

1 Abstract

2 A brief, three-factor structure for the Eating Disorder Examination-Questionnaire (EDE-Q) has
3 been identified that has stronger psychometric properties than the original four-factor EDE-Q
4 structure. However, there is a need for independent replication of the brief version in different
5 samples, and examination of how comparable the brief version is in women and men of diverse
6 ages. This study compared factor structure fit and other psychometric properties between the
7 original and brief versions in three independent samples of adults to evaluate the reliability and
8 validity of this brief version. It also examined measurement invariance across gender in a
9 middle-aged community sample. Participants included university women ($N=659$), university
10 women and men ($N=358$), and crowdsourced community women and men ($N=544$). Across
11 samples, compared to the original version the brief version demonstrated greater internal
12 consistency, somewhat less item overlap, and superior model fit in confirmatory factor analyses,
13 although some fit indices fell below recommended cut-offs. Separate confirmatory factor
14 analyses of the brief version in community women and men suggested the brief version may
15 better fit community men than women, and measurement invariance across gender for the brief
16 version was not supported for the community sample. This independent replication supports the
17 factorial validity of the brief version in three samples of students and crowdsourced community
18 adults, and highlights the importance of further examination of the psychometric properties of
19 this brief three-factor version across gender and age categories, among others sample
20 characteristics.

21 *Keywords:* eating disorders; body dissatisfaction; assessment; psychometrics;
22 questionnaire

Evaluating an Abbreviated Three-Factor Version of the Eating Disorder Examination
Questionnaire in Three Samples

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1 **1. Introduction**

2 The Eating Disorder Examination-Questionnaire (EDE-Q; Fairburn & Beglin, 1994) is a
3 widely-used eating disorder psychopathology measure that yields a Global score and four
4 subscales (Restraint, Eating Concern, Weight Concern, and Shape Concern; see Supplemental
5 Figure 1), mirroring the EDE interview. Studies have supported the EDE-Q's concordance with
6 the EDE interview (e.g., Cooper, Cooper, & Fairburn, 1989; Luce & Crowther, 1999; Reas,
7 Grilo, & Masheb, 2006), but many have failed to replicate the EDE-Q's four factors (e.g.,
8 Gideon et al., 2016; Grilo, Henderson, Bell, & Crosby, 2013; Grilo, Reas, Hopwood, & Crosby,
9 2015; Peterson et al., 2007; Waller, 2006).

10 Failure to replicate the original four factors spurred investigations of several alternative
11 solutions for the EDE interview (Byrne, Allen, Lampard, Dove, & Fursland, 2010; Mannucci et al.,
12 1997; Wade et al., 2008) and EDE-Q (Allen, Byrne, Lampard, Watson, & Fursland, 2011;
13 Gideon et al., 2016; Kliem et al., 2016). These have included: an alternative four-factor version
14 (Becker et al., 2009); a one-factor version (Pennings & Wojciechowski, 2004); a brief one-factor
15 version (Wade et al., 2008); a two-factor version (Mannucci et al., 1997); and two three-factor
16 versions (Peterson et al., 2007; Waller, 2006; Grilo et al., 2010). Notably, an abbreviated three-
17 factor version has accrued the most research support of the revised solutions, as described below.
18 Its seven items form three factors: Dietary Restraint, Shape/Weight Overvaluation, and Body
19 Dissatisfaction (see Supplemental Figure 2).

20 This brief three-factor version of the EDE-Q has received support in adults with
21 overweight and obesity (Grilo et al., 2013), college students (Grilo et al., 2015), female high
22 school and college students (Machado, Grilo, & Crosby, 2018), treatment-seeking patients with
23 eating disorder diagnoses (Machado et al., 2018), and female Mexican students and eating

1 disorder patients (Unikel Santoncini et al., 2018). Although preliminary support for this brief
2 version is promising compared to alternative versions, replication in various samples is important
3 to increase confidence in its reliability, validity, and utility in these populations. Additionally,
4 investigation by independent investigators enhances confidence in its replicability.

5 It is important to determine how comparable the brief version is in women and men. The
6 EDE-Q's initial validation and most subsequent research on the brief EDE-Q has been conducted
7 with female-only samples (Fairburn & Beglin, 1994; Machado et al., 2018; Unikel Santoncini et
8 al., 2018). Assessment of measurement invariance between genders is limited. Grilo et al. (2015)
9 found support for the brief version's measurement invariance across male and female college
10 students who averaged 20 years old. However, men and women differ in their experiences of
11 age-related changes in their bodies (McMullin & Cairney, 2004), and research has yet to
12 examine gender invariance of the brief version in adults older than college students.

13 This study evaluated the brief EDE-Q version (Grilo et al., 2013) in three adult samples.
14 We compared model fit, internal consistency, and subscale intercorrelations of the brief vs.
15 original versions, and explored whether the brief version demonstrated measurement invariance
16 across gender in a community sample. Compared to the original version, we hypothesized the
17 brief EDE-Q would demonstrate superior fit, internal consistency, and subscale intercorrelations.

18 **2. Methods**

19 **2.1. Participants**

20 **2.1.1. Canadian university women**

21 Undergraduate women ($N = 659$) received credit in a psychology course in exchange for
22 participation. Ages ($M = 20.3$, $SD = 3.2$) ranged from 17 to 52 years. Most identified as

1 Caucasian (53.0%). Body mass index (BMI; $M = 22.3$, $SD = 4.0$) ranged from 14.8 to 42.9
2 kg/m^2 .

3 **2.1.2. Canadian university women and men**

4 Undergraduates ($N = 358$) received credit in a psychology course for participating. Ages
5 ($M = 20.5$, $SD = 3.5$) ranged from 18 to 53 years. Most identified as female (80.7%) and
6 Caucasian (55.3%). BMIs ($M = 22.2$, $SD = 3.4$) ranged from 15.6 to 37.3 kg/m^2 .

7 **2.1.3. American Mechanical Turk (MTurk) women and men**

8 MTurk is an online crowdsourcing tool (Buhrmester, Kwang, & Gosling, 2011). For a
9 small payment, workers complete tasks or participate in research studies. For this study, MTurk
10 workers ($N = 544$) were required to own a U.S. bank account, have completed at least 90% of
11 previous tasks satisfactorily, and pass three attention-check questions. Compensation was \$0.50.
12 Ages ($M = 38.6$, $SD = 12.5$) ranged from 19 to 79 years. Most identified as female (70.3%) and
13 Caucasian (83.1%), and were employed full-time (55.0%). BMIs ($M = 29.3$, $SD = 8.8$) ranged
14 from 15.0 to 107.9 kg/m^2 .

15 **2.2. Procedure**

16 The study received approval from the University of Calgary Conjoint Faculties Research
17 Ethics Board (REB14-0963). Measures were administered through Qualtrics.com after
18 participants provided informed consent.

19 **2.3. Measures**

20 **2.3.1. EDE-Q**

21 The EDE-Q 6.0 (Fairburn & Beglin, 2008) is a 32-item self-report measure of eating
22 disorder psychopathology over the past four weeks. Items are rated on seven-point Likert scales.
23 Higher scores indicate greater severity/frequency of the behavior or attitude.

1 2.4. Statistical Analyses

2 Confirmatory factor analysis (CFA; Mplus version 7) was used to compare the fit of the
3 brief and original versions in each sample. Missing data were deleted listwise, as suggested with
4 $\leq 1\%$ missing data (Köse, 2014). When we achieved model convergence, we employed robust
5 maximum likelihood model estimation to adjust for skewness of EDE-Q data; when convergence
6 was not achieved using RML, maximum likelihood estimation was employed. Two incremental
7 fit tests (comparative fit index, CFI; Tucker-Lewis index, TLI) and one absolute measure of fit
8 (root mean square error of approximation, RMSEA) assessed model fit based on recommended
9 standards (Hu & Bentler, 1999): $CFI \geq 0.900$, $TLI \geq 0.900$, and $RMSEA \leq 0.080$. Alpha
10 coefficients indexed internal consistency and subscale intercorrelations assessed scale overlap.
11 Two CFAs compared the fit of the brief version separately in female and male MTurk workers,
12 using the same recommended standards as above to assess model fit. A multi-group CFA for the
13 brief version then tested measurement invariance across MTurk women and men. We followed
14 steps outlined by Vandenberg and Lance (2000), which recommend testing the following models
15 successively, with established configural invariance a requirement for evaluating successive
16 models: 1) configural invariance model: assesses if the same factor loading pattern holds for both
17 groups; 2) metric invariance model: constrains respective factor loadings of each item to
18 equality; and 3) scalar invariance model; places equality constraints on the indicator thresholds.
19 We assessed adequacy of the configural model with non-significant χ^2 and the same
20 recommended standards as above to assess model fit. Non-significant changes in the χ^2 and
21 changes in the $CFI < .010$ and/or changes in the $RMSEA < .015$ were considered to support
22 invariance at each successive step (Chen, 2007).

23 3. Results

1 **3.1. Structural Validity**

2 CFA fit indices indicated poor model fit for the original version across samples: no index
3 met recommended standards (Table 1). Indices indicated better fit for the brief version: the CFI
4 met the recommended standard across samples, and the TLI met the standard in the MTurk
5 sample and approached the recommended standard in both student samples. The RMSEA
6 demonstrated poor fit across samples for both factor structures, although in the MTurk sample,
7 RMSEA for the brief version approached recommended standards. See Supplemental Table 1 for
8 CFA factor loadings for the brief version.

9 **3.2. Internal Consistency**

10 Across samples, subscale alpha coefficients (Table 1) were similar or slightly higher for
11 the brief (ranges .85-.96; means .90-.92) than the original version (ranges .78-.93; means .84-
12 .88).

13 **3.3. Subscale Overlap**

14 In university women, university men/women, and MTurk workers, subscale
15 intercorrelations (Table 1) were lower for the brief (respective ranges .56-.78, .54-.80, .25-.76)
16 than the original version (ranges .65-.92, .69-.93, .42-.92). Across samples, intercorrelations
17 of the Weight Concern and Shape Concern subscales in the original version of the EDE-Q were
18 particularly high (.92-.93).

19 **3.5. CFAs and Measurement Invariance for MTurk Women and Men for the Brief Version**

20 CFI and TLI met recommended standards for both women and men (Table 2). RMSEA
21 met the recommended standard for men, but only approached recommended standards for
22 women (Table 2). Modification indices for men suggested allowing one pair of items to
23 correlate, but suggested five pairs of items to correlate for women. Configural measurement

1 invariance was not supported across gender; fit indices suggested poor model fit. The configural
2 model resulted in $\chi^2(28) = 648.87, p < .001, CFI = 0.808, TLI = 0.712,$ and $RMSEA = 0.287$.
3 Metric and scalar invariance models were not conducted due to poor fit of the configural
4 invariance model, in accordance with recommended stepwise procedures for testing nested
5 models in invariance analyses (Vandenberg & Lance, 2000).

6 **4. Discussion**

7 Our findings suggest a brief three-factor EDE-Q version has better psychometric
8 properties overall than the original version among university students and crowdsourced adults.
9 Findings provide additional support for the psychometrics of this brief version (Grilo et al., 2013;
10 Grilo et al., 2015). However, measurement invariance was not supported across genders in the
11 MTurk sample.

12 Across samples, CFA results demonstrated better model fit of the brief version, although
13 its fit indices were still below recommended cut-offs in certain instances (RMSEA demonstrated
14 poor fit across samples). It is suggested that RMSEA often falsely indicates poor model fit with
15 small degrees of freedom (Kenny, Kaniskan, & McCoach, 2015), and there were relatively few
16 degrees of freedom in the brief version analyses. Although we could have conducted EFAs
17 to derive an alternative model that would have provided better fit to our data, or applied
18 modification indices, we chose not to do so. Continued exploration of new factor structures on
19 different samples has already resulted in multiple alternative versions of the EDE and EDE-Q
20 (Becker et al., 2009; Grilo et al., 2010; Grilo et al., 2013; Mannucci et al., 1997; Pennings &
21 Wojciechowski, 2004; Peterson et al., 2007; Wade et al., 2008; Waller, 2006) which yield
22 optimal fit for each of the samples on which they were based, but replicability across samples
23 may be limited. Additionally, atheoretical specification searches (e.g. modification indices) often

1 result in over-fitting of models to data (Brown & Moore, 2012). Furthermore, given that
2 scores on different versions of the EDE-Q have different meanings, a large number of alternative
3 versions and factor structures of the EDE-Q could decrease the questionnaire's ability to fulfill
4 its main purpose, which is to facilitate communication about eating pathology by creating
5 reference points commonly understood by researchers and clinicians. Rather than adding to the
6 extensive array of alternative EDE-Q versions which have been developed, our view is that there
7 is a need for continued investigation of existing versions of the EDE-Q, through replication in
8 additional samples. Accordingly, we believe it is important to continue to attempt to replicate the
9 EDE-Q brief version, as it has accrued the most support of the revised versions.

10 In this study, high intercorrelations ($>.90$) of the Weight Concern and Shape Concern
11 original subscales suggest they do not measure two distinct constructs. The brief version
12 demonstrated slightly greater internal consistency and lower subscale intercorrelations than the
13 original version, suggesting less item overlap and greater efficiency. The brief version combines
14 Shape and Weight Concern items into a single scale, reducing redundancy.

15 In the MTurk sample, all indices among men met recommended standards, whereas
16 among women fit indices were lower and RMSEA was below recommended standards. These
17 findings unexpectedly suggest the brief version may better fit community men than women.
18 Modification indices also suggested allowing more items to correlate to improve model fit for the
19 female sample, suggesting greater overlap in items used to derive the three factors in women.
20 Additionally, poor model fit for configural invariance across gender in the MTurk sample
21 suggested that the constructs represented in the brief version are not measured with equivalent
22 precision across genders. While measurement invariance for gender was supported in college-
23 aged students (Grilo et al., 2015), the constructs of the brief version may be represented

1 differently among women vs. men, who collectively averaged twice the age of the college
2 students. Men differ from their female counterparts in their experience of body image as they age
3 (Clarke & Korotchenko, 2011). For instance, men demonstrate less concern with age-related
4 changes in their bodies (McMullin & Cairney, 2004), and may place less value on physical
5 appearance as they age (Paxton & Phythian, 1999). As men get older, physical functioning may
6 play a larger role in their negative feelings towards their bodies (Clarke et al., 2008), and chronic
7 illness or disability may be particularly disruptive to middle-aged men when compared to older
8 older men (Gibbs, 2008). These age-related differences may affect men and women's
9 experiences of the constructs assessed by the brief version.

10 Study strengths include replication across three samples and inclusion of moderately
11 large sample sizes, collectively diverse in age and recruitment source. Limitations include the
12 use of convenience samples; inclusion of female-only or predominantly female samples; online
13 survey administration (though three attention-checks were included); and that the original
14 version was underidentified in the university women/men sample (although we adjusted degrees
15 of freedom, and model fit statistics for the underidentified models were comparable to those of
16 the larger sample). This model underidentification is likely related to this sample's relatively
17 small sample size, as improper solutions are more common in smaller versus larger samples
18 (Chen, Bollen, Paxton, Curran, & Kirby, 2001; Gagne & Hancock, 2006). Although our findings
19 provide some support for the factorial validity of this brief EDE-Q version, further research
20 should examine sensitivity to change over time, test-retest reliability, and compare the fit of
21 structural models separately in women and men.

22 In conclusion, our findings support the brief EDE-Q's reliability, which is essential for
23 clinical and research utility (Haynes, Smith, & Hunsley, 2011). A large benefit of the brief

1 version is its shortened administration time, reducing client and research participant burden. It
2 also provides improved clinical and research utility by collapsing the Shape Concern and Weight
3 Concern subscales, which have been considered unnecessarily divided (Cooper, Cooper, &
4 Fairburn, 1989), and provides separate indices of body dissatisfaction and overvaluation. Body
5 dissatisfaction is a key risk factor in the development of eating disorders (Stice, Gau, Rohde, &
6 Shaw, 2017), and its high prevalence makes it an important target in both clinical and research
7 prevention efforts (Stice, Rohde, & Shaw, 2013). Overvaluation is a core cognitive symptom of
8 eating disorders that indicates greater psychopathology (Grilo et al., 2010). Dissatisfaction and
9 overvaluation make distinct contributions in predicting onset of disordered eating behaviours
10 (Sharpe et al., 2018). Thus, conceptualizing these constructs separately provides a clinically
11 useful distinction. Additionally, the finding that measurement invariance across gender was not
12 supported in a sample with mean age of 40 years highlights the importance of examining the
13 psychometric properties of the brief EDE-Q across various sample characteristics (e.g., weight,
14 age, and gender categories in clinical and non-clinical samples).

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12

1 Table 1. Psychometric properties of original and brief versions of the Eating Disorder Examination-Questionnaire in three independent
 2 samples

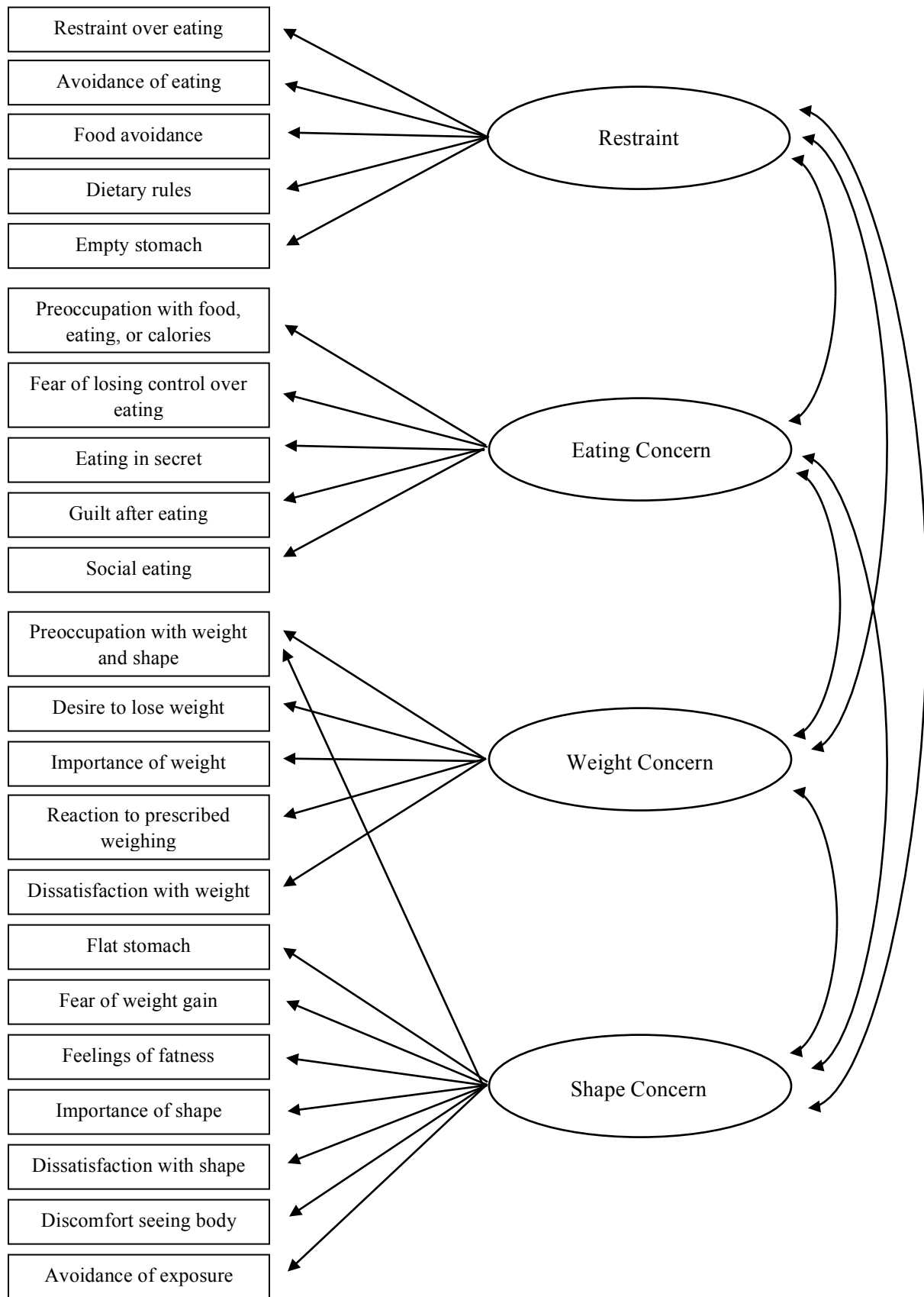
Original Four-Factor Version	University Women (n = 659)				University Men/Women (n = 358)				MTurk (n = 544)			
	df	Goodness of Fit Index			df	Goodness of Fit Index [‡]			df	Goodness of Fit Index		
		CFI	TLI	RMSEA		CFI	TLI	RMSEA		CFI	TLI	RMSEA
Maximum Likelihood	202	.840	.800	.122	202	.831	.788	.124	202	.808	.760	.124
Robust Maximum Likelihood [†]									202	.801	.773	.110
Internal consistency and subscale intercorrelations		Subscale correlations				Subscale correlations				Subscale correlations		
Subscale	α	2	3	4	α	2	3	4	α	2	3	4
1. Restraint	.85	.65*	.72*	.71*	.85	.69*	.69*	.70*	.84	.42*	.44*	.50*
2. Eating concern	.85		.78*	.77*	.84		.75*	.76*	.78		.66*	.67*
3. Shape concern	.93			.92*	.93			.93*	.90			.92*
4. Weight concern	.89				.87				.83			
Brief Three-Factor Version	University Women (n = 659)				University Men/Women (n = 358)				MTurk (n = 544)			
	df	Goodness of Fit Index			df	Goodness of Fit Index			df	Goodness of Fit Index		
		CFI	TLI	RMSEA		CFI	TLI	RMSEA		CFI	TLI	RMSEA
Maximum Likelihood	11	.948	.866	.163	11	.960	.897	.142	11	.984	.959	.094
Robust Maximum Likelihood	11	.932	.870	.147	11	.948	.902	.130	11	.976	.954	.083
Internal consistency and subscale intercorrelations		Subscale correlations				Subscale correlations				Subscale correlations		
Subscale	α	2	3		α	2	3		α	2	3	
1. Dietary restraint	.87	.56*		.58*	.85	.54*		.54*	.87	.34*		.25*
2. Shape/weight overvaluation	.93			.78*	.94			.80*	.96			.76*
3. Body dissatisfaction	.89				.90				.94			

3 Note. [†] CFA models were underidentified when using robust maximum likelihood estimation in the student samples, so maximum
 4 likelihood estimation statistics are reported in these samples. [‡]This CFA model was underidentified, with degrees of freedom adjusted
 5 for underidentification: interpret statistics with caution. CFA = Confirmatory factor analysis; MTurk = Mechanical Turk; df = degrees
 6 of freedom; CFI=Comparative Fit Index; TLI= Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation. * $p <$
 7 .001.

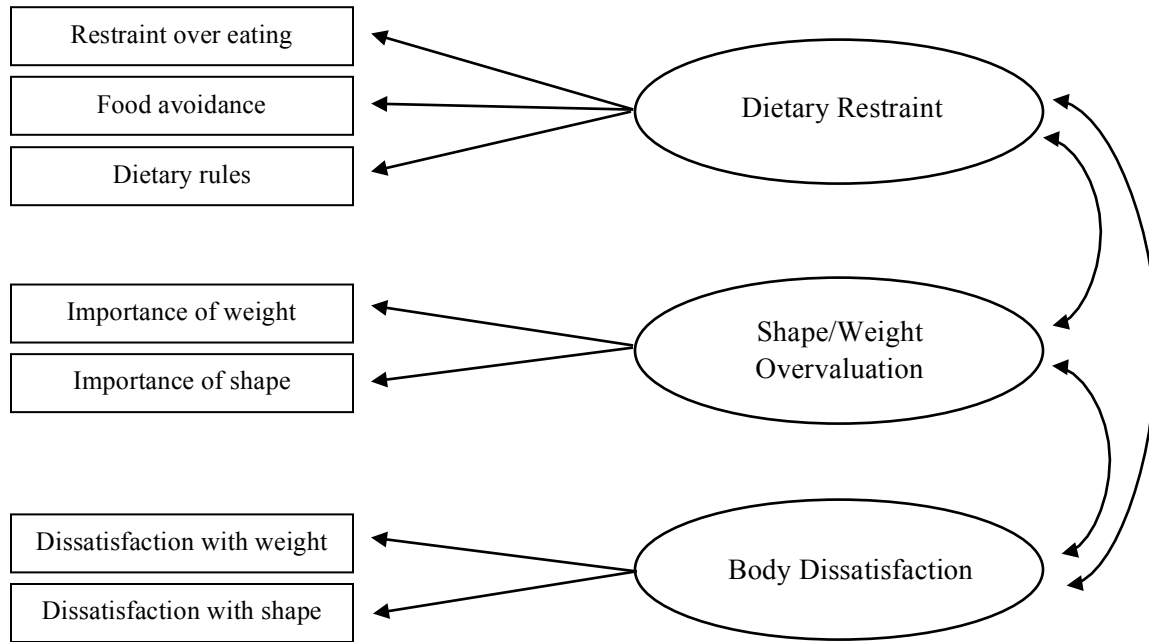
- 1 Table 2. Standardized factor loadings and fit indices for confirmatory factor analysis of the Eating Disorder Examination-
 2 Questionnaire brief version separately for women ($n = 382$) and men ($n = 156$) in the MTurk sample.

Factor:	Dietary Restraint		Shape/Weight Overvaluation		Body Dissatisfaction			
	Women	Men	Women	Men	Women	Men		
Sample: EDE-Q Item								
1. Restraint over eating	0.875	0.863						
3. Food avoidance	0.821	0.827						
4. Dietary rules	0.815	0.796						
22. Importance of weight			0.985	0.893				
23. Importance of shape			0.944	0.990				
25. Dissatisfaction with weight					0.937	0.892		
26. Dissatisfaction with shape					0.952	1.008		
	Women			Men				
	Goodness of Fit Index				Goodness of Fit Index			
CFA Indices	df	CFI	TLI	RMSEA	df	CFI	TLI	RMSEA
Robust Maximum Likelihood	11	.968	.939	.094	11	.991	.982	.055

- 3 *Note.* The item numbers in this table correspond to the original EDE-Q item numbers (Fairburn & Beglin, 1994).



Supplemental Figure 1. Factor diagram for the original four-factor version of the Eating Disorder Examination-Questionnaire (EDE-Q)



Supplemental Figure 2. Factor diagram for the brief three-factor version of the Eating Disorder Examination-Questionnaire (EDE-Q)

Supplemental Table 1. Standardized factor loadings for confirmatory factor analysis of the Eating Disorder Examination-Questionnaire brief three-factor version

Brief Three-Factor Version CFA Standardized Factor Loadings										
Factor:	Dietary Restraint			Shape/Weight Overvaluation			Body Dissatisfaction			
	Sample:	1	2	3	1	2	3	1	2	3
EDE-Q Item										
1. Restraint over eating	0.868	0.864	0.873							
3. Food avoidance	0.840	0.839	0.821							
4. Dietary rules	0.793	0.726	0.811							
22. Importance of weight				0.922	0.949	0.961				
23. Importance of shape				0.941	0.931	0.958				
25. Dissatisfaction with weight							0.875	0.905	0.924	
26. Dissatisfaction with shape							0.917	0.900	0.969	

Note. Sample 1 = University women ($n = 659$); Sample 2 = University men/women ($n = 358$); Sample 3 = MTurk ($n = 544$). The item numbers in this table correspond to the original EDE-Q item numbers (Fairburn & Beglin, 1994).

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