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Criterion and Incremental Validity of the MMPI-3 Eating Concerns Scale in a University Sample

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Abstract
The purpose of the current study was to evaluate the validity of scores on the Eating Concerns (EAT) scale on the recently released Minnesota Multiphasic Personality Inventory-3 (MMPI-3), which aims to assess for problematic eating behaviours. It was hypothesised that the EAT scale scores would be correlated with binge eating, purging, restrictive eating, weight and body shape concerns. Participants were 396 university students, who completed a series of well-validated eating disorder measures. The EAT scale scores evidenced moderate to large correlations with many symptom dimensions of EDs, including binge eating, purging, restrictive eating and weight and shape concern, thus, supporting the hypotheses and showing evidence for criterion validity. Hierarchical regression analyses also revealed incremental validity for the EAT scale above and beyond other MMPI-3 Specific Problems scale scores. Overall, scores on the new MMPI-3 EAT scale were associated with positive support for validity in a university population and seem promising as a good screening measure for eating pathology.

Keywords MMPI-3 · Eating disorders · Personality assessment · Criterion validity

Introduction

Eating disorders (EDs) constitute a global public health problem that manifests across a number of different countries and cultures (Hoek, 2016). In a US sample of adolescent females using Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5; American Psychiatric Association, 2013), 13.1% females suffered from an ED (5.2% had anorexia nervosa, AN, bulimia nervosa, BN, or binge-eating disorder, BED; and 11.5% had an unspecified or other specified eating or feeding disorders, USFED, OFED; Stice, Nathan Marti, & Rohde, 2013). In a European meta-analysis, the prevalence rates for women were 1–4% for AN, 1–2% for BN, and 1–4% for BED (Keski-Rahkonen & Mustelin, 2016). ED symptoms were found to be especially prevalent in college and university students, with 11.9% being at risk for an ED, 40.2% recording binge eating in the past month and 30.2% engaging in compensatory behaviour in the past month (Lipson & Sonneville, 2017).

EDs can be difficult to treat and have a high mortality rate. Less than 50% of AN and BN patients fully recover, about 33% show an improvement in symptoms, and 20% remain in a chronic state (Steinhausen, 2002; Steinhausen & Weber, 2009). Statistics indicating high chronicity are alarming, as EDs have high mortality rates (deaths per 1000 diagnosed individuals) of 5.1 for AN, 1.7 for BN and 3.3 for EDNOS (Arcelus et al., 2011). It is therefore important to assess EDs to allow for early intervention. A new Eating Concerns (EAT) scale has been developed for a recently released clinical assessment instrument, the Minnesota Multiphasic Psychopathology Inventory-3 (MMPI-3; Ben-Porath & Tellegen, 2020a, 2020b). This project focussed on examining the criterion and incremental validity of scores on this new scale.

Eating Disorders

The DSM-5 classifies eight "Feeding and Eating Disorders"; however, the current study focuses primarily on the symptom dimensions associated with the main three EDs: anorexia nervosa (AN), bulimia nervosa (BN) and binge-eating disorder (BED) because they were the most relevant. Each ED encompasses specific features and intensity of symptomatology; however, common symptom dimensions of people

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diagnosed with an ED include restrictive eating, purging and compensatory behaviours (e.g. vomiting, laxatives, extreme exercise), being dissatisfied with one's body shape and fear of gaining weight (American Psychiatric Association, 2013). These ED symptoms are often associated with serious medical issues (e.g. anaemia and dehydration due to starvation, irregular menstruation, and loss of dental enamel due to vomiting; American Psychiatric Association, 2013).

Individual EDs have many overlapping symptoms and high cross-over in diagnosis. Indeed, only one third of patients retain their original ED (diagnosed with DSM-5) within a 30 month period (Milos et al., 2005). It is also worth noting that although eight "Feeding and Eating Disorders" are included in DSM-5, unspecified or other specified eating or feeding disorders (USFED, OFED; previously referred to as Eating Disorder Not Otherwise Specified; EDNOS) are the most commonly diagnosed (Stice et al., 2013) indicative that the current discrete diagnostic categories do not sufficiently encompass ED-related psychopathology. Symptom overlap and diagnostic cross-over can be resolved with a dimensional symptom approach (assessment using symptom scales). Measures that emphasise symptom dimensions, for example, the Eating Pathology Symptoms Inventory (EPSI; Forbush et al., 2013), tend to have high internal consistency, reliability and good criterion and discriminant validity (Forbush et al., 2013). Rather than diagnosing EDs per strict categories (e.g. AN or BN), the EPSI uses subscales each associated with a different symptom dimension of EDs, such as restrictive eating, purging or excessive exercise. These scales can be used to inform a clinician about both symptom severity and symptom constellation, thus, resolving issues of overlapping symptoms and high cross-over. Furthermore, this symptom dimensions' approach provides more information associated with an ED in people who would otherwise be diagnosed with USFED or OFED. The new MMPI-3 EAT scale also aims to assess ED symptoms on a dimensional scale.

Minnesota Multiphasic Personality Inventory

The Minnesota Multiphasic Personality Inventory (MMPI; Hathaway & McKinley, 1943), and its subsequent revisions, have been the most frequently used personality inventories in clinical psychology practice, but have never contained a formal scale for the assessment of eating pathology. The most recent version of the MMPI family of instruments, the MMPI-3 (Ben-Porath & Tellegen, 2020a), was released in October 2020, with a new normative sample consisting of 1620 participants (810 men, 810 women), representing the projected 2020 U.S. census for age, ethnicity and education. The MMPI-3 consists of 335 items, which make up 10 validity scales measuring various forms of response bias, and 42 scales measuring substantive clinical content that are organised in hierarchical structure. Three Higher-Order (HO) scales measure broad-based domains of emotional/internalising dysfunction, behavioural/externalising dysfunction and thought dysfunction. Furthermore, there are 8 Restructured Clinical (RC) scales, 26 Specific Problem (SP) scales, and 5 Personality Psychopathology Five scales (PSY-5), measuring dimensional aspects of personality disorders. Unlike its predecessors, the MMPI-3 has a new a SP scale, the aforementioned Eating Concerns (EAT), which was developed to screen for potential problems associated with disordered eating. The scale consists of five items: two items assess binge-eating symptoms, two items assess purging behaviours (specifically vomiting), and one item assesses restrictive eating. Ben-Porath and Tellegen (2020a) expressed an expectation that elevations on EAT scale scores will encourage clinicians to consider diagnoses related to disordered eating as well as consideration of disordered eating as a target for intervention.

The MMPI-3 is an immediate revision of the MMPI-2 Restructured Form (MMPI-2-RF; Ben-Porath & Tellegen, 2008), and a substantial amount of external validity data presented in the MMPI-3 Technical Manual (Ben-Porath & Tellegen, 2020b) show that the nomological networks associated with MMPI-2-RF scale scores are virtually identical to those of their MMPI-3 counterparts. Although research on EDs using the MMPI-2-RF is limited, one study (Martin-Fernandez & Ben-Porath, 2019) examined associations between scores on the MMPI-2-RF and the Eating Disorder Examination Questionnaire (EDE-Q, Fairburn & Beglin, 1994) in a sample of 425 undergraduate students. They found that the Shape Concerns subscale scores on the EDE-Q had the highest number of correlations with the MMPI-2-RF emotional/internalising and somatic/cognitive dysfunction scale scores (e.g. Demoralisation and Gastrointestinal Complaints). The Weight Concern and Binge-eating subscale scores on the EDE-Q were correlated with scores on the emotional/internalising dysfunction on the MMPI-2-RF scale (e.g. Dysfunctional Negative Emotions and Anxiety). Compensatory behaviours were only correlated with scores on the AXY (Anxiety) scale. Restraint and Eating Concerns subscale scores were not found to be significantly correlated with scores on any of the MMPI-2-RF scales. Finally, they found that score elevations on 21 of 40 MMPI-2-RF scales predicted a heightened risk for subthreshold ED symptoms. Although the findings were promising in that scores on the psychopathology scales of the MMPI-2-RF were associated with eating pathology, their findings would unfortunately have limited utility for the actual screening of eating disorders, as high scores on these various scales would be more directly reflective of other psychopathology and maladaptive personality constructs. Therefore, with the advent of the MMPI-3, and its new EAT scale, more specificity to such measurement is encouraging. With respect to

initial research on the MMPI-3 EAT scale specifically, the MMPI-3 Technical Manual presented preliminary data on correlations for scores on this scale with scores on the Eating Attitudes Test-26 and the aforementioned EDE-Q in a university sample (Ben-Porath & Tellegen, 2020b). More specifically, these correlations were generally weak (EAT-26 scales) to moderate (EDE-Q scales) in a male subsample and generally large (EAT-26 and EDE-Q scales) in a female subsample. Moreover, the MMPI-3 Technical Manual also indicated that EAT scale scores were associated with therapists' ratings of both excessive eating and concerns about body image in a large community mental health sample.

Marek et al. (2020) conducted the only independent peer-reviewed study to this point that has evaluated the validity of scores on the new MMPI-3 EAT scale. The participants were 38 patients who underwent bariatric surgery 5 years prior to completing the instrument. The participants completed the MMPI-2-Restructured Form-Expanded (MMPI-2-RF-EX) from which the MMPI-3 scales were scored in addition to the EDE-Q. They also calculated per cent weight regain (%WR) after surgery. Consistent with the Technical Manual results, the MMPI-3 EAT scale scores were significantly correlated with scores on Eating Concerns ($r = .67$), Shape Concerns ($r = .54$) and the total score of the EDE-Q ($r = .39$). Furthermore, there were smaller correlations between the MMPI-3 EAT scale scores and scores on the EDE-Q Restraint ($r = .31$) and Weight Concerns ($r = .39$) scales. MMPI-3 EAT scale scores were also correlated with higher %WR ($r = .37$). Marek et al. (2020) concluded that the MMPI-3 EAT scale scores are associated with good convergent validity and that the MMPI-3 EAT scale is a promising instrument for the assessment of eating pathology in post-operative bariatric surgery population. Further validation is required, however, as Marek et al. (2020) used a very small sample in a highly specific context with respect to eating concerns and behaviours.

The Current Study

The main objective of the current study was to further examine the criterion validity of MMPI-3 EAT scale scores in a large university sample, in the first, to our knowledge, independent evaluation of this scale. More specifically, we examined correlations between scores on the EAT scale and different well-validated measures assessing symptoms of EDs. The focus was on ED symptom dimensions rather than specific disorders as the MMPI-3 uses a dimensional rather than categorical approach in assessing mental health. Based on the content of the five items of the EAT scale, preliminary data published in the MMPI-3 Technical Manual (Ben-Porath & Tellegen, 2020b) and Marek et al.'s (2020) findings, we developed five hypotheses. First, it was hypothesised that the EAT scale scores would be correlated with binge-eating symptoms. Second, it was hypothesised that the EAT scale would be correlated with purging behaviours. Third, it was hypothesised that the EAT scale would correlate with restrictive eating. Fourth, the EAT scale would be correlated with concerns about body shape and weight gain, as that is the prominent feature of all EDs. However, scores on the EAT scale were also hypothesised to have smaller correlations with non-purging compensatory behaviours (e.g. excessive exercise) and other ED symptom dimensions, such as muscle building and negative attitudes towards obesity (Forbush et al., 2013).

A secondary aim of this research was to evaluate the incremental validity of the EAT scale scores above and beyond scores on the other 25 SP scales against ED symptom dimensions. Because EAT scale scores evinced larger correlations with external ED criteria in the MMPI-3 Technical Manual and was explicitly designed to assess for eating pathology, we hypothesised that the EAT scale would indeed increment the other SP scales in such assessment.

Method

Participants

A sample of 399 undergraduate students from the University of Otago were recruited via the psychology research participation programme. The sample consisted of 314 females (79%), 84 males (21%), one person who identified as transgender and one person with unspecified gender. The mean age of the participants was 19.75 ($SD = 3.16$), ranging from 17 to 51. The largest ethnic groups in the sample were 75% New Zealand European/Pākehā, 16% Other Europeans (e.g., Australian, English), 12% Māori, 8% Chinese, 4% Indian, and 2% Pacifika. Thirty-eight participants (9.5%) were excluded due to invalid MMPI-3 profiles based on unscorable responding, random responding, fixed indiscriminant responding, or excessively deviant responding using criteria stated in the MMPI-3 manual (Cannot Say > 14, Combined Response Inconsistency, Variable Response Inconsistency, True Response Inconsistency > 79T, Infrequent Responses and Infrequent Psychopathology responses > 99T), leaving a final of 361 participants' data in the analysis.

Measures

Table S1 in the Online Supplemental Materials shows the descriptive statistics and internal consistency reliability estimates for all scale scores used in the current study.

The Minnesota Multiphasic Personality Inventory-3

The Minnesota Multiphasic Personality Inventory-3 (MMPI-3; Ben-Porath & Tellegen, 2020a) is a self-report inventory designed to assess a range of mental health symptoms and maladaptive personality traits. The MMPI-3 contains 335 items that are rated "True" or "False". It contains 10 validity scales which measure various forms of response bias. There are also 42 scales that measure substantive clinical content and are organised in a hierarchical structure: 3 Higher-Order scales, 8 Restructured Clinical scales, 26 Specific Problem scales and 5 PSY-5 scales. The main focus of this study was the new Specific Problem scale, the Eating Concerns scale (EAT), which was described earlier. The EAT scale contains 5 items that aim to assess eating pathology.

Eating Pathology Symptoms Inventory

The Eating Pathology Symptoms Inventory (EPSI; Forbush et al., 2013) is a self-report questionnaire that aims to measure dimensional symptoms of EDs. It contains 45 items which assess the frequency of ED symptoms within the last 4 weeks. The participants rated each item on a 5-point response scale ranging from "Never" to "Very Often". The EPSI comprises eight subscales measuring ED symptom dimensions: Body Dissatisfaction, Binge Eating, Cognitive Restraint, Purging, Restrictive Eating, Excessive Exercise, Negative Attitudes Towards Obesity and Muscle Building. Forbush et al. (2013) validated the scale finding acceptable internal consistency and test–retest reliability. Further analysis of EPSI scale scores using a large college sample demonstrated support for convergent and discriminant validity (Forbush, Wildes, & Hunt, 2014).

Eating Disorder Examination Questionnaire

The Eating Disorder Examination Questionnaire (EDE-Q; Fairburn & Beglin, 1994) is a self-report questionnaire that aims to assess behaviour and thoughts that characterise eating pathologies. It consists of 28 items that make up a Global Scale and 6 subscales: Restraint, Eating Concern, Shape Concern, Weight Concern, Binge eating and Compensatory Behaviours. The EDE-Q assesses the frequency of behavioural and cognitive ED symptoms in the last 28 days, mainly using a 7-point response scale ranging from "No Days" to "Every Day". Examining the psychometrics of the EDE-Q scores across 10 different studies indicated that EDE-Q is significantly associated with similar measures of EDs (Berg et al., 2012).

Eating Disorder Diagnostic Scale

The Eating Disorder Diagnostic Scale (EDDS; Stice, Telch, & Rizvi, 2000) is a self-report questionnaire that aims to measure AN, BN and BED based on the DSM-5 criteria. EDDS has 22 items that consist of Likert scales, YES/NO questions, frequency scores and open-ended questions regarding weight and height. The EDDS scale scores have been associated with good criterion and convergent validity, internal consistency and test–retest reliability in a large female sample (Stice et al., 2000; Stice, Fisher, & Martinez 2004).

Binge-eating Scale

The Binge-eating Scale (BES; Gormally et al., 1982) aims to measure the severity of loss of control during excessive-eating behaviour on a one-dimensional scale. The BES is a self-report questionnaire consisting of 16 items, 8 of which assess binge-eating behaviour and 8 of which assess the feelings that accompany it. Each item consists of three to four statements, each worth zero to three points. Higher scores (from a possible range of 0–46 points) are indicative of more severe loss of control over eating. Scores on the BES were found to be significantly associated with binge-eating behaviour in a study that compared food records with BES scores in 56 females with non-purging BED (Timmerman, 1999).

The Body Image: Acceptance and Action Questionnaire

The Body Image—Acceptance and Action Questionnaire (BI-AAQ; Sandoz et al., 2013) is a self-report questionnaire that aims to assess psychological flexibility with respect to body image disturbance. It consists of 12 statements that are rated on a 7-point response scale from "Never True" to "Always True". Using a large college sample, Sandoz et al. (2013) found the BI-AAQ scores to have a good internal consistency, test–retest reliability and construct validity, as the BI-AAQ scores were positively correlated with measures of psychological flexibility and negatively correlated with and also predicting disordered eating and body dissatisfaction.

Procedure

The study received ethical approval by the University of Otago Human Ethics Committee (Health). Before completing the study, all participants gave informed consent and were informed that their responses would be anonymous. Participants individually completed the series of questionnaires on computers via the Qualtrics platform in groups up to 12 under the supervision of a trained research assistant. After completing the study, participants received course credit through the research participation programme.

Data Analyses

To examine the validity of the MMPI-3 EAT scale scores, Spearman rank correlations (ρ) were calculated between such scores and scores on the ED criterion measures. Spearman rank correlations were used rather than the conventional Pearson product-moment correlation because the MMPI-3 EAT scale scores were not normally distributed. Bootstrapping (5000 replications) was used to generate standard errors to estimate bias-corrected 95% confidence intervals for each correlation for a more accurate depiction of associations between the EAT scale scores and those of external criterion measures. Because of shared method variance inflating the magnitude of correlations to an unknown degree, we only interpreted medium effect size correlations (i.e. $|\rho| \geq .30$). The threshold for statistical significance for the correlations was determined using alpha level of .002 (.05/24 criterion measures); a correlation of |.30| would be significant at this alpha level ($p < .001$), so the focus was, therefore, on effect size interpretation.

Furthermore, for subsequent analyses, we reduced the ED criterion measures to a more manageable set of variables, as similar ED symptom dimensions were being assessed across ED scales. For this purpose, we conducted a principal axis factor analysis which we rotated to simple structure using the oblique promax procedure. Parallel analysis was used to determine the number of factors to extract. The resulting higher-order symptom dimensions were used for subsequent analysis. We formed higher-order symptom dimension scales by standardising and averaging scale scores that loaded prominently on each respective factor.

A multiple regression analysis was used to determine the unique associations between various ED symptom dimensions and the MMPI-3 EAT scale, which would allow for a more distinct articulation of what the EAT scale measures when the commonality of the various ED symptom dimensions was controlled for. Specifically, MMPI-3 EAT scale scores were regressed onto the resulting ED symptom dimensions from the factor analyses. Because of the non-normal distribution of EAT scale scores, we estimated robust standard errors associated with individual beta coefficients.

Finally, we examined whether the EAT scale scores evinced incremental validity over those of other SP scales. For this purpose, hierarchical regression models were estimated in which the other 25 SP scales were in the first step and the EAT scale in the second step in predicting scores on the criterion measures.

Data analyses were completed using STATA 15 and R (version 1.2.5033).

Results

Twenty-four Spearman rank correlations (ρ) were calculated between the MMPI-3 EAT scale and the other measures (see Table 1). All correlations were positive, indicating that higher scores on these scales were associated with higher scores on the MMPI-3 EAT scale. The MMPI-3 EAT scale scores had large effect size correlations ($\rho \geq 0.5$) with (in order of magnitude) EDDS-5 Sum Score, Binge-eating scale (BES), EDE-Q Eating concerns, EDDS-5 Purging, EDDS-5 Binge Eating, EDE-Q Global Index, EPSI Binge Eating, EDE-Q Binge Eating, EDE-Q Shape Concerns, Body Image Flexibility (BI-AAQ), EDE-Q Weight Concerns, EPSI Purging and EDE-Q Restraint. The MMPI-3 EAT scale showed medium-sized correlations ($0.3 \leq \rho < 0.5$) with EDDS-5 Compensatory Behaviour, EPSI Body Dissatisfaction, EDE-Q Compensatory Behaviours, EDDS-5 Weight Fear, EPSI Cognitive Restraint and EDDS-5 Weight/Shape Concerns. Small correlations ($\rho \leq 0.3$) were observed between the scores of the MMPI-3 EAT scale and EPSI Restrictive Eating, EPSI Negative Attitudes Toward Obesity, EPSI Excessive Exercise and EDDS-5 Weight Loss, although these were not interpreted as meaningful per a priori threshold as indicated earlier. Finally, there was no evidence of association between the scores on the MMPI-3 EAT scale and EPSI Muscle Building scale and EDDS-5 Weight Loss. The results of the Spearman rank correlation are displayed in Table 1.

We conducted a principal axis factor analysis in order to reduce the ED symptoms into broader higher-order symptom dimensions for subsequent analyses. The first five observed eigenvalues were 9.853, 1.819, 1.695, 1.401 and 0.969, with the first five random-generated 95th percentile values derived from parallel analysis being 1.549, 1.448, 1.378, 1.319 and 1.274. These results supported the extraction of a four-factor solution which was rotated to simple structure using the oblique promax rotation method. The rotated factor loadings are shown in Table 2, and based on these results, the factors were labelled Body Dissatisfaction and Weight Concerns, Restrictive Eating and Purging, Binge Eating and Excessive Exercise and Muscle Building. The intercorrelations ranged from 0.38 (Binge Eating and Excessive Exercise and Muscle Building) to .63 (Body Dissatisfaction and Weight Concerns and Binge Eating), with a median $r = .54$. We formed higher-order symptom dimension scales by standardising and averaging scale scores that loaded prominently on each respective factor.

The EAT scale score rank-order correlations with the four higher-order dimensions were .57, .50, .63 and .18 (all $ps < .001$), respectively. The multiple linear regression model (see Table 3) with the four factors as predictors was

Table 1 Spearman rank-order correlations (with 95% confidence intervals) between MMPI-3 Eating Concerns Scale and other ED measures

Variable	ρ	95% CI lower	95% CI upper
EPSI Body Dissatisfaction	**0.44**	0.35	0.53
EPSI Binge Eating	**0.55**	0.47	0.63
EPSI Cognitive Restraint	**0.40**	0.31	0.49
EPSI Purging	**0.50**	0.41	0.59
EPSI Restrictive Eating	0.26	0.17	0.36
EPSI Excessive Exercise	0.13	0.03	0.23
EPSI Negative Attitudes Toward Obesity	0.14	0.03	0.24
EPSI Muscle Building	−0.02	−0.13	0.09
Binge-eating Scale (BES)	**0.64**	0.56	0.70
EDE-Q Global Index	**0.56**	0.48	0.64
EDE-Q Restraint	**0.50**	0.42	0.58
EDE-Q Eating Concerns	**0.63**	0.56	0.70
EDE-Q Shape Concerns	**0.53**	0.44	0.60
EDE-Q Weight Concerns	**0.51**	0.43	0.59
EDE-Q Binge Eating	**0.54**	0.45	0.62
EDE-Q Compensatory Behaviours	**0.42**	0.33	0.51
EDDS-5 Sum Score	**0.66**	0.59	0.72
EDDS-5 Binge Eating	**0.57**	0.48	0.66
EDDS-5 Compensatory Behaviours	**0.48**	0.40	0.56
EDDS-5 Purging	**0.58**	0.49	0.66
EDDS-5 Weight/Shape Concerns	**0.36**	0.27	0.45
EDDS-5 Weight Fear	**0.42**	0.33	0.50
EDDS-5 Weight Loss	0.09	−0.02	0.20
Body Image Flexibility (BI-AAQ)	**0.52**	0.43	0.60

Bolded correlations are ≥|.30|

CI confidence interval, *EPSI* Eating Pathology Symptoms Inventory, *EDE-Q* Eating Disorder Examination Questionnaire, *EDDS-5* Eating Disorder Diagnostic Scale for DSM-5

statistically significant, $F(4, 356) = 130.3$, $p < 0.001$. Overall, the linear combination of the four factors accounted for 59% of variance (adjusted $R^2 = .59$). The multiple regression showed that Body Dissatisfaction and Weight Concerns, Restrictive Eating and Purging and Binge-Eating factors contributed uniquely and significantly to predicting the MMPI-3 EAT scale. Binge Eating was the largest predictor ($\beta = .48$) of EAT scale scores. The Excessive Exercise and Muscle Building factor did not contribute significantly to the model.

Finally, we conducted hierarchical regression analyses to determine if the EAT scale scores accounted for incremental variance in the four ED symptom domains above and beyond those of the other 25 SP scales. These results are shown in Table 4. In every instance, EAT scale scores accounted for incremental variance above and beyond the other SP scales in the prediction of ED symptom dimensions.

Discussion

The current study aimed to validate the new MMPI-3 EAT scale by examining correlations between scores on this scale and those of other well-validated measures of EDs, as well as examining the incremental utility of EAT scale scores above those of other MMPI-3 SP scales. The findings generally supported our hypotheses. Scores on the EAT scale exhibited moderate to large correlations with scales measuring binge eating, purging, restrictive eating, and weight and shape concerns. As the MMPI-3 EAT scale contains items that assess binge eating, purging and restrictive eating, it is not surprising that moderate to large correlations were found between these symptom dimensions and the MMPI-3 EAT scale. Interestingly, there were moderate to strong correlations between scores on the MMPI-3 EAT scale and weight and shape concerns symptom dimensions which are not directly assessed by the scale. This finding might be due to weight and shape concerns being associated with other, behavioural ED symptom dimensions such as binge eating, purging or restrictive eating, and being at the core of eating pathology (Christian et al., 2019). These findings

Table 2 Rotated factor loadings for eating disorder scales

Eating Disorder Scales	Factor			
	1	2	3	4
EDE-Q Weight Concerns	**.93**			
Body Image Flexibility	**.93**			
EDE-Q Shape Concerns	**.92**			
EDDS-5 Weight/Shape Concerns	**.91**			
EPSI Body Dissatisfaction	**.83**			
EDDS-5 Weight Fear	**.75**			
EDDS-5 Compensatory Behaviours	**.49**			
EPSI Binge Eating		**.93**		
EDDS-5 Binge Eating		**.81**		
EDE-Q Binge Eating		**.79**		
Binge Eating Scale (BES)	**.35**	**.74**		
EDDS-5 Purging			**.99**	
EPSI Purging			**.93**	
EDE-Q Restraint	**.40**		**.46**	
EPSI Cognitive Restraint			**.40**	
EDE-Q Eating Concerns	**.36**		**.38**	
EPSI Restrictive Eating	.34	−.37	**.37**	
EDDS-5 Weight Loss			.32	
EPSI Negative Attitudes Toward Obesity				
EPSI Excessive Exercise				**.90**
EDE-Q Compensatory Behaviours			**.47**	**.51**
EPSI Muscle Building				**.43**

Factor loadings of |.35| appear in bold and were interpreted as meaningful. Loadings below |.30| are not shown for improved readability

EPSI Eating Pathology Symptoms Inventory, *EDE-Q* Eating Disorder Examination Questionnaire, *EDDS-5* Eating Disorder Diagnostic Scale for DSM-5

demonstrate good criterion-related validity of MMPI-3 EAT scale scores, given its correspondence with other well-validated measures of EDs.

Scores on the MMPI-3 EAT scale were also found to have small correlations with non-purging compensatory behaviours (EPSI Excessive Exercise) and other ED symptom dimensions (EPSI Negative Attitudes towards Obesity), further supporting the hypotheses. However, these small correlations were not interpreted as meaningful, as they did not meet the a priori threshold. The small correlations are understandable, as the MMPI-3 EAT scale does not include items assessing any of these symptom dimensions. Although it was expected that the EPSI Muscle Building scale would exhibit small correlation with the MMPI-3 EAT scale, no evidence of a relationship was found between these two scales. This might be due to the majority of the sample being females, who have a smaller tendency towards muscle building than males (Eisenberg, Wall, & Neumark-Sztainer, 2012). Furthermore, it is important to note that there are no items on the MMPI-3 EAT scale that aim to assess muscle building. As the MMPI-3 EAT scale assesses binge eating, purging and restrictive eating but does not assess other symptom dimensions, the above findings are not surprising.

The current findings are similar to the preliminary findings of the MMPI-3 Technical Manual (Ben-Porath & Tellegen, 2020b). Both studies show generally moderate to large correlations between the MMPI-3 EAT scale and other eating pathology measures (such as the EDE-Q that was used in both studies) in a female/predominantly female university sample, providing evidence of good criterion-related validity of the MMPI-3 EAT scale. The present findings are also similar to some degree to the Marek et al. (2020) study of post-operative bariatric patient sample. Consistent

Table 3 Multiple linear regression analysis predicting the MMPI-3 EAT scale scores from ED symptom dimensions

Variable	*b*	SE	*β*	*t*	*p*
Body Dissatisfaction and Weight Concerns	.26	.08	.16	3.11	< .001
Restrictive Eating and Purging	.56	.09	.30	6.11	< .001
Binge Eating	.74	.07	.48	11.23	< .001
Excessive Exercise and Muscle building	−.10	.07	−.05	−1.42	.160

Table 4 Hierarchical regression analyses with other SP scales in first step and EAT in second step predicting external criteria

Criteria	SP Step 1: R/R^2	EAT Step 2: ΔR^2	*p*
Body Dissatisfaction and Weight Concerns	.61/.37	.18	< .001
Restrictive Eating and Purging	.51/.26	.17	< .001
Binge Eating	.56/.27	.29	< .001
Excessive Exercise and Muscle Building	.36/.13	.03	< .001

All overall models were statistically significant, $p < .001$

SP Specific Problems scales, *EAT* Eating Concerns scale

with Marek et al. (2020), scores on the MMPI-3 EAT scale showed large correlations with the EDE-Q Eating Concerns and Shape Concerns scales; however, the findings of the current study demonstrated larger correlations with scores on the other EDE-Q scales (Weight Concerns, Binge Eating, Compensatory Behaviours, Restraint and Global Index). This discrepancy could be due to our sample being larger and more heterogeneous in regards to eating pathology than the bariatric post-operative sample Marek et al. (2020) examined.

The multiple regression analyses provided a more distinct account of the association between the MMPI-3 EAT scale scores and higher-order ED symptom dimensions. Body Dissatisfaction and Weight Concerns, Restrictive Eating and Purging, and Binge-eating factors were found to have a unique relationship with scores on the MMPI-3 EAT scale when accounting for the overlap between the four factors. This finding is not surprising, as the items on the MMPI-3 EAT scale assess binge eating, purging and restrictive eating. Body Dissatisfaction and Weight Concerns may have a unique association with the MMPI-3 EAT scale scores due to it being a core ED symptom (Christian et al., 2019). The Excessive Exercise and Muscle Building factor was not significantly associated with the MMPI-3 EAT scale, which supports the findings from our correlation analysis, where both excessive exercise and muscle building symptom dimensions were not significantly correlated with scores on the MMPI-3 EAT scale. This finding is not surprising as the MMPI-3 EAT scale does not aim to assess these symptom dimensions.

MMPI-3 EAT scale scores also evinced promising discriminant validity. The correlation and multiple regression analyses both revealed that the MMPI-3 EAT scale is associated with symptom dimensions regarding body dissatisfaction, weight and shape concerns, restrictive eating, purging and binge eating. The symptom dimensions such as negative attitudes towards obesity, excessive exercise and muscle building factor are not significantly associated with scores on the MMPI-3 EAT scale. These findings show that the MMPI-3 EAT scale scores have an association almost exclusively with symptom dimensions that are essential for diagnosing an ED from the DSM-5 perspective, which was the intended goal (Ben-Porath & Tellegen, 2020b) but does not capture other ED-related phenomena that might be important to clinicians. However, it is necessary to acknowledge that the zero-order correlations showed moderate to large correlations with symptom dimensions not assessed by the MMPI-3 EAT scale nor required for the diagnosis of an ED, such as body image flexibility. Future research is needed to further determine the discriminant validity of the MMPI-3 EAT scale scores.

The current findings also provided support for incremental validity of the EAT scale scores above and beyond those of other MMPI-3 Specific Problems scales in the measurement of ED symptom dimensions. This finding is not surprising, of course, given that the EAT scale was explicitly designed to measure eating pathology, whereas none of the other SP scales were designed for this purpose. Nevertheless, eating disorders tend to be highly correlated with internalising and other forms of psychopathology (Forbush et al., 2010, 2013) and the fact that the EAT scale statistically incremented those 25 other indicators in a regression model is viewed as quite promising.

Small representation of symptom dimensions within the MMPI-3 EAT scale could potentially impair the content validity of the scale. The MMPI-3 EAT scale only contains five items and these assess binge-eating symptoms, purging behaviours (specifically vomiting) and restrictive eating. There are, however, many other symptoms typical of EDs, such as negative emotions regarding body shape or other types of purging behaviours (e.g., use of laxatives). However, despite the small number of symptoms covered by this MMPI-3 scale, scores on the scale exhibited moderate to strong correlations with symptom dimensions that are not explicitly measured by the scale, such as concerns regarding eating, body weight and shape. Therefore, although the MMPI-3 EAT scale could potentially benefit from additional items assessing further symptom dimensions (as discussed in the following section), the under-representativeness of ED symptom dimensions in scale content does not seem to be detrimental for the validity of the scale.

Limitations

The current study was not without limitations. First, the use of a university student sample limits the generalisability of the present findings. Most of the participants were university-educated women, aged between 17 and 22 years old. The high homogeneity of the sample limits the generalisability of the current findings. Furthermore, the male-to-female ratio was too low to perform a formal comparison analysis of the findings for the two genders. Future research should aim to examine how the MMPI-3 EAT scale scores correlate with established ED measures in more diverse samples such as samples with a wider age-range, higher male-to-female ratio and a more ethnic diversity.

Second, the prevalence of eating pathology within the sample is unknown as participants were generally recruited through an undergraduate participation programme, rather than specifically recruited for eating pathology. However, previous studies have indicated that university samples (particularly women) tend to have high prevalence rates of eating pathology (Stice et al., 2013), indicating that use of a university sample in the current study may not have resulted in significant range restriction of eating pathology. Regardless, future research on the validity of MMPI-3 EAT scale scores

would benefit from using samples with known levels of eating pathology, such as patients who have been diagnosed with EDs.

At last, the current study relied on the use of monomethodology, as only self-report measures were used. Previous research indicates that self-report measures in general (regardless of what they measure) tend to be correlated with one another to some degree due to similar response styles (Cronbach, 1946). Using only self-report measures might have, therefore, inflated the observed correlations to an unknown degree, which was only able to be partly accounted for by interpreting scales with $\rho \geq |0.3|$ as meaningful. In order to further elucidate the validity of MMPI-3 EAT scale scores, future research should evaluate the MMPI-3 EAT scale against eating disorder and other relevant criteria using other methods, such as clinical interviewing and informant reports.

Implications and Conclusions

The new MMPI-3 EAT scale provides for a good screening measure for dysfunctional eating behaviour. An elevated score on the MMPI-3 EAT scale might signal a potential for an eating pathology that could be further assessed, and targeted during therapy. Most likely, scoring high on the MMPI-3 EAT scale would imply that a person experiences some behavioural symptoms of EDs, namely binge eating, purging and/or restrictive eating. Furthermore, the findings of the current study imply that an elevated score on the MMPI-3 EAT scale could also mean that a person is experiencing cognitive symptoms of an ED, such as body dissatisfaction. Given the frequency with which the MMPI-3 is likely to be used in clinical practice, having a scale that is specific to eating pathology will provide valuable information for clinicians of potential areas of concern.

Overall, scores on the new MMPI-3 EAT scale demonstrated good criterion and incremental validity as they were correlated with measures of EDs and accounted for variance in such above and beyond scores on the other MMPI-3 SP scales. The new MMPI-3 EAT scale shows promise as a useful screening tool for eating pathology and increases the measurement complexity of the MMPI-3 as it allows for the assessment of a pathology not previously encompassed by the MMPI instruments.

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Data Availability Data and analysis code are available from the corresponding author on reasonable request. It will not be stored in a public repository for test security purposes and in accordance with ethics approval.

Declarations

Conflict of interest Martin Sellbom is a paid consultant to the University of Minnesota Press, publisher of the MMPI-3, which was used in this study. He also received grant funding for this research project from the University of Minnesota Press.

Ethical Approval The University of Otago Human Ethics Committee (Health) approved this research.

Informed Consent All participants were fully informed of the research and gave implied consent to participate to maintain anonymity; all were informed and consented to their data being published.

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