92	12.29	51.83	10.46	< .001	.62
SFD	66.38	10.89	55.52	12.41	< .001	.93
NFC	62.94	10.19	56.35	10.30	< .001	.64
STW	65.72	10.84	57.40	11.42	< .001	.75
AXY	70.15	15.91	57.70	14.60	< .001	.82
ANP	60.12	8.70	53.51	10.47	< .001	.69
BRF	60.89	13.75	55.80	12.75		
MSF	49.00	8.67	47.95	7.11		
JCP	49.03	7.72	49.24	9.44		
SUB	55.82	10.91	53.09	12.90		
AGG	53.49	9.55	51.96	11.20		
ACT	59.45	14.12	56.62	13.32		
FML	56.47	10.86	52.79	10.07		
IPP	48.88	11.59	46.73	9.17		
SAV	47.98	11.21	48.06	10.68		
SHY	52.98	9.99	50.77	9.87		
DSF	53.45	10.71	55.23	12.40		
AGGR-r	51.36	11.08	53.40	11.24		
PSYC-r	58.87	10.14	56.59	11.83		
DISC-r	51.26	9.26	52.89	10.79		
NEGE-r	65.37	10.78	56.52	11.20	< .001	.81
INTR-r	49.62	13.33	46.95	10.54		

All scales for which Cohen's *d* is reported were found to be significantly different beyond the $p \leq .001$ level. EID (Emotional/Internalizing Dysfunction), BXD (Behavioral/Externalizing Dysfunction), THD (Thought Dysfunction), RCd (Demoralization), RC1 (Somatic Complaints), RC2 (Low Positive Emotions), RC3 (Cynicism), RC4 (Antisocial Behavior), RC6 (Ideas of Persecution), RC7 (Dysfunctional Negative Emotions), RC8 (Aberrant Experiences), RC9 (Hypomanic Activation), MLS (Malaise), GIC (Gastrointestinal Complaints), HPC (Head Pain Complaints), NUC (Neurological Complaints), COG (Cognitive Complaints), SUI (Suicidal/Death Ideation), HLP (Helplessness/Hopelessness), SFD (Self-Doubt), NFC (Inefficacy), STW (Stress/Worry), ANX (Anxiety), ANP (Anger Proneness), BRF (Behavior-Restricting Fears), MSF (Multiple Specific Fears), JCP (Juvenile Conduct Problems), SUB (Substance Abuse), AGG (Aggression), ACT (Activation), FML (Family Problems), IPP (Interpersonal Passivity), SAV (Social Avoidance), SHY (Shyness), DSF (Disaffiliativeness), AGGR-r (Aggressiveness-Revised), PSYC-r (Psychoticism-Revised), DISC-r (Disconstraint-Revised), NEGE-r (Negative Emotionality/Neuroticism-Revised), INTR-r (Introversion/Low Positive Emotionality-Revised)

Discussion

The current study aimed to examine the associations between college students' MMPI-2-RF scores and ED symptoms and behaviors. As hypothesized, experiencing ED symptoms, as measured by the overall subthreshold ED variable and the individual EDE-Q subscales, was associated with emotional/internalizing dysfunction. For example, MMPI-2-RF Scales measuring emotional/internalizing dysfunction, demoralization, low positive emotions, dysfunctional negative emotions, helplessness/hopelessness, self-doubt, inefficacy, stress and worry, anxiety, and negative emotionality were associated with ED symptoms. Higher scores on these MMPI-2-RF Scales are associated with low morale, pessimism, low self-esteem, insecurity, hopelessness, poor coping skills, social introversion and disengagement, low energy, excessive rumination, stress reactivity, and passivity [34]. These results are consistent with previous research that has found that individuals diagnosed with an ED experience higher levels of emotional/internalizing psychopathology [8–11].

Contrary to our hypotheses, engaging in binge eating and/or compensatory behaviors was not associated with higher scores on the MMPI-2-RF Behavioral/Externalizing Dysfunction Scales. This finding may be in part due to the use of a non-clinical sample. In other words, these students may not be experiencing significant levels of externalizing dysfunction that may be related to/exacerbating clinical/full-threshold binge eating. However, engaging in binge eating and/or compensatory behaviors was found to be associated with emotional/internalizing. Binge eating was associated with MMPI-2-RF Scales measuring demoralization, dysfunctional negative emotions, inefficacy, anxiety, behavior-restricting fears, and negative emotionality/neuroticism. Higher scores on these MMPI-2-RF Scales are associated with pessimism, poor coping skills, feeling hopeless, low self-esteem, low self-efficacy, worry proneness, stress reactivity, rumination, low frustration tolerance, worry, self-criticalness, and guilt proneness [34]. Engaging in compensatory behaviors was associated with the MMPI-2-RF Scale measuring anxiety. Higher scores on this scale are associated with significant anxiety and anxiety-related problems, intrusive ideation, and sleep difficulties. The associations between binge eating and compensatory behaviors and predominantly emotional/internalizing psychopathology found in this study are consistent with some previous research that found associations between binge eating and internalizing and psychopathology [9, 11].

Somatic/cognitive dysfunction was also found to be associated with subthreshold ED symptoms, as measured by the overall subthreshold ED variable and the Shape Concerns subscale. For example, higher scores on MMPI-2-RF Scales

measuring malaise, gastrointestinal complaints, head pain complaints, and cognitive complaints were found to be associated with subthreshold ED symptoms. Higher scores on these MMPI-2-RF Scales are associated with preoccupation with and complaints about physical health problems (e.g., headaches, gastrointestinal problems, chronic pain, and memory problems), problems with sleep, low energy, low frustration tolerance, sensory problems, and difficulties in concentrating [34]. These results are consistent with previous research that found high somatic symptom severity among individuals with AN or BN [35].

Clinical implications

Given the associations among all ED symptom presentations and emotional/internalizing dysfunction, individuals experiencing subthreshold EDs may benefit from interventions aimed at increasing their coping skills (e.g., stress management) and positive emotional experiences. This may decrease their susceptibility to engaging in ED behaviors if their mood and well-being are improved. However, although these individuals may experience emotional difficulties that motivate them for treatment, their lack of positive emotions may decrease their engagement in treatment [34]. This is important not only for clinical populations, but non-clinical populations who may be experiencing significant dysfunction and/or at-risk for developing a full-threshold ED as they may benefit from an early intervention, but feel too helpless and overwhelmed to engage in services.

Associations were also found among MMPI-2-RF Scales measuring somatic/cognitive dysfunction and subthreshold ED symptom presentations. These individuals' preoccupation with their general discomfort and poor health may impede their willingness or ability to engage in treatment. As such, they may benefit from interventions focused on pain management and/or stress reduction to better manage their symptoms and improve their overall functioning and well-being [34]. Additionally, improving these symptoms may alleviate associated emotional distress and dysfunction, and subsequently reduce their ED symptoms.

Conclusions

As in previous research, our results highlight the significant prevalence of ED symptoms experienced among college students [4]. We also found similar associations between narrowly defined personality and psychopathology constructs among individuals experiencing various subthreshold ED symptoms. MMPI-2-RF Scales measuring various facets of emotional/internalizing dysfunction were found to be associated with all ED symptom presentations. Given these

Table 2 Correlations between ED symptoms and MMPI-2-RF Scales

MMPI-2-RF Scales	Risk classification						
	Subthreshold ED	Restraint	Eating concerns	Weight concerns	Shape concerns	Binge eating	Compensatory behaviors
EID	.27*	.15	.15	.27*	.33*	.14	.13
THD	.05	.04	.00	.02	.03	.13	.08
BXD	−.01	−.03	−.06	−.08	−.07	.05	.05
RCd	.25*	.16	.12	.23*	.30*	.15	.14
RC1	.18*	.10	.08	.10	.19*	.11	.13
RC2	.19*	.12	.16	.20*	.22*	.05	.10
RC3	.10	.00	.01	.10	.08	.06	.11
RC4	.03	.00	−.03	−.02	.02	.07	.06
RC6	.10	.06	.01	.09	.11*	.13	.06
RC7	.27*	.10	.13	.25*	.30*	.22*	.13
RC8	.06	.05	.02	.03	.03	.12	.08
RC9	.01	−.07	−.07	−.06	−.04	.07	.03
MLS	.18*	.12	.04	.14	.20*	.12	.11
GIC	.20*	.13	.13	.13	.22*	.17	.14
HPC	.18*	.09	.07	.10	.20*	.12	.15
NUC	.03	.03	−.02	.00	.03	.05	.03
COG	.18*	.07	.08	.15	.17*	.16	.12
SUI	.13	.16	.15	.08	.12	.04	.13
HLP	.22*	.11	.11	.21*	.27*	.16	.10
SFD	.29*	.15	.10	.25*	.33*	.12	.11
NFC	.21*	.10	.11	.21*	.20*	.20*	.12
STW	.24*	.07	.09	.23*	.30*	.16	.06
AXY	.27*	.17	.14	.24*	.27*	.21*	.17*
ANP	.21*	.03	.01	.14	.20*	.04	.12
BRF	.13	.05	.11	.05	.13	.19*	.05
MSF	.05	.04	.11	.07	.13	.11	−.06
JCP	−.01	.01	−.06	−.07	−.07	.01	.06
SUB	.07	.00	−.01	.01	.04	.12	.10
AGG	.05	−.04	−.05	.01	.02	.14	.03
ACT	.07	−.02	.03	.02	.02	.14	.06
FML	.12	.03	.02	.18*	.19*	.02	−.01
IPP	.08	.03	.14	.12	.11	.09	.03
SAV	.00	.07	.08	.08	.03	−.01	.00
SHY	.07	.01	.12	.11	.12	.05	.02
DSF	−.05	−.02	−.01	−.11	−.06	−.04	−.01
AGGR-r	−.06	−.07	−.10	−.09	−.09	−.02	−.04
PSYC-r	.07	.05	.04	.03	.02	.16	.10
DISC-r	−.05	−.03	−.07	−.11	−.11	.03	.04
NEGE-r	.26*	.05	.07	.25*	.30*	.18*	.09
INTR-r	.08	.13	.14	.14	.13	−.01	.04

Significant ($p \leq .001$) correlations in bold. EID (Emotional/Internalizing Dysfunction), BXD (Behavioral/Externalizing Dysfunction), THD (Thought Dysfunction), RCd (Demoralization), RC1 (Somatic Complaints), RC2 (Low Positive Emotions), RC3 (Cynicism), RC4 (Antisocial Behavior), RC6 (Ideas of Persecution), RC7 (Dysfunctional Negative Emotions), RC8 (Aberrant Experiences), RC9 (Hypomanic Activation), MLS (Malaise), GIC (Gastrointestinal Complaints), HPC (Head Pain Complaints), NUC (Neurological Complaints), COG (Cognitive Complaints), SUI (Suicidal/Death Ideation), HLP (Helplessness/Hopelessness), SFD (Self-Doubt), NFC (Inefficacy), STW (Stress/Worry), ANX (Anxiety), ANP (Anger Proneness), BRF (Behavior-Restricting Fears), MSF (Multiple Specific Fears), JCP (Juvenile Conduct Problems), SUB (Substance Abuse), AGG (Aggression), ACT (Activation), FML (Family Problems), IPP (Interpersonal Passivity), SAV (Social Avoidance), SHY (Shyness), DSF (Disaffiliativeness), AGGR-r (Aggressiveness-Revised), PSYC-r (Psychoticism-Revised), DISC-r (Disconstraint-Revised), NEGE-r (Negative Emotionality/Neuroticism-Revised), INTR-r (Introversion/Low Positive Emotionality-Revised)

Table 3 MMPI-2-RF relative risk ratios for ED risk

Scale	Cutoff	SR (%)	Risk if elevated (%)	Risk if not elevated (%)	RRR	95% CI
EID	75	5.7	42.9	11.0	3.90	(2.19, 6.95)
EID	70	12.5	30.4	10.3	2.96	(1.72, 5.10)
EID	65	22.3	25.6	9.1	2.81	(1.67, 4.72)
RCd	75	11.4	33.3	10.2	3.28	(1.92, 5.61)
RCd	70	16.1	28.8	9.7	2.96	(1.75, 5.00)
RCd	65	27.2	25.0	8.2	3.03	(1.8, 5.13)
RC1	75	6.5	29.2	11.7	2.50	(1.26, 4.98)
RC1	70	20.2	21.6	10.6	2.04	(1.18, 3.53)
RC1	65	31.1	21.1	9.1	2.32	(1.37, 3.92)
RC2	75	4.1	33.3	11.9	2.79	(1.29, 6.03)
RC2	70	7.6	32.1	11.2	2.87	(1.55, 5.31)
RC2	65	15.5	24.6	10.6	2.31	(1.32, 4.03)
RC7	75	10.1	29.7	10.9	2.73	(1.52, 4.88)
RC7	70	18.3	25.4	10.0	2.54	(1.49, 4.32)
RC7	65	26.2	25.0	8.5	2.95	(1.75, 4.97)
MLS	65	19.3	23.9	10.1	2.36	(1.38, 4.04)
GIC	75	10.9	32.5	10.4	3.13	(1.81, 5.41)
GIC	70	21.8	26.3	9.1	2.90	(1.72, 4.87)
GIC	65	21.8	26.3	9.1	2.90	(1.72, 4.87)
HPC	75	7.9	37.9	10.7	3.56	(2.04, 6.23)
HPC	70	15.3	28.6	10.0	2.87	(1.68, 4.88)
HPC	65	28.3	21.2	9.5	2.23	(1.32, 3.77)
COG	75	16.1	25.4	10.4	2.45	(1.42, 4.23)
COG	70	16.1	25.4	10.4	2.45	(1.42, 4.23)
COG	65	30.0	20.0	9.7	2.06	(1.21, 3.48)
SUI	75	9.5	25.7	11.4	2.25	(1.19, 4.25)
SUI	70	9.5	25.7	11.4	2.25	(1.19, 4.25)
HLP	75	4.4	43.8	11.4	3.84	(2.05, 7.19)
HLP	70	4.4	43.8	11.4	3.84	(2.05, 7.19)
HLP	65	14.4	28.3	10.2	2.78	(1.62, 4.76)
SFD	75	21.8	28.8	8.4	3.44	(2.05, 5.76)
SFD	70	21.8	28.8	8.4	3.44	(2.05, 5.76)
SFD	65	39.2	23.6	5.8	4.05	(2.21, 7.41)
NFC	75	10.4	28.9	10.9	2.65	(1.47, 4.75)
NFC	70	10.4	28.9	10.9	2.65	(1.47, 4.75)
NFC	65	22.1	23.5	9.8	2.40	(1.41, 4.06)
STW	70	21.3	28.2	8.7	3.26	(1.95, 5.46)
STW	65	39.0	23.1	6.3	3.69	(2.05, 6.65)
AXY	75	15.3	28.6	10.0	2.87	(1.68, 4.88)
AXY	70	31.6	21.6	8.8	2.46	(1.45, 4.17)
AXY	65	31.6	21.6	8.8	2.46	(1.45, 4.17)
ANP	65	23.7	20.7	10.4	2.00	(1.17, 3.42)
BRF	70	19.6	22.2	10.5	2.11	(1.23, 3.65)
BRF	65	19.6	22.2	10.5	2.11	(1.23, 3.65)
MSF	70	2.2	37.5	12.3	3.06	(1.20, 7.80)
FML	65	12.0	25.0	11.1	2.24	(1.23, 4.08)
IPP	65	6.5	29.2	11.7	2.50	(1.26, 4.98)
NEGE-r	75	8.7	28.1	11.3	2.48	(1.32, 4.65)
NEGE-r	70	15.3	26.8	10.3	2.60	(1.51, 4.48)
NEGE-r	65	29.2	25.2	7.7	3.28	(1.93, 5.59)

Table 3 (continued)

Scale	Cutoff	SR (%)	Risk if elevated (%)	Risk if not elevated (%)	RRR	95% CI
INTR-r	75	2.5	33.3	12.3	2.71	(1.03, 7.12)
INTR-r	70	5.7	28.6	11.8	2.41	(1.16, 5.03)
INTR-r	65	6.8	28.0	11.7	2.39	(1.2, 4.79)

SR selection ratio, RRR relative risk ratio, CI confidence interval. EID (Emotional/Internalizing Dysfunction), RCd (Demoralization), RC1 (Somatic Complaints), RC2 (Low Positive Emotions), RC7 (Dysfunctional Negative Emotions), MLS (Malaise), GIC (Gastrointestinal Complaints), HPC (Head Pain Complaints), COG (Cognitive Complaints), SUI (Suicidal/Death Ideation), HLP (Helplessness/Hopelessness), SFD (Self-Doubt), NFC (Inefficacy), STW (Stress/Worry), ANX (Anxiety), ANP (Anger Proneness), BRF (Behavior-Restricting Fears), MSF (Multiple Specific Fears), FML (Family Problems), IPP (Interpersonal Passivity), NEGE-r (Negative Emotionality/Neuroticism-Revised), INTR-r (Introversion/Low Positive Emotionality-Revised)

findings, regardless of symptom presentation, individuals experiencing subthreshold ED symptoms may benefit from interventions aimed at increasing their coping, mood, and self-efficacy. Reducing their emotional dysfunction may also reduce their associated ED symptoms and/or increase their ability to then engage in treatment to address their ED symptoms.

There are several limitations and suggestions for future research based on the current study. Because this sample was predominantly Caucasian females and African-American participants were found to produce more invalid MMPI-2-RF profiles, future studies should seek to replicate these findings with more diverse samples. Future research should also examine these associations within a clinical ED college student sample, which is likely to exhibit a broader range of ED symptoms and psychopathology, to determine whether similar patterns emerge. Lastly, including non-self-report information regarding ED behaviors, such as clinician ratings of ED symptoms and behaviors, may lead to more accurate symptom reporting and subsequent risk classifications and associations.

Overall, this study identified narrowly defined personality and psychopathology constructs relevant to and found across college students experiencing various subthreshold ED symptoms. The identification of these associations can provide important complementary information about comorbid symptoms that may generally exacerbate ED symptoms or interfere with ED treatment. Considering this additional information in ED screening or treatment planning could reduce the likelihood of subthreshold symptoms worsening and increase the effectiveness of ED interventions with at-risk college student populations.

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Compliance with ethical standards

Conflict of interest Katy W. Martin-Fernandez, M.A., declares that she has no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee (Kent State University Institutional Review Board in coordination with the Office of Research Compliance) and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Human and animal rights This article does not contain any studies with animals performed by any of the authors.

Informed consent Informed consent was obtained from all individual participants included in the study.

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